

The Study of Water Management System in Ancient Towns: A  
Case Study of Ayutthaya

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จากการประสบอุทกภัยครั้งใหญ่ เมื่อ พ.ศ. 2554 นครประวัติศาสตร์พระนครศรีอยุธยาได้รับความเสียหายอย่างไม่เคยมาปรากฏมาก่อนตลอดระยะเวลา 417 ปี ที่เป็นศูนย์กลางการปกครองหรือเมืองหลวงของอาณาจักร ทั้งนี้ พื้นที่ภาคกลางตอนล่างของประเทศไทยซึ่งพระนครศรีอยุธยาตั้งอยู่นั้นเป็นพื้นที่ประสบความเสี่ยงจากภัยธรรมชาติที่เกี่ยวข้องกับน้ำโดยเฉพาะอุทกภัยเนื่องมาจากสภาพแวดล้อมตามธรรมชาติของพื้นที่ซึ่งเป็นที่ราบลุ่มต่ำ วิทยานิพนธ์ฉบับนี้มีวัตถุประสงค์ในการที่จะศึกษาวิจัยเพื่อทำความเข้าใจระบบบริหารจัดการน้ำในอดีตของพระนครศรีอยุธยา กล่าวคือ การสถาปนาถาวรสร้างเมือง การพัฒนาเมืองจนมีความเจริญรุ่งเรือง ตลอดจนความสามารถในการอยู่รอดของพระนครศรีอยุธยาในสภาพพื้นที่ราบลุ่มซึ่งมีความเสี่ยงจากอุทกภัย และประยุกต์ใช้ความรู้ความเข้าใจดังกล่าวในการบริหารจัดการเพื่อลดผลกระทบจากอุทกภัยในอนาคต การวิจัยนี้จึงได้พัฒนาแนวทางบูรณาการในภาพกว้าง (Landscape Integration Approach) โดยใช้ภาพทัศน์ของสหสาขาวิชาที่เกี่ยวข้องในการศึกษาระบบบริหารจัดการน้ำของเมืองเก่าต่างๆ จากกระบวนการศึกษาซึ่งมาจากแนวทางบูรณาการในภาพกว้างพบว่า การพัฒนาระบบการบริหารจัดการน้ำในเมืองเก่าโดยเฉพาะเมืองที่ตั้งอยู่ตามริมน้ำหรือสามเหลี่ยมปากน้ำต่างๆ นั้น มีรูปแบบที่เป็นวัฏจักรคล้ายๆกัน ทั้งนี้ งานวิจัยนี้ได้แนะนำแนวทาง และกระบวนการที่พัฒนาขึ้นมาประยุกต์ใช้กับกรณีศึกษาของพระนครศรีอยุธยา ผลที่ได้รับนอกจากความเข้าใจในระบบบริหารจัดการน้ำของพระนครศรีอยุธยาที่มีความชัดเจนขึ้นแล้ว ยังแสดงให้เห็นถึงศักยภาพในการนำแนวทางบูรณาการในภาพกว้างนี้ไปใช้ในการศึกษาระบบการบริหารจัดการน้ำของเมืองเก่าอื่นๆที่มีบริบทและปัจจัยต่างๆคล้ายคลึงกับพระนครศรีอยุธยาด้วย

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Hatthaya Siriphatthanakun : The Study of Water Management System in Ancient Towns: A Case Study of Ayutthaya. Advisor: Assoc. Prof. PINRAJ KHANJANUSTHITI, Ph.D. Co-advisor: Dr DANAI THAITAKOO, Ph.D.

Due to catastrophic flood in 2011 the Historic City of Ayutthaya was severely damaged while it was never negatively impacted by flood in its 417-year-history. In fact, the lower central plain of Thailand where Ayutthaya is located is vulnerable from water - related hazards, especially flood regarding its natural settings. This research initially aims to understand what the water management system of Ayutthaya was and how the city was emerged and evolved within the flooding prone area so as to apply the knowledge to present-day circumstances. As a result, the landscape integration approach is developed by using multidisciplinary perspectives since water management system of Ayutthaya or other old towns needs the knowledge from various subjects. The methodology resulting from this approach comes across water development cycle that occurred at any settlements particularly in riverine and deltaic areas. Thus, the research adopts this approach and its methodology to Ayutthaya which covers areas beyond Ayutthaya City Island as a case study. Besides clearer understanding the water management system of Ayutthaya, the case study also helps to demonstrate how to apply the landscape integration approach to other towns and cities sharing the same conditions as Ayutthaya.



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# Chapter 1

## Introduction

### 1.1 Background

Ayutthaya is generally well-known among historians or relevant professionals as an administrative center or capital city of the Kingdom of Siam from 14th to 18th centuries. It is noted in the Statement of Outstanding Universal Value for inscribing the Historic City of Ayutthaya into the World Heritage List that the water management system of the city took advantage from its location amid three rivers and was technologically advanced and unique in the World (UNESCO., n.d.-e). However, based on the mainstream Thai history, the emergence of Ayutthaya and its development into the capital of the kingdom which is related to water management like other cities prior to its establishment is still unclear. Furthermore, the development of city to be one of the most advanced water cities in the world during its prime has rarely been studied. It appeared that Ayutthaya, a city island surrounded by three rivers and composed of canal system that formed the city plan suddenly emerged, which, logically, is hard to believe. On one hand the water management system of Ayutthaya has been described as a spectacular and intelligent system by interpretation of various pictures and maps drawn by foreigners who visited Ayutthaya in those days. It is obvious that the historical documents and recorded written by the foreigners involve politics and trades, therefore, the functionality of the system which served nearly a million populations of the city and the kingdom has never been explained and recorded. In fact, Ayutthaya is not the first city located in Southeast Asia Peninsular which developed its water management system. According to archaeological evidence, Vallibhotama S argues that, in prehistoric period, settlements, towns and cities located around Thailand had the knowledge on water management (Vallibhotama, 1997). From aerial photographs the evidence of circular moats are clearly seen. In addition, earthen dikes for controlling water flow and gigantic reservoirs for domestic uses are obviously present in many cities such Khonsawan (Chaiyaphum province). Then, around 600 CE to 1000 CE based on geographical features, settlements of ancient towns can be categorized into two

groups: the mountainous and the riverine settlements. It is obvious that the water management of these two kinds of settlement were different. For instance, in U-thong, one of major towns in that period located in the area of the present Suphanburi province, the remains of earthen reservoir for domestic uses and dike encircling the town to identify the boundary are still seen. On one hand, in the mountainous area not far from the town, earthen levee was built to control water flowing from the mountain to the area called Khok Chang Din which is surrounded by more than 10-meter-high earthen dike to keep the water during dry season. On the other hand, Nakhon Chai Si town located in the present Nakhon Pathom province, which is a riverine settlement, the canals in the town were widened to facilitate transportation in the past (Vallibhotama, 1997).

Around 1100 CE Khmer Empire extended its power to the area which is the present Northeast Thailand evident by buildings in Khmer architectural style and reservoir similar to the Baray in Angkor Wat of Cambodia, the center of Khmer Empire, for instance, Ku Phra Kona in Roi Et province. Furthermore, earthen levees have been discovered along Siao river which was a salt production area for Lawo, one of the main cities in the period. Other example of water management influenced by Khmer civilization can be seen at Phimai town situated in Nakhon Ratchasima province. The area is basically arid so a vast rectangular reservoir was built, the size of which remarkably reflects the size of the settlement. In addition, the weir at a small water channel was made, presumably to transfer water to the reservoir in Phimai. At present, this reservoir is no longer functioning but the remains of the earthen dikes are still present.

Evidence of Khmer water management with adaptation to natural setting was dominant in Sukhothai, one of the administrative towns which rose to power around 1200 CE. The town is located at foothill, rectangular-shaped, enclosed by three rings of man-made city moats. Since Sukhothai is far from river and lack underground water table so the overflow weirs called “Saritphong” were built between mountains in order to reduce water force as well as divert water from Sok Phra Ruang, the stream originated from the mountains. During inundation period, the water from Saritphong was drained to the city moats (Sihamat &

Chaopreecha, 2014). From several studies, earthen levees which connect Sukhothai to the smaller towns have been discovered, which are believed to have been roads. These levees are also perceived to have functioned as weirs for diverting water to agricultural areas.

In contemporary period, another important kingdom was the Lanna kingdom located further north from Sukhothai. From archaeological studies, it is believed that the first administrative center of the Kingdom was located at Wiang Kum Kam on eastern side of the Ping river, which lasted only 20 years before the center was moved to the western side of the Ping river at foothill of Doi Suthep mountain where Chiang Mai the present day Chiang Mai is located. The reason for moving is still unclear, however, there are several theories for explanation, the popular assumption is that Wiang Kum Kam was severely flooded thus people had been evacuated to safer area. Chiang Mai is a square-shaped town surrounded by city moat and walls. To control, collect and reduce water force from the mountain, a small settlement known as Wiang Chet Lin was built between the city and the mountain. Moreover, within the mountainous area many small weirs called Mueang Fai were constructed. The ruler who found the city also proclaimed Mang Rai Sat (King Mang Rai Book of Knowledge) which includes instructions to people to maintain and protect these weirs. It is believable that the water flow from Doi Suthep mountain was very strong that a water channel to divert the water from the city had to be built. Today this water channel still exists partially, which is known as Khlong Mae Kha.

In accordance with the consequences of water management in various ancient towns mentioned above, the water management of Ayutthaya in its glorious period might have emerged, evolved, and developed based on the systems of those cities. However, it is still questionable that, what exactly was the water management of Ayutthaya, how was it developed, how did it work, etc.

Therefore, to clarify and understand the issue, an in-depth research on Ayutthaya focusing on its water management is required.

## 1.2 Problem statement

In recent years, it is obvious that natural disasters have increasingly happened and caused damages as well as losses of lives and properties around the world and Asia Pacific region in particular. Since 2004 CE, Tsunami occurred as consequence of Indian Ocean earthquake and damaged the coastal areas from Indonesia, Thailand to the other side of the ocean including Sri Lanka and India. The disaster was followed by several others, for instance, Nargis cyclone in Myanmar in 2008 CE, Typhoon Ketsana in Laos in 2009 CE, devastated flood in Thailand in 2011 CE and Haiyan Typhoon in the Philippines. As a result, humanity has become more realized and aware of the impacts from natural disasters. Various kinds of technologies and modern knowledge have been introduced to protect, prevent or reduce the impacts of disasters. However, considering the investment on disaster protection in terms of money, time and side effects, there is still no prove that the attempts have been satisfactory since the impacts from disasters seem to be continuously more severe from time to time. On the other hand, traditional knowledge has been mentioned and discussed since there have been several cases that indigenous knowledge or local technologies can help mitigate impacts from disasters. One example is that, when Tsunami occurred in Phuket, Moken, the indigenous people, also known as sea gypsy, noticed the sea water decreasing rapidly so they could predict what would happen and knew how and where to escape. It was reported that all Moken people were safe. After the central plain of Thailand was severely flooded in 2011 CE because all flood protection systems failed in function, traditional knowledge on water management is worth considering according to the fact that the Southeast Asian Peninsula is a prone area for water-related disasters i.e. flood, drought, storm, cyclone, etc. yet the people in the past could survive and the impact from disasters to properties was not particularly recorded.

At present, Ayutthaya is a province of Thailand covering 2,556.640 square kilometers with 808,360 population. Part of Ayutthaya City Island has been inscribed on the World Heritage List. As one of the World Heritage properties, the Statement of Outstanding Universal Value of Ayutthaya declares that Ayutthaya demonstrates one of the most advanced knowledge and technology in



hydrology and water management in the world at its glorious time as mentioned above. However, several issues are still unclear, for instance, what the water management of Ayutthaya exactly was, how it functioned, if it really helped protect the city from flood. According to previous studies about Ayutthaya as a kingdom or a city, the author has found that the research and studies on water management issues are surprisingly limited. Remarkably, most of the existing studies are concentrated on politics, the usurpation of the throne among royal members or various monarchies, wars or battles with other nations and international connection in terms of trade and invasion. Among a small number of the studies focusing on other aspects are the study on geographical and urban hydrological study of the Chao Phraya River basin and related river basin (Takaya, 1969) as well as the article of Tanabe entitled “*Historical Geography of the Canal System in the Chao Phraya River Delta, from the Ayutthaya Period to the Fourth Reign of the Ratanakosin Dynasty*” (Tanabe, 1977).

Furthermore, it should also be noted that the studies on Ayutthaya are mostly monodisciplinary, for example, they focus only the historical, geological, or social, aspects. In fact, to understand the emergence, evolution and development of the water management of Ayutthaya or other ancient towns, the interdisciplinary approach is strongly needed. Moreover, it is basically insufficient to understand the water management system of any ancient towns from one single discipline since each ancient town shows their uniqueness and outstanding water management character depending on their natural settings, political regime, or other specific circumstances. The limitation of the previous studies and research, as mentioned, essentially requires the interpretation and comparative analysis. In conclusion, the more comprehensive and integrated methodology to find out and understand the water management system of Ayutthaya should be developed.

Thus, this research aims to find out the characteristics of the water management of Ayutthaya in its prime period in order to understand how Ayutthaya could survive and had never been damaged from flood by developing the methodology

that can provide rational and convincing explanation for these questions. Moreover, the methodology should be able to be implemented to the study of other ancient towns or other forms of heritage place to bring out the existing or hidden knowledge. It is also expected that the result of this research will help demonstrate how the heritage, which is the historic city of Ayutthaya in this study, can serve the present-day circumstances. That is why the heritage is extremely worth to be conserved.

### 1.3 Research questions

According to the limited knowledge and understanding in water management of Ayutthaya and the gaps in current research mentioned above, the research questions are raised. One main research question leads to other four main questions as follows.

- 1.3.1 How can the water management of the ancient cities within a limited number of previous research be clarified and explained rationally?
  - a) What is the methodology to study or understand water management in the ancient towns?
  - b) Is there already proper methodology?
  - c) Which disciplines should be used to study water management in the ancient towns?
- 1.3.2 What was water management in the ancient towns?
  - a) How was the management emerged and developed?
  - b) What were the management techniques?
  - c) Did the water management in the ancient towns really work, how and why it worked?
- 1.3.3 What is physical evidence of water management in the ancient towns?
  - a) How did the management change the landscape?
- 1.4.4 Why was the water management built?
  - a) How did human in those days know how to manage water?

b) Was the knowledge in water management adopted or adapted from other towns?

1.4.5 Did geological, geomorphological and hydrological conditions reflect water management system in the ancient towns?

a) How have these natural factors affecting the water management system?

#### **1.4 Objectives**

1.4.1 To develop the rational and convincing methodology for the study of water management of ancient towns or heritage places.

1.4.2 To explore the water management of Ayutthaya in its prosperous period which is claimed to be one of the most technological advanced systems in the world.

#### **1.5 Hypothesis**

From historical documents and archaeological studies, it is claimed that Ayutthaya had never been damaged by flood even though, based on historical records, the flood was so powerful that it could drive away the troop of the enemy blockading the Ayutthaya City Island. Furthermore, it is convinced that people in Ayutthaya period took several advantages from being able to control water because they had highly advanced knowledge in hydrology. Therefore, one could say that Ayutthaya was the water city because canals were found throughout the whole City Island. Considering the principal structures of the city, it can be said that the city was not actually wet since people lived dry during flooding period. The author would surmise that Ayutthaya was a wet-feet city. The city moat and walls were not built to protect the city from flood. Instead, flood water was allowed to let in the city at a certain level so water force would not be too strong. It is believed that people in Ayutthaya knew how to drain the flood water out of the city before it could make daily life difficult. In addition, to clarify and understand the water management system in Ayutthaya period the integration of information on geomorphology, hydrology, history, anthropology, and landscape archaeology should be combined and analyzed.

## 1.6 Delimitation and limitation

- 1.6.1 This dissertation entitles “*Developing Landscape Integration Approach to Understand Water Management System in Ancient Towns: the Case Study of Ayutthaya*”. It aims to find the methodology on how to understand the water management in the ancient towns that may be implemented to present day circumstances. Water management system of Ayutthaya in its prime period was used as a case study. Therefore, it is necessary to also acknowledge how the system was developed.
- 1.6.2 The ancient towns in this dissertation refer to the settlements which emerged or established in the past and still continues until present day. Some circumstances the towns are also recognized or called “the old towns”.
- 1.6.2 The study defines what water management was in the ancient towns located particularly in delta plains by comparing to other ancient towns in the major cultural areas and to water management at present. Then the water management issues to be studied were identified in order to provide the framework of this research.
- 1.6.3 The study relies on information from previous studies i.e. archaeological reports, historical books and etc. as well as chronicles, legends, archival resources, old maps, paintings, photos and aerial photos. The individual interviews and site observation were also carried out. Therefore, both primary and secondary sources of information were used.
- 1.6.4 The study focuses on Ayutthaya City Island or *Koh Muang* in Thai and its precinct. However, the whole Chao Phraya River basis and the connecting river basin were considered to understand the natural transformation while the area of the Kingdom of Siam during the glorious time of Ayutthaya, which was the kingdom’s capital, was also studied to explore how political and social factors formed the water management. In addition, in this research “Ayutthaya Kingdom” will be used instead of “the Kingdom of Siam”. Actually, it seems that the scholars in Thai history accepts that between 1350-1767 CE Ayutthaya Kingdom was also known as the Kingdom of Siam.

However, after 1767 CE, the year that Ayutthaya was defeated by the Burmese army and the capital was destroyed and deserted, the Kingdom of Siam has developed and moved its capital city to Krung Thon Buri and to Krung Rattanakosin, the present-day Bangkok, consecutively. Therefore, since this study focuses mainly on Ayutthaya during 1350 CE-1767 CE as the case study to understand its water management system, “Ayutthaya Kingdom” is the term used to emphasize the focus of this research.

1.6.5 The timeframe of this study starts from the period before the establishment of Ayutthaya to the present day but concentrates on the period that Ayutthaya was the capital city of the Kingdom of Siam. In some parts, the focused period is from the time water management might have emerged to the time when it was the most advanced and developed. Its changes and declines are observed to point out its present state as seen nowadays.

1.6.6 The spelling of Thai words in English, for proper names, place names, specific Thai ceremonies and etc. are spelled based on the owners of the names or referable sources, in other cases the spelling is based on the transcription announced by the Royal Institute of Thailand dated 11 January 1999.

## 1.7 Assumptions

1.7.1 In this dissertation Ayutthaya Kingdom means the the Kingdom of Siam from 14th century to 18th centuries, whereas Ayutthaya or City Island is the administrative center or capital city of the kingdom from 1350-1767 CE.

1.7.2 The term “the Kingdom of Siam” are used in the writing to refer to any moments before 1939 C.E. which is the year Siam was officially changed to Thailand. Accordingly, the people are called Siamese for those who lived in the Kingdom of Siam while Thai refers to the people who live in Thailand.

1.7.3 The definition of water management and water management system will be differentiated. At the beginning of this dissertation water management are

used until it can be proved whether water management or water management system should be used in case of Ayutthaya.

### 1.8 Theoretical Framework (see figure 1.1)

The landscape concept, which is a way to look at, perceive and understand any heritage places such as the ancient towns in a holistic view are used to frame and conduct this dissertation. On the basis of the inter-relation between human and nature, the water management since the ancient time is considered as the result of human's adaptation and modification to their natural environment for several purposes ranging from survival, the simplest one, irrigation, drainage to the more complicated ones e.g. water used as part of rituals or ceremonial activities.

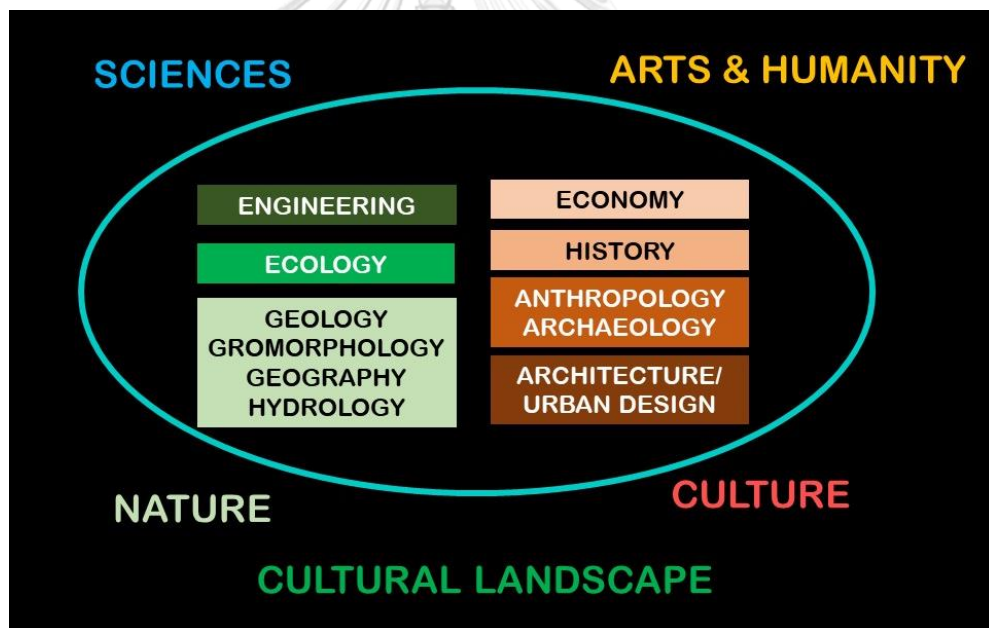


Figure 1.1 Proposed theoretical framework

Source: Author

As water management system composes of natural aspect as well as cultural components, the study of water management system from historical, land archaeological and anthropological perspectives as well as geological, geomorphological and hydrological theories carried out previously were used to

frame this dissertation based on the landscape concept which is proposed as the “landscape integration approach”.

### **1.9 Research method**

Using landscape integration approach, the methodology is proposed. The research has been worked out through literature review starting from the landscape as a concept of understanding nature and culture to the second part of the review which is multidisciplinary study on water management in ancient towns, especially the ancient civilization areas. The review carefully and thoughtfully selected the towns which are located at river basin. The emergence, development and technical issues on water management were considered. The last part of this review focuses on the previous study about water management of Ayutthaya from different disciplines as a case study.

The methodology proposed discussed the relevant approaches or studies based on literature review, the information required for the studies, their tools and expected findings. Then, after the methodology was formed, the information of case studies from the literature review, interview and field survey were filled in and manipulated by various methods such as interpretation, comparison, mapping and etc. See table below.

### **1.10 Expected Output**

- 1.10.1 The understanding or knowledge in water management system of Ayutthaya in its glorious time that is highly technologically advanced.
- 1.10.2 The methodology will be developed to clearly bring out the rational and convincing result of the research.
- 1.10.3 This dissertation will provide the methodology that can be implemented to other heritage places or ancient towns.

### **1.11 Expected Outcome**

- 1.11.1 The result of this dissertation is expected to demonstrate how people in the modern day can benefit from their heritage and that is why it should be conserved.
- 1.11.2 The study on the historic or heritage place should illustrate and enhance the consideration as the scientific and integrated study.
- 1.11.3 Landscape concept should be wider known among relevant scholars in Thailand and in Southeast Asia.





## Chapter 2

### Literature review

This chapter aims to revisit the existing information, research and studies relating to water management in ancient towns in order to identify the current gaps of the studies of water management in ancient towns located in the central plain of Thailand, focusing on Ayutthaya. It comprises four main parts, starting from current state of discipline-based studies of water management in ancient towns. In this first part, “landscape concept” as an integrated and holistic approach bringing inter-disciplinary methodology into its studies is discussed on how it has been evolved and developed over time. The initiative of English Heritage “Historic Landscape Characterisation” is one of the empirical evidence of this evolution. Then the research and studies on water-related heritage by each discipline, from both arts and humanities as well as sciences, are reviewed to clarify the methodologies, approaches and outputs of the studies of water management in ancient towns by these disciplines.

The second part of the literature review reveals the existing water-related heritage studies. The study on polder cities exemplifies the methodology developed to understand the emergence and development of water-related urban settlements whereas UNESCO Intergovernmental Hydrological Programme (IHP) conducted and published its research on water history showing another approach on how to study water management in various cultural areas or civilizations around the world. The temporal scope of this research covers ancient period to the present time. The following part is exploration on water management in various civilizations relating to the emergence and development of water management in the central plain of Thailand especially in Chao Phraya delta. It attempts to identify what the water management found in these civilizations are and how they have evolved, and their possible influences on the establishment and development of ancient towns in the central plain of Thailand. As a result, the water management knowledge could also be transmitted from these civilizations to the case study of this research, Ayutthaya. On the contrary, they may provide the understanding on how water management in ancient towns in other areas reflects the natural and cultural conditions which could occur in Ayutthaya and other ancient towns in central plain of Thailand. The last main part of this chapter

contributes to the studies relating to water management of Ayutthaya based on chronological order. It explains and discusses on the studies carried out by various scholars from several fields, ranging from the topography, geomorphology, geology to architecture, history and archaeology.

This chapter concludes with the analytical identification of current gaps of the studies and research on water management in ancient towns located especially in the central plain of Thailand. These gaps provide the fundamental concept to develop and introduce the approach and methodology for the study of water management in ancient towns presented in Chapter 3.

## **2.1 Current state of discipline-based studies of water management in ancient towns.**

### **2.1.1 Evolving of “Landscape” as a concept**

#### **1) Perception of a landscape in various contexts over time**

In general, “Landscape” is an English word which is widely used at present in various means and contexts. For this research, the relevant definitions of water management will be considered. Regarding to the Merriam Webster dictionary, landscape is “a picture representing a view of natural inland scenery or the landforms of a region in the aggregate” (<https://www.merriam-webster.com/dictionary/landscape>) whereas in Oxford Dictionary, “Landscape” is defined as the visible features of an area of land, for example, a picture representing an area of countryside. The meanings from dictionaries are of generic and maybe based on the conceptualization of the English landscape in 18th century, which is well known among scholars in the image of landscape designed to look like a beautiful picture, also known as the picturesque landscape.

Obviously, the term “cultural landscape” started to be used in the late of 20th century, especially in the field of landscape conservation, which was later called cultural heritage conservation. As widely accepted, “cultural landscape” is a landscape affected by or interacting with human actions over a span of time. However, it has been argued that in the present-day human interaction happens everywhere until natural landscape which does not have any relation, association and interaction with

human are practically non-existent. Therefore, landscape or cultural landscape have no differences and can be used interchangeably.

In Germany “landscape” as a concept has also been developed. The term “landscape” was introduced to Germany by Alexander von Humboldt around 200 years ago. It was used as a means of total character of the region and a reflection of holistic idea. On the other hand, in the late 19th century, the term “landscape architecture” was invented by Gilbert Laing Meason in 1828, which in general, it means the applied art to create a better environment in terms of functions, security and recreation while retaining our natural resources (anon., n.d.-e). Recently, according to Goodchild P (2004) it is remarked that landscape is a way that people can perceive or look at their surroundings (Siriphatthanakun, 2005). Therefore, it can be claimed that landscape has been transformed from one of the heritage types and tangible features to a concept which is an intangible feature. It is obvious that the concept has been strongly implemented in Europe as clearly seen from the establishment of European Landscape Convention. Accordingly, it can be seen that the concept of landscape is now acknowledged and are widely used as a holistic and integrated way to study or understand the emergence and changes of human culture (anon., n.d.-d) .

## **2) Natural landscape and cultural landscape**

Considering the awareness in landscape as a heritage, United Nations Educational, Scientific and Cultural Organisation or UNESCO has developed concept of heritage for its protection through its legal instruments including conventions and recommendations. One of the most concerned conventions of UNESCO state parties is the Convention concerning the protection of the world cultural and natural heritage 1972 or the World Heritage Convention according to the highest number of its member countries. Since 1972 through this convention the evolution of heritage typology is obviously seen. The convention categorizes heritage into two groups: 1) cultural heritage and 2) natural (UNESCO, 1972). However, according to the Operational Guidelines for the Implementation of the World Heritage Convention, two other categories of heritage are defined: the mixed cultural and natural heritage and cultural landscape (UNESCO, 2019). In fact, “cultural landscape” has become

recognized formally by the World Heritage Committee in 1992 as the Committee decided to include cultural landscape into the guidelines of the convention.

Since then, the cultural landscape under the world heritage context has been explored. It is defined as a "*combined works of nature and of man*" which means cultural site indicated in the Article 1 of the convention. Then the detailed definition and category are provided in the Annex 3 of the Operational Guidelines for the Implementation of the World Heritage Convention. Cultural landscape is also acknowledged as the landscape showing diverse results of the interaction between man and its natural surroundings. It comprises three categories as follow:

- 1) Landscape designed and created intentionally by man,
- 2) Organic evolved landscape including relic or fossil landscape and continuing landscape,
- 3) Associative cultural landscape justified by the immaterial evidence.

The introduction and inclusion of cultural landscape into the World Heritage Convention, on the one hand, shows the attempt of UNESCO in combining natural and cultural heritage. Also, the third category tries to go beyond the tangible aspect of the heritage. However, cultural landscape in the World Heritage context is still a typology of the heritage that can be inscribed on the World Heritage List if its outstanding universal value is successfully justified while its definition and categories initially aim to help fill the gap of the convention in terms of the protection of a site and its physical components carrying the value. Considering a number of cultural landscape in the World Heritage List, the inclusion of cultural landscape probably helps encouraging and influencing the concept of blending nature and culture but cultural landscape still falls to cultural site, not even mixed one.

In addition, it should be noted that recently the concept of and perception in cultural landscape has been focused on specific issues to reflect the attempt in combining nature and culture through human actions. Agricultural landscape demonstrates human adaptation to nature by taking advantage of its natural surroundings to produce foods and other productions for their living needs. The production process has been evolved over a span of time. Consequently, unique landscape e.g. tea forest, rice

fields, salt farm, vineyard, etc. has been recognised as heritage that is part of people's life closely connecting their nature (Siriphatthanakun, 2019).

### **3) Historic landscape characterization: from archaeological monuments to landscape**

According to Siriphatthanakun H, Historic Landscape Characterisation (HLC) is the research programme of English Heritage which is part of the Historic Buildings and Monuments Commission for England. Starting in the mid 1990s, the programme aims to characterise every piece of land of England to be an informative tool for policy making and decision makers (Siriphatthanakun, 2005). This desk-based research took advantages of an impressive number of historical cartographic documents such as old maps from various periods of hundred years. Each characteristics of English landscape was defined with description, then each data including characteristics, period, location, present character, etc. was set as each layer. The data was manipulated by geographic information system (GIS) to identify the character of each piece of land. By 2008, the whole area of England was completely characterized.

It is worth to know that Historic Landscape Characterisation (HLC) was developed under the newly introduced principles. Some are explored as they probably are worth to be applied to the study of water management in ancient towns (Clark et al., 2004).

#### 1) Focusing on present, not past.

Regarding the approach of understanding landscape introduced at the time that this research was developed, the landscape was shaped by human activities over time that makes the landscape historic, thus the historic landscape exists at present, not in the past. However, to define the historic landscape character, it is necessary to understand its previous characteristics and how they transformed.

#### 2) The scope is wider than site but landscape.

Based on the conventional approach in heritage conservation and management, the monuments and sites were protected. However, for HLC, the spatial aspect is beyond site, but landscape covers all the land. As a result, the comprehensive understanding of the landscape is found.

3) Biodiversity is result of cultural process.

Regarding the heritage conservation when this programme was initiated, natural areas were separated as another field of work while heritage conservation focused on building and archaeological features. However, as the characterisation aims to cover the whole area of England. The natural areas were included. Furthermore, the combination and integration of cultural and natural characteristics was considered to demonstrate a distinguishable character of that particular landscape.

4) Any scales of work

This principle is extremely specific for the programme as its scope covers the whole England led by English Heritage as headquarter but working by the counties. The methodology needs to be adaptable and flexible to fit with local circumstances. Therefore, the scale of work is flexible. It may be worth to consider that water management can be discussed in varied scales ranging from wells, reservoirs, canals to river basins.

5) Managing change

The research proposes that landscape dynamic changes all the time while it is the result of change as well. Historic landscape characterisation aims to neither preserve nor fossilise the landscape. In fact, its significance should be kept while the change continues and is managed. It is worth to consider that some components of water management systems such as canals are changing.

6) Integration

The output of the historic characterisation which is integrated into environmental and heritage database is used for cooperation among organisations such as English Heritage, Countryside Agency and English Nature. It is used as a supportive tool for conservation and environmental planning. In addition, characters of landscape are the result of the integration of a set of information.

### 2.1.2 Mono-disciplinary study

Considering the water issues in ancient towns including its emergence, evolution and development, function, etc., scholars in diverse disciplines have studied based on their respective viewpoints, knowledge, experience and methodology. For the discipline to be implied in the study, one may claim that hydrological engineering should be used as a core subject while other would argue that environmental study can cover more comprehensively. However, in case the water issues discussed in this research are activities happened in ancient towns and were initiated in the past, the historical study is perhaps more necessarily needed. Thus, it is worth to start from reviewing the main disciplines involving in water management in ancient towns.

According to the academic study at present, it is clearly seen that subjects in most universities are categorized into two main groups: 1) arts and humanities and 2) sciences. It is noted the discussion on disciplinary matters mainly contributes to the methodology and the expected results of each discipline in relation to water management in ancient towns.

#### 1) Historical studies in polity, urbanism, architecture

In general history is defined the study of the human's past which is documented in any written forms such as chronicles, inscriptions and etc. Anderson J.J states in A Manual of General History that History is the happenings of humanity i.e. the rise and fall of nations, politics and society of each racial group of people (Anderson, 1876). As a result, it can be seen that one of the most well-known historical research on Ayutthaya is "*The Rise of Ayudhaya*" written by Professor Dr Charnvit Kasetsiri. In his fruitful and important research, it can be claimed that the natural aspect of the setting of Ayutthaya and the period before the establishment of Ayutthaya in 1351 CE were mentioned for the very first time (Kasetsiri, 1976) after Chit Phumisak proposed his theoretical perspective on Ayothaya, the settlement prior to Ayutthaya (Phumisak, 1983). The main research question leads to the reinterpretation of the emergence of Ayutthaya and its political and social development in order to expand its kingdom and establish the Thai state. However, it is rarely mentioned about the building and development of Ayutthaya in terms of physical features, especially the water management system in the kingdom and the administrative center itself.

Nowadays, historical study of various subjects has been found such as architectural history, the study of old town and urban areas, etc. A research on water management in Ayutthaya Island was carried out by a well-known Thai scholar and architect, Sumet Jumsai na Ayudhya. His work is based on various maps drawn by foreigners who visited Ayutthaya in 18th century and mostly relied on a survey map of Phraya Boranratchathanin made between the late reign of King Rama V (1868-1910) and the reign of King Rama VI (1910-1925) when Ayutthaya was not changed so much after its decline. The study can identify the urban fabrics such as main canals, sub canals, bridges, water gates, city gates, city wall, etc. It is worth to note that most historical studies on water management focus only the city island which may provide us understanding in water-related features in the city while the working system needs to be considered at the river basin level. It is noted that the work of Sumet Jumsai na Ayudhya can also be seen in the lights of architectural or urban history which comprises the knowledge and methodology of both history and architecture as well as urbanism (Jumsai-Na-Ayudhya, 1986).

From the recent publication entitled “*A History of Ayutthaya, Siam in the Early Modern World*” of Baker C (2017) the term “historiography” is used when explaining how the history of the Chao Phraya plain to the eve of Ayutthaya’s foundation is traced through secondary sources of information from previous study (Baker & Phongpaichit, 2017). Sittiphon K (2008) referred Gottschalk L (1950) on the historical method that the history is the study of man in the past as known (Kruarattikan, 2008). But it has been argued that historical study has never achieved according to two reasons, firstly, because there are too many stories relating to man to observe, remember or be reminded. Most human activities in the past did not leave any evidence, or in some cases there are only inconvincible traces. In this light it can be claimed that history is limited as the imperfect or unreliable proofs. Secondly, the existing small amount of evidence does not reflect the object in reality but subjectivity. As a result, historians need to build up the history from their imagination based on the evidence provided as well as the most related information and interpretation to recall or reconstruct the past events. This methodology is known as writing history or historiography which has been claimed to be a scientific method. However, Charnvit K and Suchart S (1984) argues that, practically historians play a



major role in selecting or emphasizing on some specific information and ignoring the others, therefore, it can be claimed that the history that we read is based on the perspectives of the historians rather than the facts which no one at present knows.

## **2) Anthropology**

At present it is known that anthropology is a holistic study related to human beings. According to the Princess Maha Chakri Sirindhorn Anthropology Centre, anthropology can be divided into three main branches including physical anthropology, archaeology and social anthropology which is also known as cultural and social anthropology (Duangwiset & Centre., 2021).

Physical anthropology focuses on biological features which make this living creature become human such as genetic component, historical nutrition, evolution, physiology and etc. For archaeology, it is a study of human and its ancestors through archaeological excavation and scientific study. In addition, referring to the Thai Royal Academy, archaeology defines the subject as the study of antiques and ancient places (Academy., 2021).

While cultural and social anthropology involves a social aspect of humanity such as culture, politics, religions, languages and etc., in the United States of America, linguistic anthropology is another branch of this discipline. It is about the study of languages in relation to social culture including the invention and development of both written and spoken languages to understand about people who own the language, their behaviors, environment and society, for instance. It should be noted that archaeology is a subject within anthropology in the United States of America but in Europe and Asia, it is separated as an individual subject.

Apart from consideration of archaeological studies as another subject, the water management in ancient towns studied by anthropologists is obviously limited in Asia and may be also in Southeast Asia as well as Europe. The reason could be that anthropology is a new subject introduced in the early 19th century. However, in case of the study of water management in ancient towns, the anthropological points of view are interesting and probably help for better understanding on the uses of water ranging from simple human needs, state formation, ruling and governing regime to the

prosperity of state, kingdom, or empire. It is also evident that for anthropologists, water management is considered from a social perspective rather than focusing on physical structures. For example, Steward J, an anthropologist, claimed that irrigation accelerated the formation of state or kingdom (Steward, 1955). It should also be noted that for anthropological study the term water domestication is more widely found than management.

For Ayutthaya, the study on water management using anthropological approach is still rarely seen whereas the studies on people and their lives in the past in general are more present. However, it is still worth looking into some anthropological studies about Ayutthaya to find supportive information or evidence for this research.

### **3) Archaeology, Landscape archaeology**

As a big umbrella, archaeology has developed various new branches such as digital archaeology, bio archaeology, field archaeology, landscape or land archaeology which is a scientific study on how the people in the past built and used their surroundings. For the study of water management in ancient towns and water-related issues in spatial scope, landscape archaeology has been applied because the key difference of landscape archaeology from archaeology is to the concern about the relationships between material culture, nature and the alteration or medication to natural environment of human.

In Thailand, it is obvious that archaeological studies on ancient towns such as Ayutthaya have been carried out except the aspect of water management. This could be because landscape archaeology is a new subject for the country and, probably the Southeast Asian region. Currently, only the study entitled “*A New Interpretation of the Boundary of Dvaravati Shoreline on the Lower Central Plain*” is conducted by applying the landscape archaeological methodology. The study aims to redefine the shoreline of the gulf of Thailand in the Dvaravati period, around the 2<sup>nd</sup> to 10<sup>th</sup> centuries, which is related to the foundation of settlements in the lower flood plain of Chao Phraya river basin where Ayutthaya Kingdom was established (Hutangkura, 2014a).

#### **4) Geology, geomorphology and hydrology**

Geology aims to understand the earth in terms of materials it is made of, the structure and the processes action. The other discipline which is closed to geology or sub-branch of geology is geomorphology. In general, the landforms, their processes which form the character and change the landscape, sediments at the earth surface as well as the history of landscape are studied in this discipline. Considering the study of water management, hydrological study is another relevant discipline to provide a clear understanding on water issues i.e. the occurrence, distribution, movement and properties and the relationship between environment and hydrological cycle. The knowledge on hydrology can be applied to water-related problems' solutions. It is noted that water availability and control has always been an important matter for humanity since ancient times.

In relation to water management of Ayutthaya, a limited number of geomorphological, geological and hydrological studies that can contribute to the understanding on the formation and evolution of water management system of Ayutthaya have been carried out such as the study of Takaya entitled '*Topographical Analysis of the Southern Basin of the Central Plain, Thailand*' in the late 1960s and Tanabe in *Historical Geography of the Canal System in the Chao Phra River Delta from the Ayutthaya period to the fourth reign of the Ratanakosin dynasty*. It should be noted that most studies were made quite a long time ago but are still the fundamental theory used by scholars in later times. The other observation is that compared to historical study, this approach is broader and river-based study.

#### **5) Engineering**

This discipline is related to water management in a wider perspective. Obviously, it plays a main role in physical aspects of water management structural components such as embankment, dam, well, reservoirs, etc. particularly in the modern day when the scale of these structures has been enlarged and more complicated. From the existing physical remains of water management system in ancient towns, the knowledge of structural engineering has been used since the old days. On the other hand, the present environmental engineering also deals with water management in

other aspects including water resource management, water supply and wastewater disposal and treatments. Due to urban expansion, increasing population, water consumption, industrialisation, etc, the knowledge of environmental engineering has been developed to suit the present condition since the circumstances of society in the past is simpler, therefore, engineering technology was different and relied on natural conditions rather than invention (Yannopoulos et al., 2015).

As for water management in ancient towns, it is obvious that the major engineering works comprise irrigation system comprising dam, reservoir, water pump and canalisation such as Dujiangyan Irrigation System in China. This irrigation system was initially built around 256 BC and additionally constructed during several dynasties. Besides the water management structure, taking advantage from the natural topography and hydrology of the area, water from Minjiang River was diverted to irrigate Chengdu plains. The system which still functions until today also provides flood control, transportation and consumption (Zheng et al., 2020). For water management of Ayutthaya, the limited studies on engineering aspect should be noted. According to archaeological excavations, evidence of engineering works of water management system have been revealed, however, further study is still required. From the review of each discipline for the study of water management in ancient towns, to understand the water management system through a single discipline is not possible and will not yield convincing results.

## **2.2 Water-related heritage studies.**

### **2.2.1 Polder Cities: existing study based on water-based urban area.**

Hooimeijer F L (2011) studied various methodologies for his dissertation entitled the Tradition of Making Polder Cities which can be adapted to the study of water management in the ancient towns such as Ayutthaya. One of the reasons is that polder city can be perceived as the city which uses polder for the irrigation and drainage systems to manage water. Her research aims to understand the development of polder cities and to identify the clearer meaning of the Fine Dutch Tradition (Hooimeijer, 2013) which has been applied for making landscape that shows how water is used and forms an aesthetic character of the city. It can be seen that she thought the definition

was not so convincible and the systematic analysis of urban development relating to water management was intrinsically needed. She sampled the polder cities in the Netherlands but focused on Rotterdam as a living city which has changed over time.

Her hypothesis is that the Fine Dutch Tradition is an inter-discipline between engineering and urbanism which was developed and implemented in the Netherland until the industrial revolution. It is claimed that the analysis method used by architectural historians is more systematic as it is based on literature, archives, iconography, maps, and pictures as well as its critical method. Accordingly, she used this method to analyze part of her research. In addition, the history of technology and urbanism is used to identify the timeframe. She interpreted the polder city into phases according to the representation in each development stages. Each phase's duration varied on its circumstances and the domination of the development.

Hooimeijer proposed that the development of polder city can be interpreted into five stages comprising the Nature and Defense, Anticipative, Offensive, Manipulative and Adaptive Manipulative. As mentioned, she used the history of technology and urbanism as the timeframe of his research. The five stages can be identified as the period of Natural Power (Before 1500), the Power of Unity (1500-1800), the New Power (1800-1890), Accelerating Power (1890-1990) and Adaptive Power (From 1990) (Hooimeijer, 2011) .

Following Brown R, Hooimeijer referred to her methodology to study on the Cumulative Transition of Australian Cities in Relation to the Water. Her study shows logical analysis and model which are the result of Systematic Analysis. She applied the temporal ideological and technological contexts in order to frame the stages of Australian cities that move toward sustainable urban water conditions. As a result, regarding the city's characters in each period of time, Brown identified Australian Cities in Relation to the Water to six types including the 'Water Supply City', the 'Sewered City', the 'Drained City', the 'Waterways City', the 'Water Cycle City', and the 'Water Sensitive City' (see figure 2.1)(Hooimeijer, 2011).

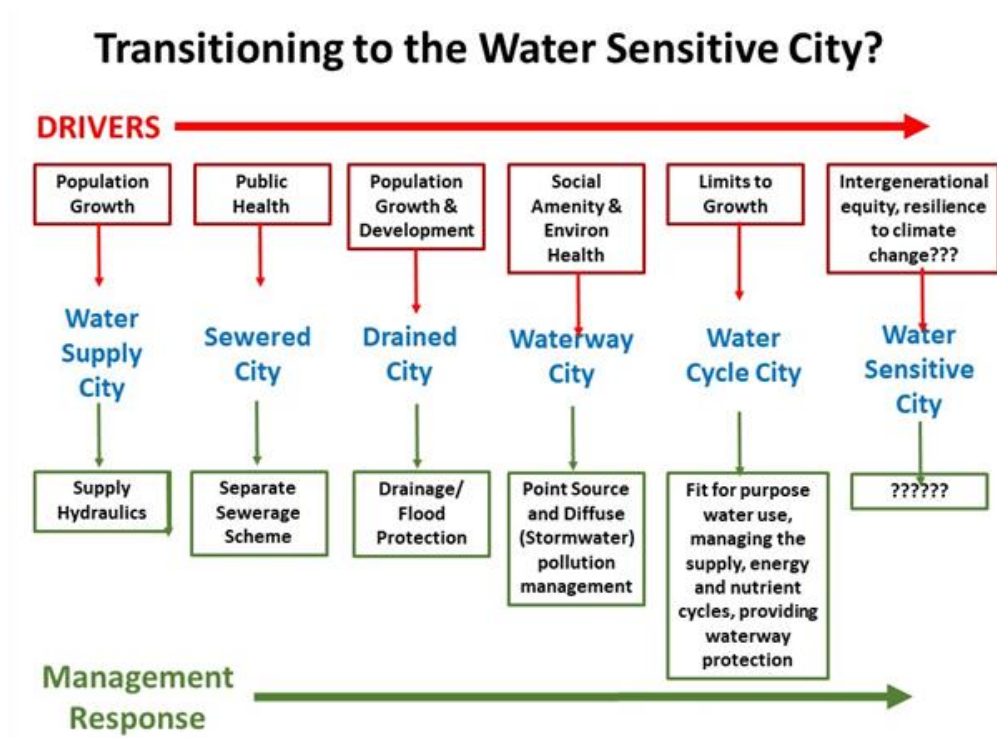


Figure 2.1 Brown's cumulative transition of Australian cities

Source: Brown (2008)

Hooimeijer also applied methodologies proposed by other two scholars. The first one is Willem van der Ham who developed the Dutch Landscape's phases based on water-state historical criteria (see figure 2.2). It is proposed that the development of the Dutch Landscape can be defined into four phases including Natural Water State (until around 1000), Defensive Water State (1000-1500), Offensive Water State (1500-1800) and Manipulative Water State (1800-present). It can be seen from the figure 00 that each state is related to the evolution of water management, for instance, the ditch to drain out water from the land marks the Natural Water State, while the induction engines and electricity represents the Manipulative Phase resulting from the industrial revolution. However, Hooimeijer argues that Van der Ham only focuses on water management and landscape perspectives. The second one is Van Dam who proposed a concept of Amphibious Culture which perhaps is human adaptation to landscape that is resilient in wet and dry condition. Ships are the main mode of transportation for amphibious culture while landscape features were built by slightly changing the nature to meet the needs of human. Based on the two methodologies adopted by Van

der Ham and Van Dam and observing Brown's approach, Hooimeijer develops her methodology for her research as mentioned above (see figure 2.2).

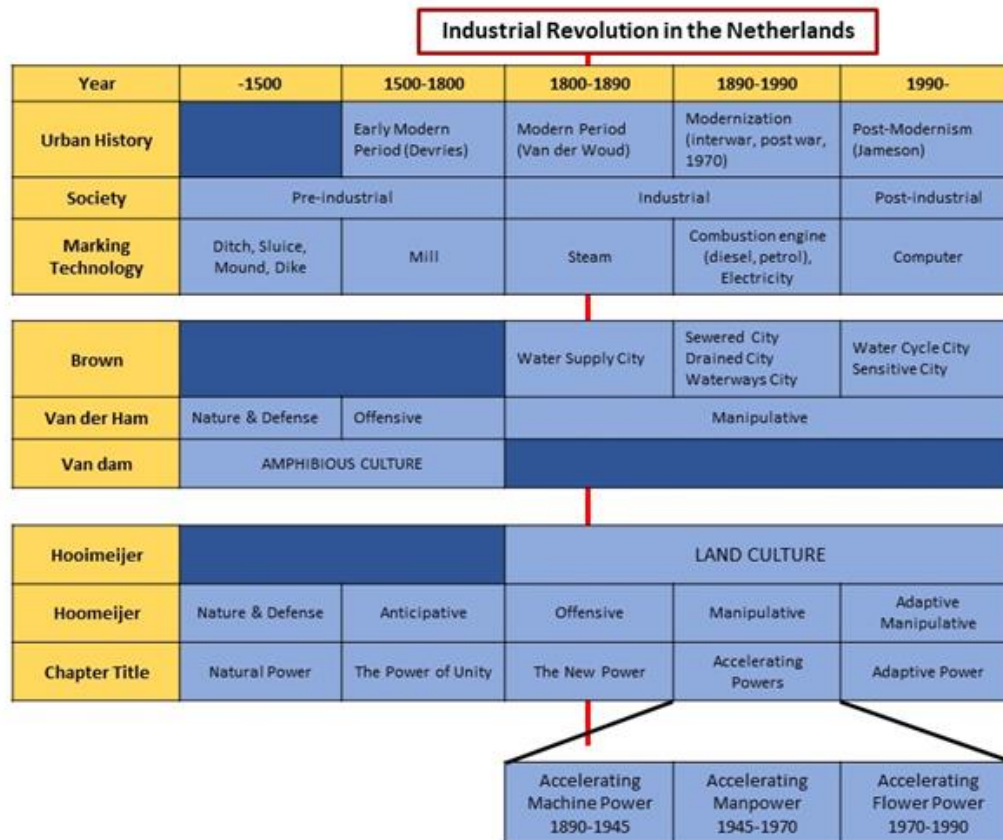


Figure 2.2 Hooimeijer's proposed methodology for his research  
Source: Hooimeijer (2011)

It can be argued that the inter-disciplinary research may not be comprehensive enough for the cities that have limited amount of information like Ayutthaya. Furthermore, the study is concentrated in the city in the country while, as proposed, in the ancient period, the water management is believed to have been a shared or exchanged knowledge between or among cultures or civilizations. Under Ayutthaya's circumstances, it will be worth to widen the methodology to be multidisciplinary. In addition, it is clearly seen that the research of Hooimeijer is based on urbanism approach and still lack the anthropological and archeological dimensions.

### **2.2.2 Water History: UNESCO Intergovernmental Hydrological Programme (IHP)**

Since the importance of water has been recognized and quoted repetitively, UNESCO (United Nations Educational, Scientific and Cultural Organization) established an Intergovernmental Hydrological Programme (IHP) to dedicate to water research, water resources management, and education and capacity building. Under the programme that lasts more than 40 years, many researches, activities and related works have been carried out (Hassan, 2004). These include one of the most outstanding research on water, namely Water History for Our Times written by Fekri Hassan, one of the most well-known experts in the field of water history.

This research is based on the idea that water management has always been part of the historical transformation in relation to social development. The transformation comprises the creation and development of water-lifting devices, irrigation and drainage system, water transport technologies, water storage techniques, etc. It can be implied from Fekri's serial essays for IHP that to understand water history is to study the civilization since water management is a key component for settlements and creation of civilizations.

Regarding the IHP essay on Water History for Our Times, Fekri wrote the history of water management by using two approaches. The first approach identifies the stage of water management in our history by punctuated and co-evolutionary theory which are based on the notion that social organization and water management technologies are related and demonstrate cultural change as well as transformation of water management elements. As a result, to understand the emergence and development of water management in a particular area or town or civilization, it is necessarily to investigate the social development both tangibly and intangibly. Additionally, it is noted that the approach is also called history-bending transformation theory.

Fekri explains that the components of this theory comprise geography/ecology/ climate, population, and knowledge. In this light it can be clearly seen that the emergence and development of water management is the result of the interaction of natural factors including geography/ecology/climate with human or population which is an agent to the creation and innovation of water science and technologies or



knowledge. Regarding this theory, Fekri claims that water management emerged in different stages of our history at each level of complication. The development of water management varied in a specific period and areas as it is also the consequences of historical, political, socio-economic factors such as religious propaganda, expansion of empire, trade, climate change, etc. Thus, he wrote the water history based on the theory without specific period but depending on the factors happening in each major cultural area of the world as follow.

- a) Early Artificial Irrigation
- b) The Age of Water –Lifting Technology
- c) The Age of Water Industry: Antecedents and Consequences
- d) The Age of Water Industry and the Making of Europe
- e) The Age of Water Science and Modernity
- f) Managing Water in a Time of Crisis

Then, in the same research, he shifts to different approach to study the history of water management. It is a paradigm-based approach which is claimed similarly to disciplinary approach. This approach includes 8 paradigms ranging from Spiritual-Religious Paradigm, Aesthetic-Recreation Paradigm, Scientific Paradigm, Ecological Paradigm, Hydraulic- Engineering Paradigm, Financial-Economic Paradigm, Governance-Managerial Paradigm and Legal-Ethical Paradigm. Fekri demonstrates the relation of historical development ranging from Hunting-gathering period, early agriculture to Early Industrial – Scientific Society, Advanced Industrial States and Global Financial System, and these water management paradigms as shown below. He also analysed the intensity of the degree of dominance of each paradigm relative to the period of time (Hassan, 2011).

On one hand the methodology of paradigm-based approach clearly shows an overall picture of water management in terms of its emergence and development in the global context from the ancient time to the present day. While various paradigms which are from different disciplines are used to understand the issues of water management in each time period. However, the methodology Fekri adopted for this part of his research can be argued that it is still incline on historical approach rather than multidisciplinary. The research additionally focuses on the main and perhaps well-

known and represented civilizations of each part of the world. For instance, the water management system of Angkor is chosen to represent Southeast Asia. But it is obvious that the Angkor civilization developed quite early and declined even before the other settlements in the region emerged. Moreover, Angkor is categorized in the same region as India and Sri Lanka while another representative from Asia is only China. Even though from many researches and studies it is accepted that, in terms of water management in ancient towns in Southeast Asian Peninsular, Chinese influence is more prominent than Indian's. Consequently, the water management in Southeast Asian ancient towns emerging in the later periods such as Sri Ksetra and other Pyu ancient cities and Bagan in Myanmar, Nanchao in Vietnam, Dvaravati cities such as U-Thong, Chiang Mai, Sukhothai and Ayutthaya in Thailand, Luang Prabang in Laos, etc. are excluded.

### **2.3 Water management in civilizations toward ancient towns.**

It is undeniable and scientifically proved that water is one of the most important and necessary objects for the existence of humanity as well as other living creatures. It is part of the four basic living factors which includes food, clothes, dwellings and medicines. Scarborough V L states that water is the main component of human body while 2/3 of the earth is covered by water in forms of oceans, seas, lakes and other water resources (Scarborough, n.d.). However, fresh water for domestic uses as well as food productivities i.e. agriculture, farming and etc. exists only 2.5% of the whole amount of water in the world. Therefore, dating back to the origin of humanity, it is significantly important to manage the limited amount of fresh water efficiently in order to survive. Consequently, it can be seen that the emergence and development of human communities from prehistoric nomads to sedentary villages, towns, cities and states have related to water management as a fundamental need of mankind.(Hoogervorst, 2012) In this research the water management in various ancient civilizations can be traced through several ancient towns, both the archaeological remains or living towns, in order to explore the means of water management as well as the development of water management techniques. Water management of ancient towns which have only limited amount of concrete evidence are explored by comparing to the water management of other ancient towns sharing

some similarities e.g. natural location, living tradition, beliefs, etc. as well as the influences or exchange with civilizations of other geographical areas (Violatti, 2014).

Although the previous part explores water management in ancient towns through the disciplinary perspective, the following part investigates the issues from another aspect, that is, chronology. It is necessary to clarify that the review in this issue follows chronological order from the prehistoric period to the beginning of industrial revolution around 1760 CE, which is also marked as the starting point of the modern world when steam machines changed people's way of life from the ancient and medieval periods. The change happened around the same time of the fall of Ayutthaya, the capital city of Siam or Ayutthaya Kingdom, in 1767 CE. The reason is that this research aims to explore the water management in the period that the technology used to manage water still relied on traditional knowledge and energy or power from humans or animals' which has limited studies and research (Hackett L 1992). The issues from the existing studies and research in water management in the ancient towns based on the chronological order is discussed as follows.

### **2.3.1 Water for survival: lives in prehistory period**

In this earliest time of humanity when social development was still at hunting-gathering as well as nomadic stages, water was managed for the survival of individuals or group of people. It is evident that man observed and learned from nature how to keep water for consumption including drinking and daily uses, therefore, many prehistoric settlements can be found near water resources such as Pong Manao in Lop Buri province of Thailand, one of the well-known archaeological sites in Southeast Asia. It is noted that the mineral lick or salt lick or "Pong" in Thai is the area containing natural minerals which are food resources for wild animals. Normally, the lick is found in the area where there are water channel flowing through underground lime layer or underground water resource and soaking water on the ground. In consequences, these areas are fertile habitats for living creatures.

Later, from the evidence found at Phu Phra Bat Historical Park, a proto-historical archaeological site located in the stone table mountain of Northeast Thailand, parts of the natural areas have been adapted to reserve water for consumption during dry

season. The chisel marks are clearly seen at the ponds which are man-made on the natural rock, in caves or under rock shelters. It can be said that the ponds were made to store rainwater. Remarkably, based on the size of these ponds, only a few people lived on the mountain because they are quite small.

Up to the present, there are several studies and research on the prehistory in Thailand and neighbouring countries focusing on various matters and issues such as funerary culture, osteoarchaeology or the study of bones, etc. but not on water management. Nevertheless, water-related issues are studied i.e. rice growing, which must involve water resources. According to the recent archaeological research, especially landscape archaeology and geo-archaeology, the evidence of rice grains found from the excavation has been interpreted to identify the land fertility including the condition of water amount due to the nature of each rice species. It is notable that, in tropical areas where the amount of rainwater is high, water might not have to be managed by man-made devices or structures because the crop cultivation during the rainy season produced enough food for consumption in small-scale communities.

### **2.3.2 Water and the emergence of ancient civilizations**

Obviously, water management started to be developed where the groups of people or settlements located at river plains, probably because they were near water resources. In consequence, most world civilizations were established along the rivers or at the river basins i.e. the Nile Valley, Tigris-Euphrates river basin, Ganges river basin and Yangtze river basin (Hassan, 2011). It can be seen that, in this period, water management was more systematic than previous times because of the larger-scale settlements. Water was reserved not only for daily uses but also for agriculture and farming. It also shows the more sophisticated knowledge of man on the natural power of water. Most major world civilizations emerged and were developed in this period as the following examples.

It is obvious that the water management was highly developed early in the arid areas. Hassan F claims that the irrigation system along the Nile River as part of Egyptian civilization testifies one of the first successes of human dating back to around 7000 years ago (Hassan, 2017). Originally, it aimed to cope with the excessive or

decreasing amount of water. Consequently, the drains were constructed to let the excessive water flow of the area while the canals were dug to distribute water to the dry area. In consequences, various water works and structures were developed including Nilometer, a structure to measure water level and clarity during inundation period, dams, canals, harbours, cisterns, aqueducts, *Sabils* or public fountains and *Qanut*. In addition, Fekri argues that only Mesopotamian civilization was comparable to the Egyptian while Indian and Chinese civilizations came consecutively.

Among the water works mentioned above, it is obvious that Qanuts can well-exemplify the geographical and scientific knowledge of the Egyptian in those days. *Qanut* literary means water channel in Persian, found in the Middle East and Maghreb to the West China and North Africa (anon., 2004). This water management technology is called differently depending on where it was built. Initially Qanuts were developed around 1,000 BCE, perhaps by the Persian. Regarding the knowledge of people in the far past, the water from aquifer lying underground has been transported to surface level at the lower areas. Several shafts were dug through the subterranean water level then the water tunnel connecting each shaft was built to deliver water to the irrigated areas (see figure 2.3). At present, Qanuts are still found in the areas influenced by the Persians, Romans and Arabs. Most Qanuts are still in functions , and some have been repaired and upgraded (Alemohammad & Gharari, 2010; Hassan, 2011; Mays, 2008; Yazdi & Khaneiki, 2017).

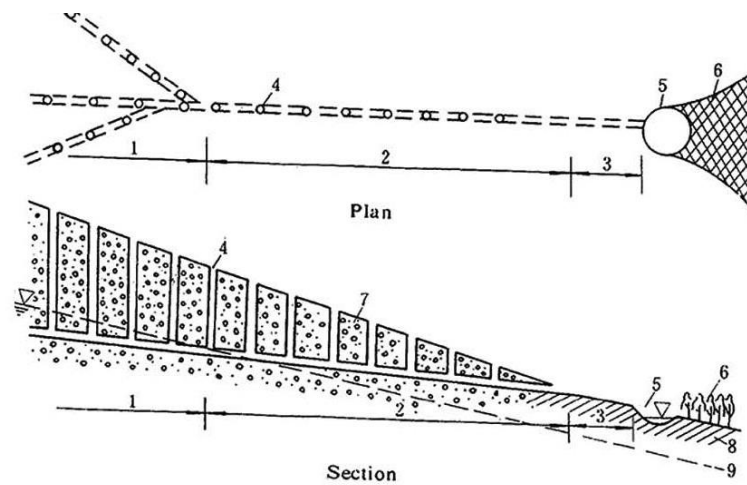


Figure 2.3 General system of Qanat

1) Infiltration part of tunnel 2) Water conveyance part of tunnel 3) Open channel 4) Vertical shafts 5) Small storage pond 6) Irrigation area 7) Sand and gravel 8) Layers of soil 9) Groundwater surface. Source: Water History Website

For the purpose, the Egyptian screw, which is claimed to be the world oldest water lifting device, was invented. It is also known as Archimedes' screw (figure 2.4). According to the Britannica Encyclopedia, this device is a spiral material within an oblique cylinder at the angle of 45 degree. The lower part dunks into the water which is risen to the upper level by rotating the spiral part. The Archimedes's screw has been claimed the prototype of man-power pumping machine in the later period (anon., n.d.-a).

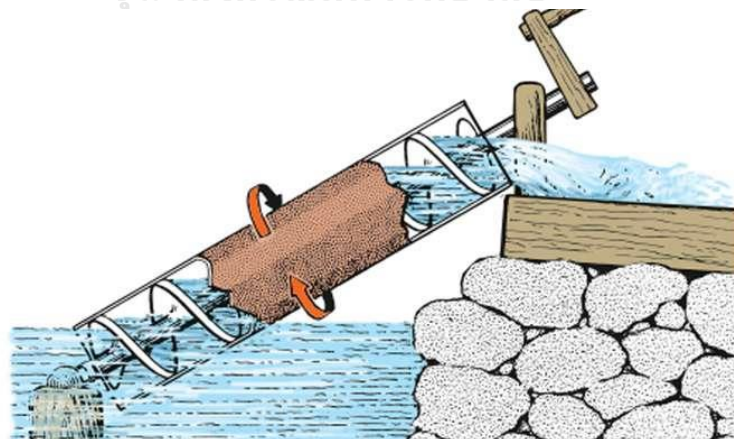


Figure 2.4 Archimedes' screw

Source: Encyclopædia Britannica, Inc.

(<https://www.britannica.com/technology/Archimedes-screw>)

In China, dating back around 256 BC, by the State of Qin, Dujiangyan was initially developed to irrigate water and control flood resulting from the Min River (Minjiang), the longest tributary of the Yangtze River, affecting Chengdu plain (see figure 2.5). The system includes the artificial levee built to divert water flow to another direction while water channels were changed to irrigate the dry areas. Due to the technology in this early period, the construction relied on local materials such as bamboo and rock. Furthermore, the cumulative knowledge derived from the observation of people in those days was implemented. For example, to change water channels, the natural stones which obstruct water flow were heated and cool until they cracked and finally were removed. The Dujiangyan irrigation system has been developed and altered over the time, and still functions at present (UNESCO., n.d.-b).

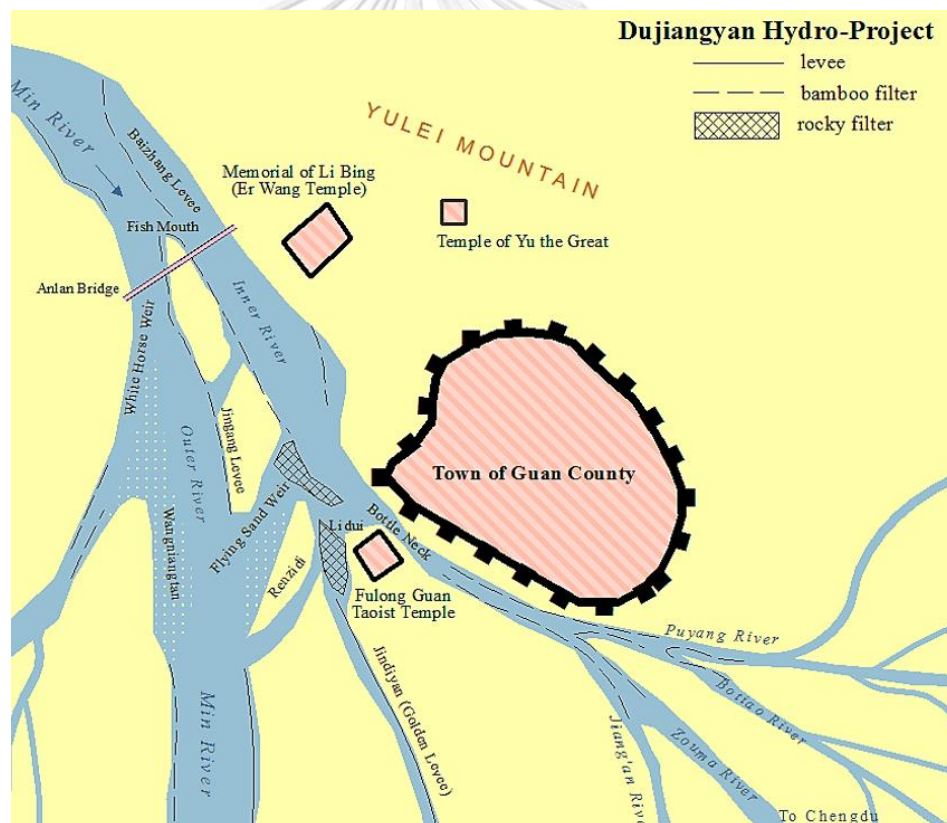


Figure 2.5 Dujiangyan Water Management System in PR China

Source: <https://en.wikipedia.org/wiki/Dujiangyan>

### 2.3.3 Water to demonstrate power and governing regime

While civilizations expanded, settlements and towns were flourished, populated and became centres of civilizations or kingdoms. Consequently, irrigation system including larger water storages, dams, as well as man-made watercourse or aqueducts were found. Comparing to previous period, irrigation and drainage systems became more advanced to ensure the food and water security of kingdoms or states . For example, ones who occupied and controlled water resources would be able to govern the cities, kingdoms, or states. Built earlier in Egyptian and Greece civilizations but has been well-known as an evidence of Roman Empire, aqueduct (see figure 2.6), a man-made water channel found in the Roman Empire was constructed to distribute water from its source to other points. Aqueduct is an open water channel structure constructed above ground like a bridge that passed through the area of Roman Empire to feed its population. However, it has been argued that the open water channel was not hygienic and contaminated, thus it became one of the reasons that the Empire collapsed (Mithen, 2010).



Figure 2.6 The remain of Roman Aqueduct at Via Apia Antica, Italy  
Source: Author's collection

Another example is the ancient Khmer civilization which was highly developed because of its advanced water engineering seen mainly in the areas ruled and



influenced by Angkor Empire such as the Angkor plain and Kulen Plateau. The water management of the Khmer is clearly developed as the irrigation system comprising artificial canals, spillways, ditches, and dikes which diverted water from the rivers to agricultural lands. While the system also helped control flood water to fill the remarkable water work of Khmer civilization, a man-made rectangular reservoir, *Baray* (Engelhardt, 1995). Nowadays a number of Barays found throughout Cambodia, central plain and northeast Thailand and parts of Lao PDR signify the trace of the Khmer civilization in these areas.

Furthermore, beyond the physical needs in this period, water management was used to intensify spiritual power of rulers or governors as the medium between human and God or supernatural beings. In some culture in the past, it was a governing strategy to apply the spiritual aspect of administration. In connection to Hinduism, the rulers of ancient Khmer empire were believed to be the incarnation of the God Vishnu. The moats surrounding temples, monuments and residential areas marked the boundaries of the sacred areas (UNESCO., n.d.-d). In addition, the spiritual dimension of water management can be seen at Vat Phou which was part of ancient Khmer Empire, now located in the present Lao PDR. The water flowed from the sacred mountain, which has the shape similar to the “Shiva Linga” when seen from the low land to the temple compound located at the terrestrial area at the foot of the mountain (see figure 2.7). Once the water passed through several rooms of the temple to the outlet, it became sacred water which were distributed to the believers. The concept of sacred water in Hinduism was highly developed and transformed to be the holy or blessed water used in ceremonies and rituals throughout mainland Southeast Asia.

For the spiritual aspect of water management, it is obvious that the water temple in Bali, Indonesia exemplifies how water has been managed in order to sustain the community for hundred years. Owing to the integration of Hinduism and local belief, *Tri Hita Karana* meaning the three causes of goodness was developed during Javanese period in the first millennium CE and has become the Balinese belief in the harmonious relationship between spiritual world, human and nature. From the 9<sup>th</sup> century onward, the temples were built beside natural springs to create the sacred bathing pool. Then the temples become associated with the holy springs which

provide the water of immortality (see figure 2.8). Later on, the holy water refers not only to water from the spring but other resources. Because of the rituals performed in the temples, ordinary water is transformed to become holy water while the temples identify the beginning of the irrigation system. Therefore, villagers who are sprinkled by the irrigated water, worship the Goddess of Lake, *Dewi Danu*, who blesses them with the water by giving *Dewi Danu* oblation which is a portion of their crops to the temples (Lansing & Watson, 2012).

In addition, the beliefs which directly influences the founding of the governance of rice terraces through *Subak*, an irrigation system's managerial body binding society and religion together, and water temples. Water from natural resources such as springs, canals, crater lakes is diverted to rice terraces at every level from upstream to downstream (see figure 2.9). Kremer J (2012) refers to the study of Lansing S (1987) that the rice terraces at every level which certainly have the water temple at the starting point of the irrigation system are taken care of by the group of farmers and it is linked as the network of *Subaks* while they are controlled by the upstream temple. In this way, it can be seen how the Javanese kings in the past used the water management and religious belief to govern his people (Kremer, 2012).



Figure 2.7 The sacred mountain of Vat Phou symbolising “Shiva Linga”, Lao PRD

Source: Author's collection



Figure 2.8 One of the water temples in Bali, Indonesia  
Source: Author's collection



Figure 2.9 The irrigation system of rice terraces in Bali, Indonesia  
Source: Author's collection

#### 2.3.4 Water for commerce and networking

During the time before the decline of man-power engines and industrial revolution, the outstanding purposes to develop water management system were to facilitate transportation and communication for the power expansion and trades within and among the states, nations and kingdoms. Even though canalisation has been made in various river basins, especially the Nile river, the Rhine river and the Yangzi river since the long past before the first millennium, the canalisation technology, scale and purposes in each period of time were varied on circumstances of cities, states or

kingdoms. Accordingly, in the period it became much more developed as a large network strategically created in relation to global exchanges. This can be seen from several water towns and cities such as Amsterdam in the Netherlands, Venice of Italy, Ayutthaya City Island, as well as many water towns located along the Grand Canal and Yangtzi river in China including Wuzhen and Tongli (Porfyriou, 2019).

Remarkably, it is still questionable to identify whether the canalisation in this period found in each geo-cultural area was influenced by other cultures or it was coincidentally developed within its own sphere.

In Europe, from the medieval period to the 18<sup>th</sup> century, canals or inland waterways played a significant role in transportation particularly in goods exchanges. It was also used for drainage especially cities in the lowlands, irrigation, and domestic uses. Obviously, the main port cities in Europe such as Venice (see figure 2.10) and Amsterdam (see figure 2.11) the canal networks were constructed within the cities which easily connect to the sea and inland waterways. Founded in the 5<sup>th</sup> century, Venice was founded on 118 islands in the Venetian lagoon connecting to the Adriatic sea in the northwest of Italy. The islands are located on the shallow lagoon, separated by artificial canals while connected by bridges. The construction and development of the city's features including architecture and urban landscape exemplifies the dynamic process of human interaction to its ecosystem over time. For Amsterdam, the medieval fortified town was expanded and re-urbanised by the ring canal network in 17<sup>th</sup> century. Then it became one of the global port cities connecting Europe and other parts of the world, especially Asia. It can be argued that these two cities demonstrate the highly hydraulic technology and engineering to cope with the water environment as well as the knowledge in location selection, therefore, they have become the well-known global port cities historically. However, due to the industrial revolution leading to railway development, this inland waterway transportation had gradually been neglected. In contrast to international commerce and trade canalisation is still significantly beneficial that there have been the gigantic projects to construct short-cut canals such as Suez Canal in Egypt connecting Europe and Asia and Panama Canal which is the waterway connection between Atlantic and Pacific Ocean (Scarborough, n.d.).



Figure 2.10 Above: Historical maps of Venice. Below: Canal network of Venice at present.

Source: Above: <https://twitter.com/beautifulmaps/status/427934173467131905>

Below: [http://wallpaperweb.org/wallpaper/buildings/venice-from-air\\_27741.htm](http://wallpaperweb.org/wallpaper/buildings/venice-from-air_27741.htm)

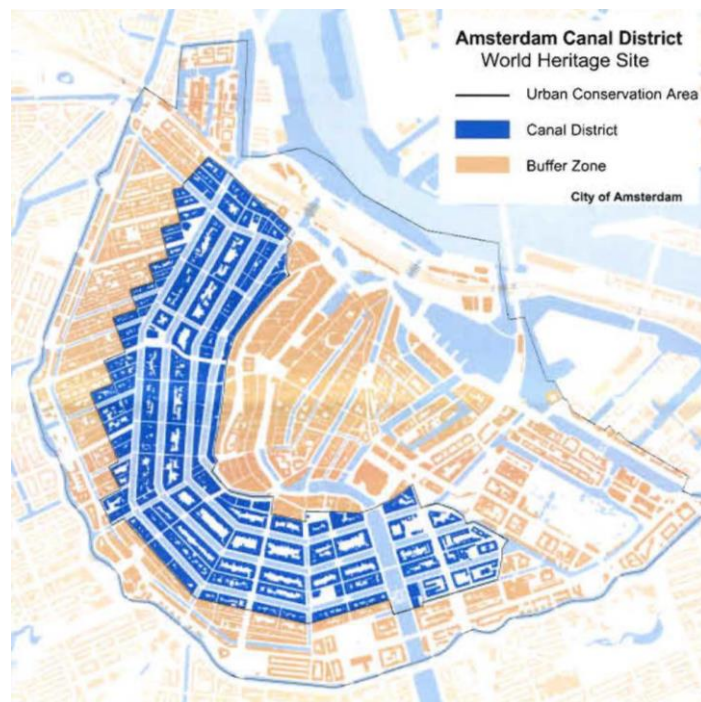


Figure 2.11 Map of Amsterdam Canal District, the World Cultural Heritage Property

Source: [https://whc.unesco.org/en/list/1349/multiple=1&unique\\_number=1666](https://whc.unesco.org/en/list/1349/multiple=1&unique_number=1666)

In the other part of the world, canalisation in China can be dated back to around several thousand years ago. The Grand Canal which played a tremendous role in the prosperity and stability of China, was initially constructed around 5<sup>th</sup> century BCE, aiming to facilitate the visit to the city at the mouth of Yangtze river and connect the north and the south parts of the empire. It runs from Beijing, the capital city in the northeast to Zhejiang province in the south while Luoyang was planned as a center of this network (see figure 2.12). The canal was constructed into four sections in different periods. However, since its glorious period, during Yuan Dynasty in 13<sup>th</sup> century, this artificial canal has unified the inland waterway network which is about 2,000 kilometres long and has linked five major river basins of China such as Huang He river or Yellow river and Yangtze river (UNESCO., n.d.-a).



Figure 2.12 The map of Grand Canal at present

Source: <https://transportgeography.org/contents/chapter1/emergence-of-mechanized-transportation-systems/grand-canal-china/>

จุฬาลงกรณ์มหาวิทยาลัย

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According to Porfyriou H (2019), hundreds of water towns were founded along the Grand Canal especially from 13<sup>th</sup> to 19<sup>th</sup> century. Her study on the water towns in China focuses on the urban forms of the water towns for further conservation planning using three water towns located to the south of Yangtze river, Nanxun, Tongli and Wuzhen as case studies. She claims that even though the water towns in China become one of the most popular tourist destinations after the Grand Canal was inscribed on the World Heritage List, they still lack in-depth study and research on their urban history and development. It is also obvious that, as water towns, their water management system and techniques should be explored. There may have been studies and researches on these water towns in several aspects in Chinese language, however, these sources are not easily accessible (Porfyriou, 2019).

As for Ayutthaya, the city had been founded as capital city of the Kingdom of Siam in 14<sup>th</sup> century, which was developed to its glorious period in 15<sup>th</sup> to 18<sup>th</sup> centuries before it was defeated by the Burmese in the second half of the 18<sup>th</sup> century. From historical documents, China and Ayutthaya had close relationship and connection in diplomacy as well as trade. Furthermore, some Thai Scholars believe that the water management of Ayutthaya, was possible to have been influenced by Chinese urban design (Wongtes, 2018). At this point, considering the urban pattern of Chinese water towns, particularly in the design of streets and canals which are built in parallel lines, it shares similarity to the urban pattern of Ayutthaya as seen in the old maps.

In conclusion, it is obvious that the canalisation of China before the industrial revolution certainly aimed to unify the Chinese Empire by linking all provinces to the capital city through its waterway network at the national level as well as city level.

#### **2.4 Water management system of Ayutthaya**

The previous studies of water management in Ayutthaya have been made by scholars from various disciplinary backgrounds. It is presumable that they have focused on certain specific issues or aspects of Ayutthaya relating to their specializations.

Accordingly, this review attempts to explore the water management of Ayutthaya by the studies and research from various disciplines in order to figure out what, why and how each discipline understands the water management in the way that they have done. It is noted that the relevant disciplines are identified into four approaches or studies.

Regarding a historical record entitled *Histoire Naturelle et Politique du Royaume de Siam* by Gervaise, N, (1662-1729) who accompanied the missionaries sent by France to propagate Christianity from 1681 CE to 1686 CE during the reign of King Narai the Great, it was recorded that the Kingdom of Siam comprises three main rivers. He claimed that the main river was called Siam Me' enam which is believed to be the Chao Phraya river. This river flew from the Gulf of Siam up to the capital city which meant Phra Nakhon Si Ayutthaya or Ayutthaya city. The river bed was quite deep, which enabled big ships to enter into Ayutthaya via the river during high tides. In addition, the shoreline of the river at Ayutthaya was deep enough to anchor close to



the city wall. This river was obviously meandering and split into several small rivers flowing to the surrounding flood plains. Furthermore, it was recorded that the areas along both side of the river were populated. The second river mentioned was Tenasserim river which flows down from the mountainous area of city of Ava, an old administrative centre of Burma, known as Shan domination period (1364 CE-1527 CE). This river contained many isles and flew torrentially so it was not proper for sailing. The third river Gervaise mentioned was Chanthaboon river at the eastern side of the Gulf of Siam. The width of the river was not larger than Chao Phraya river and there are sand dunes at the mouth of the river, the depth of the river was enough to cruise (Gervaise, 1662-1729).

Gervaise explained that the Siamese called this city Si Ayutthaya while the foreigners called Yutya or Iudia and called the kingdom “Siam”. Meanwhile local people knew Mueang Thai or the Land of Thai, or Mueang Krung Thep Maha Nakhon. According to the record in relation to the water management system of Ayutthaya, Gervaise claimed that King U thong was the founder of the city which was located on an island. The royal palace was oval shaped, not so big, and surrounded by the ruined wall which seemed to be soon restored. In the city, the land was not smooth and partially flooded. He mentioned that if the land was graded by cutting some areas and bringing the soil to build the mounded dikes to the north, east, and west of the city in order to divert the water into the city similar to Venice, Ayutthaya would take various advantages from this kind of settlement. He also described that, in the city there were many canals and sub canals which flew from the surrounding rivers. The canals were built in grid pattern which divided the city into quarters and water ways like European towns.

The grand palace was situated to the north of the city and surrounded by noble residences and temples. Opposite to the grand palace, in the other side of the river, he recorded that the Royal barges were kept there. There were also the living quarters of Chinese and Moors while the Europeans did not live in the city. The crowded area was near the port where the bending of the river was. The local people lived in the largest quarter where several markets were located and many craftsmen lived. Since

there were many canals in the city, 5-6 bridges made from bricks were constructed while the rest were made of bamboos which were narrow and not well-functioned.

Hundred years later Mouhot, H (1858-1861), another French man, visited Indochina including Siam, Cambodia and Laos from 1858 CE to 1861 CE. He also wrote a record of his journey which was translated by Kannika Chanseang. Considering the period of his journey, Ayutthaya described in his record was in the condition of nearly 100 years after the fall of the kingdom. However, it should be noted that the city was not absolutely deserted because, when he arrived in Ayutthaya, he explained that Ayutthaya was the second important city of the Kingdom of Siam. It was located on the river or canal, bridging a main river and its branches, which was the communication route to Korat or Nakhon Ratchasima, a province in the northeast of Siam situated in the direction to Lao. Mouhot pointed out that most Siamese preferred to live in raft houses. He also explained that he could not see the forts of Ayutthaya. It is believable that the city walls and forts were demolished or deteriorated (Mouhot, 1826-1861).

Takaya, Y. (1969) did a study on geographical analysis of the lower plain of central Thailand which lays from the north to the south around 500 kilometers long and 100 kilometers wide. He divided the central plain of Thailand into 3 areas. The uppermost part is the catchment area of three rivers in the north including Ping river, Yom river and Nan river. This area is 25 – 100 metres above average sea level. The middle part covers Nakhon Sawan province where the three rivers meet and become the upstream of Chao Phraya river. The third part is the lower flood plain or delta area which is less than 15 meters above average sea level. There are several rivers which are separated from Chao Phraya river at this area such as Suphanburi river, Noi river. He also categorizes this lower plain into 3 areas including Sing Buri plain, Ban Phraek channel and Bangkok lowland or marsh where levees along both sides of the river are seen while the marshy areas are found behind the levees. From his study, the areas where Bangkok and Ayutthaya are situated were naturally raised up, similar to islands laying on east – west direction. Furthermore, he also categorized the areas by the river characters. There are three characters found in the lower plain. The first area is where the river is remarkably bent, the second area is where the river is influential from the

tide, and the third is the delta area where there are many branches making the fan shaped land features. It can be seen that, from the study of Takaya Y, it is clear how the geological characters were formed. This understanding provides a concrete support to the reasons of why this area was settled down in the ancient times (Takaya, 1969).

Tanabe, S (1977) studied the emergence and development of canalisation in the lower area of Chao Phraya River plain before the establishment of irrigation system by Department of Canal or *Krom Khlong*. His study focuses on the canalization since Ayutthaya period from historical documents, especially the royal chronicles. It is explained that, regarding the geography of Chao Phraya river plain, it can be categorized into two areas first, the upper area which is the old delta of Chao Phraya river and, second, the lower area where the delta and the mouth of Chao Phraya river are seen at present. However, the canalization in Rattanakosin period differed from in Ayutthaya period because it was part of the policies initiated from administrative level and aimed to serve the military and transportation purposes rather than agriculture. According to his study, canals in Ayutthaya are characterized into three types based on the purposes of construction. The first type is city moat and canals in the city island. He refers to the map made by Phraya Boranratchathanin who claims that the city moat and canals in the city island were mainly used for transportation and city protection. In addition, the water in these canals were domesticated in the dry season as the water tank was found. The second type is the short-cut canals aiming to fasten and facilitate the transportation. Transverse canal was the last category. Tanabe also mentions two canals which are Khlong Samrong which is originally natural canal and was deepen and widen during the early time of Ayutthaya in order to connect Chao Phraya river to Bang Pa Kong river to the east and Khlong Mahachai which was dug around 1704 CE to connect Chao Phraya river to Tha Chin river to the west (Tanabe, 1977; Tanabe et al., 2003).

The research on land sediment was conducted by, Wanasin, P. and Suphachanya, T. (1981) and Suphachanya, T. and Khaokhiew, C (2005) and proposed in the long past, the lower Chao Phraya river plain was believable to have been a gulf. The coastal area was large and entered deep into the land which are now Chai Nat province and

Nakhon Sawan province, located at approximately 220 kilometres distance from the present coastline. Afterwards, because of the recession of the shoreline, the land emerged until the area of the present Bangkok became the lands. According to the Royal Chronicles, Samrong canal was dredged around 1498 CE in the reign of King Rama II of Ayutthaya. From archaeological studies, it has been discovered that Ayutthaya was an important port in Dvaravati-Funan period. The settlement was surrounded by city wall and city moat while in the city many canals were dug in grid system for transportation and irrigation purposes. However, the sea recession affected these settlements, causing some settlements to be abandoned and new settlements were founded which had access to the sea. It should be noted that although theory proposed by Wanasin and Suphachanya on the period of the sea recession has been argued and discussed by other scholars, they are the first pioneers who studied the historical aspect of geomorphology and geology which could be claimed one of the early transdisciplinary studies used in the study of water-related issues in ancient towns (Thiwa Suphachanya & Khaokhiew, 2005; Wanasin & Suphachanya, 1981). Jumsai na Ayudhya, S (1986) proposes that, based on the map drawn by Vingboon, the city planning of Ayutthaya was designed as a grid system by the urban principal structures which included roads and canals. It can be assumed that Ayutthaya's city plan was influenced by ancient Khmer civilization but was adapted to fit the natural settings of Ayutthaya which is located at the oxbow of Chao Phraya river and the bending flood plain. A natural pond, *Nong Sa No*, nowadays known as *Bueng Phra Ram* (Phra Ram reservoir) was found. He claims that a water channel was dug to link Chao Praya river and Pa Sak river, resulting in the forming of Ayutthaya city island. In addition, from the map it can be seen that the fortification structure of the city comprising the city wall which was about 5 meters high, encircling the city at the length of approximately 12 kilometers long. Along the wall 17 forts and 12 water gates have been found. Jumsai na Ayudhya also claims that the cumulative length of canals in the city were approximately 56.4 kilometers long in total, therefore, there must have been a great number of bridges across the canals including the bascule (lifting) bridges which could be lifted up to let boats pass while the roads or pathways were limited. He proposes that Ayutthaya took several advantages from its location

i.e. the city protection, transportation, irrigation, agriculture and domestic uses. At present, most of the studies on the physical characteristics of Ayutthaya always refer to Jumsai na Ayudhya's study which can be used for deeper, systematic and convincing study in water management of Ayutthaya particularly in 17<sup>th</sup> to 18<sup>th</sup> century which is its glorious period (Jumsai-Na-Ayudhya, 1986).

From historical information of Ayutthaya from documents, old maps as well as field walk and survey done by Vandenberg, T. (2010), it is proposed that in 1568 CE the city was encircled by canalization which shaped the island-like character of Ayutthaya (Vandenberg, 2009). This assumption contradicts to the previous believe that Ayutthaya took the form of island since its establishment in 1350. Vandenberg, T. (2009) also did a study on cartography of Ayutthaya which includes several maps drawn in various periods so his research on physical character is mostly based on these maps. However, it is notable that Vandenberg argues that the map drawn by Kaemfer is more precise and reliable in providing the convincing proportion and scale of Ayutthaya than Vingboon's map, which is widely used and referred to in many studies of Ayutthaya's physical characteristics.

Jarupongsakul, T. and Yoshihiro, K. (2000) explained geological and geomorphological character of Chao Phraya delta covering the lower area of the central plain of Thailand. The delta is 40,250 square kilometres comprising new delta, brackish water area and sea sediment area. The rim of this plain is fan-shaped ledge. They also refer to the studies of Takaya that the lower plain can be differentiated into two areas. Sing Buri plain is 5-15 meters above average sea level while Bangkok plain is less than 5 meters above average sea level. Chao Phraya river and its branches as well as Tha Chin river are the main irrigation channels of the delta. These plains are also the catchment area of Mae Klong river to the west and Bang Pa Kong river to the east. In his study, the annual average flowage of Chao Phraya is 917 cubic meters per second (Jarupongsakul & Kaida, 2000).

Furthermore, they studies changes of Chao Phraya delta from Ayutthaya period to understand how it changed over time or it has been changing all the time by considering the relationship between nature and human evolution. During the early period of Ayutthaya, the exchange was run by Chinese, Arabian and Indian

merchants. Regarding the potential of Ayutthaya's location which was between the flood plain in the north and delta area in the south, it was developed to be a port city for commerce. In addition, according to Tanabe (1978) and Takaya (1987), Jarupongsakul and Yoshihiro state that before the establishment of Ayutthaya, there were already several ancient settlements located at the upper part of Chao Phraya river plain. Small water channels were dug to divert water from the river to agricultural area. In some areas the water was kept all year. A small number of settlements were found in the delta area in south of the plain along both sides of the riverbank. The canalisation found in this area were mainly short-cut canals, canals in the city and canals connecting to rivers. In the early period canalisation aimed for transportation. People in those times lived along both sides of the river rather than along canals. They also state that the rice growing method was from seeds while the area southward from Ayutthaya was always flooded and overgrown.

Tangsirivanit, T. is a scholar and Thai well-known collector of the old maps particular in Ayutthaya's maps. He analyzed, interpreted and edited his research on Ayutthaya's physical characteristics in a book entitled *Krung Sri Ayutthaya on the Foreigners' Maps*. His research aims to understand the development of place names and locations of cities/towns since the reign of King Borommatrailokanat (1448 CE-1488 CE) and to study the history of Ayutthaya's maps drawn by the Europeans who came to Siam since the reign of King Narai the Great (1656 CE-1688 CE). Tangsirivanit explains that there were several difficulties of the study, for examples, sources of primary information are spread around the places and countries in Europe and written by various languages while the secondary information is limited since there are only a few numbers of researches and studies of Ayutthaya's physical characters (Tangsirivanit, 2006).

In his research he categorizes the maps of Ayutthaya into three groups as follow.

- 1) The world maps, maps of Asia and Southeast Asia's maps which show only the location of Ayutthaya in the respective contexts.
- 2) Perspectives of the city which show the sceneries or maps of the city.
- 3) Maps or city plans.

Hutangkura, T. (2014) refers to Takaya, Y. (1969) that topography of the central plain of Thailand where Ayutthaya is located can be divided into two parts; the upper part or Sing Buri plain, which is 5-15 metres high above average sea level and the lower plain or Bangkok plain which is 0-5 metres high above average sea level. The connection between these two plains is the area of Amphoe Ban Phraek, Ayutthaya province where traces of erosion from the ocean wave resulting in a narrow plain penetrating into the upper plain known as Ban Phraek groove have been found. From his study, during Dvaravati Period, circa 7<sup>th</sup> – 11<sup>th</sup> centuries, Hutangkura argues that the Bangkok plain might have been slightly flooded, however, the entire plain might be inundated during the wet seasons except for some mounds while the area appeared as a wide plain in the dry season. As a result, in Dvaravati period many settlements were found in the area higher than four meters above average sea level. He assumes that flood in the lower plain might be too high for settlement even on the levees of Chao Phraya river. Until the 14<sup>th</sup> century, evidence of settlements at the area of Ayodhya were discovered. Hutangkura also refers to the record of Guy Tachard who came to Ayutthaya in 1688 to prove his assumption that Tachard came to Ayutthaya by ship that traveled through the thalweg of Chao Phraya river. He took advantage during the high tide to pass through the Bar of Siam which lays 12 kilometers along the coastline (Hutangkura, 2014b) .

Vallibhotama S and Songsiri W (2017) published a book compiling their articles which are the results of their continuous studies about cultural phenomenon in the Chao Phraya river basin as an origin of Siam for years. The articles cover the wide range of issues relating to Chao Phraya river such as the geological development of the river basin and delta, the history of Chao Phraya river, cultural landscape and water management, agriculture and society in the past, the immigration of people and the cultural shock after the disastrous flood in the Central Plain of Thailand in 2011. Written from their collective experience in deep study, research and field works on cultural issues relating Chao Phraya river basin, the articles highly contribute to supporting the interpretation and understanding in the overview of water management in ancient towns (Songsiri, 2017a, 2017b; Vallibhotama, 2017b).

Baker C and Phongpaichit P (2017, 2020) did years of in-depth research on the history of Ayutthaya before they wrote a book entitled “A History of Ayutthaya: Siam in the Early Modern World” in English in 2017. In 2020 the book was translated into Thai with additional information and minor altered title addressing the five centuries of Ayutthaya’s history toward the new era. The two scholars proposed another historiography of Ayutthaya based on their interpretation from the collective information. Instead of starting from the establishment of Ayutthaya in 1350 CE, they provide the narrative of the area which became Ayutthaya Kingdom much earlier as well as the social and economic aspect of Ayutthaya not only relating to aristocracy but ordinary people, besides the kingship, religions, governance, war, and polity. It is noted that even the natural setting of Ayutthaya is explored in their study as well as the introduction of the anthropologic aspect in the narrative of the history of Ayutthaya. However, the study did not provide much of the supportive information leading to the better understanding on Ayutthaya’s water management (Baker & Phongpaichit, 2017).

Khemnak, P. (2019), an archaeologist who contributed his life to archaeology and heritage conservation of archaeological sites in Thailand, did a research on the water network system in Ayutthaya period based on his field survey and investigation. The research, which is his last contribution was published posthumously in 2019 after he passed away in 2018. This comprehensive research provides an insight information on the waterway or canal network mainly in the larger system, which is beyond Ayutthaya city island, even though the last chapter is the exploration about Ayutthaya city island through the maps drawn by various foreigners who visited Ayutthaya in 17<sup>th</sup> century. From his long experience, he also includes the intangible aspect in his research including the relevant royal ceremonies and classical literatures as well as social condition and traditional ways of life of people in those days. The most challenging findings of this research is that Khemnak reveals the location of Patha Khu Cham or Wiang Lek which is mentioned in the Royal Chronicles, Luang Prasoet version, as a settlement located to the south of Ayutthaya city island on the other side of the Chao Phraya river by reviewing historical documents and on-site survey and investigation (Khemnak, 2019).



However, contents of the research are obviously static as the research mainly aims to trace the waterways in the certain period in the past. Therefore, the overall picture of continuous emergence, development and changes of the waterways seems fragmented while the functionality of the waterway system is not really convincing. Nevertheless, it can be said that this publication demonstrates one of the most comprehensive research of waterway network of Ayutthaya which provides the primary information for the latter research on the water management of Ayutthaya.

## **2.5 Gaps in Current Researches**

### **2.5.1 Lack of previous in-depth studies and researched in the water management of Ayutthaya.**

Even the water management system of Ayutthaya, particularly in its glorious period has been claimed to be one of the most technological advanced in the world, there remains the unclear and convincing explanation for various questions. Comparing to other old cities such as Amsterdam, the Netherland, Venice, Italy, etc., existing studies and researches on the water management of Ayutthaya are very limited. In consequence, the unclear information cannot contribute to or support the conservation intervention for this ancient city, including the restoration or reconstruction of water management system. Thus, the fundamental issue is how to understand water management of Ayutthaya in the old days under this circumstance, and whether the outcome of the study will be reliable.

### **2.5.2 Scientific method to study the past events.**

The study on the ancient towns tends to focus on both internal and international polity, governance, wars, commerce and literature because the sources of the study are still based on historical documents written by scribes, novelists and diplomats who were interested in the governing system and business leading to power and prosperity. It has been argued for years regarding this research trend how the historical studies can contribute to the present requirements. Therefore, the more systematic and convincing methodology in studying the water management in the ancient towns should be developed.

### 2.5.3 Static timeframe in the study of water management.

In relation to 2.5.2, it is obvious that, for historical study, water management in ancient towns is concentrated on a period, normally, connecting to the reign of the rulers or on a short span of time. On the contrary, water management at present is more inclined on engineering than cultural aspect and focuses on contemporary period, which is understandable. However, for water management in ancient towns, the information and knowledge of water management in the present day seems not sufficient to explore and understand the water management in the past from its beginning. Furthermore, in some ancient towns, the water management has functioned since the long past and still evolved and continuously changed until today, therefore, the study of water management in ancient towns requires to take into account the temporal comprehension.

### 2.5.4 The integration of multi-disciplines.

It can be clearly seen that the study on water management in ancient towns, especially in Thailand is a sectorial or mono disciplinary study. For example, due to data collecting for literature review, it is found that the issue on water management in Thailand at present is inclined toward engineering work than other subjects and focuses on the present-day context and, in some cases, refer back to the period that engineering was introduced to the country. Apparently, engineering study seems to lack cultural dimension . However, to understand water management of any ancient or modern cities various disciplines should be implemented i.e. archaeology, history, anthropology, geology, geomorphology, hydrology, water resource management, etc. In fact, multi-disciplinary study and the landscape approach have been mentioned in many studies but they are still fragmented since the knowledge from all the fields has not been integrated but appears as a compilation. The integration of various disciplines requires a linkage that connects each discipline and helps fill the gaps among themselves. Consequently, a newly developed approach with the methodology that includes a missing link should be proposed.

## **Chapter 3**

### **Landscape Integration Approach**

From the gaps in current research discussed in the previous chapter, the integration approach with a linkage of various disciplines should be introduced to develop a more rational and convincing conceptual framework for the study of water management in ancient towns. As a result, a new methodology in response to the approach is explored and proposed in this chapter. In the literature review, various towns and settlements located on river basins or along the riverine areas of the globally- known rivers across Asia and Europe which have certain influences on Ayutthaya are carefully and thoughtfully chosen. Based on the management purposes and complexity, the water management of those towns and settlements have been explored. The previous chapter eventually reveals the current gaps in the study and research about water management in ancient towns. Consequently, this chapter aims to build and propose a methodology to study water management in the ancient towns or civilizations which is expected to fill these gaps.

The chapter starts from the research tools and methods which comprise desk-based, and field works to collect necessary data, to set research questions and to identify the water management issues based on each discipline; relationship between the disciplines, water management issues, research questions and chronology demonstrates in Table 3.1; and landscape concept to be used as an umbrella of this proposed approach is explained. It should be noted that the human dimension relevant to water management is included in this landscape concept in order to link each discipline together when developing the principles of landscape integration approach and its methodology. In consequence, according to Table 3.1, the review of water management in various civilizations and ancient towns, as well as that of Ayutthaya based on existing studies, the cycle of water management development is described and added to Table 3.2, which shows the connection of water management development cycle and various disciplines. Finally, the proposed methodology to study water management in ancient towns is constructed by combining Table 3.1 and Table 3.2 as seen in Table 3.3. The last part of this chapter is the application of the methodology in Table 3.3. to Ayutthaya, the case study area. The application shows

that water management of Ayutthaya is developed in five stages relating to the development of Ayutthaya Kingdom.

### **3.1 Research tools and method**

Regarding the research methodology, various tools are used to identify and develop the methodology that either conveys a rationale and convincing methodology or reduce and fill the gaps in the current research.

#### **3.1.1 Desk-based review**

The gathering of relevant information and data was continually carried out during six years to propose and demonstrate how landscape integration approach should be one of the most efficient approaches in studying water management in ancient towns. Historical documents such as chronicles, historical records, etc. as well as several books relating to Ayutthaya and its connecting areas were used to find out supportive information for developing the proposed methodology based on the case study: Ayutthaya. The information helps identify a clear understanding on the missing pieces of water management in ancient towns which is Ayutthaya in this research. Analytical review of these documents focuses on the developing of the water management of Ayutthaya, the continuous picture of how it was built and developed has gradually been revealed as discussed later in this research.

On the other hand, cartographical information including old maps, pictures and paintings, as well as aerial photographs and recent maps provide tangible evidence of water network of Ayutthaya in certain periods within specific areas, especially Ayutthaya city island. These maps provide the contextual information of Ayutthaya city island, however, some maps were drawn by artists who had never been to Ayutthaya, therefore, they may not be reliable enough to be used as main references. Moreover, the proportion and size of building elements are not precisely drawn to scale.

Furthermore, even though information from the published and unpublished documents containing the information about water management in ancient towns and civilizations around the world, especially in Asia and Europe

helps understand the emergence and development of water management, this research only concentrates on the water management from the cultural areas that might have influences, transmission of knowledge or exchange with water management in ancient towns in mainland Southeast Asia such as Ayutthaya. The research also points out the coincidence of water management knowledge in various areas occurring at the same time. Furthermore, as the study and research of water management in ancient towns is limited due to lack of physical remains of water management, the information about water management of other cultural areas provides rational argument to support the assumption and interpretation of water management in Ayutthaya case study. Another good source for this research are archaeological reports from archaeological studies in Ayutthaya and its vicinity. Nevertheless, although archaeological studies in Ayutthaya have been carried out continuously since the initiative project of Phraya Boran Ratchathanin in the reign of King Rama VI, these studies and analysis of sherds have not been intended for the aspect of water management. The only archaeological report which focuses on the water management is the result of the discovery of water pipes in the Royal Palace complex, from which the in-charge archaeologist extended his study to cover water management system for domestic use. Apart from water pipes, water tank and pumping devices in the past are explored. However, because of the devastating flood in the central plain of Thailand in 2011, most archival documents including archaeological report of Ayutthaya area were damaged or disappeared.

### **3.1.2 Field survey and observation**

Based on the author's experience in working in heritage conservation in Ayutthaya since 2012 and field visits between 2015 and 2020, the information from the survey and observation on existing water management system and traces of evidence of the system seen in archaeological remains above and underground is applied with other information by the proposed methodology. During the time, amongst several archaeological excavations within and around Ayutthaya city island, at least four archaeological

excavations provided relevant outputs relating to water management of Ayutthaya were conducted. The excavated areas included the confluence of one of the main canals in Ayutthaya city island and a canal flowing through the Royal Palace archaeological complex, the area around a building within the Royal Palace, the area which is believed to be the location of one of the fortresses which also functioned as a water gate, and the area near a temple located at the area believed to be Patha Khu Cham, an earlier settlement before the founding of Ayutthaya. At present (2021), the archaeological reports are still in progress, therefore, information was obtained by interviewing archaeologists who were responsible for the mentioned excavation projects.

Apart from observation on excavated areas, field survey provided opportunities to gather information on the remaining structures of water management system such as city moats, canals, bridges, water tank, , etc. , including the recording of their changing surroundings.. This also helps understand how the water management functions at present.

### **3.1.3 Online survey with experts and academics in water sciences and heritage.**

The questionnaire aims to consolidate the proposed methodology by multi-disciplinary approach, as well as to find out from experts in relevant fields whether any disciplines are still missing from the conceptual framework of this approach. Online platform was selected as the targeted experts are living across the continents. In case of the countries that this online platform does not work, the soft copy of questionnaire was sent to the identified experts. When it was returned, the information was digitized so it could be included in the data collecting and analyzing process.

The online questionnaire was distributed to experts, professionals or practitioners working in both cultural and science disciplines, especially those who have involved in water- related issues while developing the methodology proposed for this dissertation. The questions comprise mainly the disciplinary background of the samplings, their specialized experience in

water management, particularly in ancient towns, settlements and/or civilizations, and the understanding on water management in general and in the ancient towns. Starting from identification of the disciplines, the samplings are categorized into two groups: the first group comprises experts who are known for working in the cultural sector, and the second group comprises experts who work in natural sector. Around 30 experts were invited to complete the questionnaire. It should be noted that these selected samplings may identified themselves differently from the categories they were put in when they were shortlisted. The total number of samplings is more important in providing accuracy of multidisciplinary issues for this research.

The questionnaire comprises four sections. Starting from the general background of the targeted experts, this information verifies the diversity of experts in terms of their geo-cultural residence and fields of education which includes both arts and humanities and sciences. The second section focuses on their working experiences in water management and ancient towns. The questionnaire result shows the different roles in water management of the experts who have different educational or training background. In their opinions, all listed disciplines should be included when studying water management. However, the highest score goes to history/architecture, history/history of engineering, followed by hydrology, ecology and geomorphology equally, archaeology/land archaeology and ecology equally and anthropology which is slightly less than the previously mentioned disciplines. Furthermore, it is very interesting and helpful that these experts recommended that other disciplines, including urban planning and management, urbanism, remote sensing and political economy should also involve. Accordingly, the multidisciplinary framework can be added into the methodology of the proposed approach in this research.

The third section is crucial as it focuses on the understanding of water management in ancient towns of the experts. Most of them agree but not at the highest degree that, at present, most studies of water management in the

ancient/old towns are still unclear and questionable as they are not comprehensive. While they completely support that the study of water management in the ancient towns requires various fields of knowledge including natural sciences and humanities which will make the study become more convincing. Furthermore, it is convinced that the intangible aspects are essential element for the understanding on development of water management in ancient towns. Therefore, they strongly agree that the research on water management in the ancient towns will be useful for water management at present and in the future.

The last section is a collection of the projects that the targeted experts worked or involved in, which provides another facet of the perspective of water management through the nature of the projects.

#### **3.1.4 Interview: additional and verbal information.**

From the result of the online questionnaire, which is expected to be a draft proposed methodology, interviews with some selected experts from each discipline were conducted. The interviewees selected were widely recognized in their professional fields. In case of the Thai experts, the interviews were conducted in person whereas for foreign experts the online interviews were applied in cases which were necessary. It must be emphasized that the interview was carried out during the development and testing of the proposed methodology.

### **3.2 Data analysis and research questions**

Each discipline was analysed to identify the issues relating to water management from its perspective in general. At the same time, the main research questions were set in response to the issues. In overall, it was an attempt to understand water management from various aspects and understand how water was managed in different circumstances. Furthermore, considering the chronological order, the increasing complication and changes of water management have been identified.



SCIENCE		ARTS & HUMANITY						
NATURE		CULTURE						
RESEARCH QUESTIONS								
DISCIPLINES	Geology Hydrology Ecology	Engineering Architecture Urban planning	History	Landscape / Archaeology	Spiritual/ Religious (Anthropology)	Linguistics and Oral History	Social Economic	Polity Governance
ISSUES	Natural settings	Ecosystem, Environment	Governing system, Architecture, Urban planning	Evidence of past environment	Spiritual and Religious aspects	Terminology, legendary narrative	People, living styles, trade &commerce	Kingship, policies, laws, foreign affairs
	Did water management system in ancient towns reflect geological, geomorphological and hydrological conditions?	How have these natural factors affected water management system?	What was water management in ancient towns? Was it systematic?	What is physical evidence of water management in ancient towns?	Why was the water management built?	Is there any name place relating to water or water management?	What was the social structure and demography related to or did demonstrate water management?	How did politics influence water management i.e. state security, water sharing?
CHRONOLOGY			How did the management emerge and was developed?	How did the management change the landscape?	How did human in those days know how to manage water?	Are there any literatures, local tales or legends telling about water management?	Did occupations/ agriculture i.e. rice cultivation reflect the water situation in the past?	Did economic changes effect to water management system i.e. transportation, water storage/ irrigation?
			What were the water management technology and techniques?		Was the knowledge in water management adopted or adapted from other towns?			

Table 3.1 Data analysis and main research questions

### **3.3 Landscape concept and perception in wider context.**

From the review of methodologies implemented in the studies of water management in ancient towns, civilizations or even the contemporary towns, focusing on evolutionary and developing aspects, the reinvented methodology to understand water management in the ancient towns is proposed. The expected findings are presented in two parts, the first part is the conceptual framework of the proposed methodology to explain how the methodology has been created considering the analysis of existing methodologies used in the studies of water management and related fields in the earlier part of Chapter 2. The second part is the methodology proposed in this research. The multidisciplinary methods for the study of water management in ancient towns were explored through a set of research questions that can bring about a convincing explanation through evidence from various disciplines.

This part will extract and combine the contents and/or issues from the studies of disciplines discussed in Chapter II in order to propose the method which is suitable to be used to understand water management in the past in relation to each other. Considering the Studies in Human Ecology and Adaptation, African Landscape: Interdisciplinary Approaches it can be seen how landscape concept is implemented to understand various issues, particularly in spatial understanding and studies as follows (anon., 2009).

#### **3.3.1 Landscape is a living history.**

Bollig M (2009) states that landscape is geoeological and cultural process.

Landscape changes all the time. It is a cognitive and symbolic ordering space which is materialization of various temporalities as follows.

- a) Landscape is a geological evidence of changing time.
- b) Landscape character causes the interaction between geo-ecology and human intervention. In consequence, it is likely a coincidence that happenings occur similarly in resembling environment.
- c) Landscape patterns are the seasonal changes so the observation of landscape should be carried out at least all-year round.
- d) Landscape is a reflection of human actions over time. It is also changing.

Landscape is the personal and collective memories on various levels. Landscape character shows the appearance and attribute of individuals and societies. It is linked with subjective recollections of the past and collective memories. It can also be said that landscape also demonstrates the lives and actions done by past generations, so it becomes the historical record of the knowledge and understanding of the past and culture (Bollig, 2009).

As mentioned above, it is proposed that, the study of landscape features of a particular area should enable the understanding on what happened in the past and how it has developed over time as the landscape is changing and living. Within this perception, the definition of “landscape” to be used as the title of this proposed approach extends deeper in time. It is not just what we are seeing at the moment but we need to look beyond the present time. In addition, the approach will provide the possibility to foresee how this landscape will change in the future from its historical record, therefore, the landscape approach will not only be academic theory but also practical for future study.

### **3.3.2 Landscape characteristics and character are the results of intangible expression.**

Landscape, on one hand, links with collective memories and is not only mnemonic but political as well. It has often been used as tool for testifying the power and identities as seen in several old colonial countries.

Historically, holy places, place of power and shrines are believed to serve the connection with supernatural beings and ancestors who already passed away. These places have become the permanent features of landscape, inherently sacred and loci of spiritual power. Another way to address the power in the landscape is by means of the intangible aspect of human being and social structures that shape the features of landscape, which are used as a powerful tool of the states/kingdoms administration.

Similarly, water has been managed by shaping and transferring landscape into specific forms such as sacred pond or miracle spring that provide holy water or water with curing power. Thus it is used to convince or control

people beliefs and respect which is one of the governing strategies in the past, or even today. Consequently, water management in the past civilizations which were highly developed was also used beyond its physical aspect and fundamental needs of human. Therefore, to understand water management in ancient towns deeply and comprehensively, it is necessary to study the intangible aspect of the management.

### **3.3.3 Cultural landscape: human intervention that links nature and culture**

Landscape is a cultural manifestation which develops from natural settings. As for non-English native speakers, landscape is perceived as a natural element. However, this is not a recently-invented concept but was discussed and known since the former century. Bollig M (2009) claims that the holistic approach of landscape as a link of culture and nature was dominant in the first part of 20<sup>th</sup> century. later, landscape ecology and physical geography have developed as highly specialized disciplines with natural science methodology, whereas cultural science such as archaeology, anthropology and history have applied landscape concept without taking natural factors into consideration. It is clearly seen that the definition of some cultural disciplines covers only human-related issues, showing the lack of interest in natural science.

In addition, Schama also argues that landscape is culture before they are nature. He states that culture is a sign system that articulates with exo-semiotic processes. Historical ecology is defined as “*the study of the structure, function and change of different landscapes comprising interacting ecosystem.....landscape history of the study of past ecosystem by understanding the changes of landscape over time.* The nature is perhaps seized by human rationality, thought and emotion. It can be seen that, the more intensive the farming, the more complicated the landscape is shaped. Therefore, the landscape that we see nowadays is a cumulative result of past human actions and interactions (Schama, 1995).

It is believed that people in the past held the knowledge that was multidisciplinary , especially in application of the understanding of nature to

form their culture, for instance, the creation of dwellings and houses, which were developed into towns and cities, the know-how of survival from natural disasters and the adaptation of experiences to make use of the natural environment including water management. With this understanding, landscape may symbolize the non-separation of culture and nature, or it can be said that landscape is the integration of culture and nature. Therefore, the approach developed to understand water management in ancient towns should include the knowledge in both cultural and natural sciences.

### **3.4 Landscape Integration Approach: Principles**

Regarding data analysis and the concept and perception of landscape, the Landscape Integration Approach is proposed with its principles especially for the study of water management in ancient towns. The principles are established to provide the conceptual framework (see figure 3.1) for developing methodology to be used in any ancient towns defined in the Chapter I, as follows.

#### **3.4.1 Using multidisciplinary knowledge from disciplines in arts and humanity as well as sciences.**

Managing water needs to adopt various knowledge from science i.e. geology, geomorphology, meteorology, ecology, hydrology, engineering, etc. These fields of knowledge provide the understanding why water needs to be managed in different natural environments and how it has been managed. From literature review, it is clear that, in the arid areas where there is lack of fresh water, one of the fundamental factors for human survival, water management techniques were invented and developed earlier than other parts of the world. Examples are the Nile river basin situated amid Sahara, Nubia and Libyan deserts. The difficulties based on the geological and climate conditions are potential drives for human to find out how to survive.

On the other hand, it is crucial to understand human actions in the past and knowledge in history, anthropology, traditions and custom, religious philosophy, theology, etc. When the number of population increased, the

more resources of food and water to feed the people became higher in demand, leading the tribes of people to try to expand their territory in order to acquire more resources, and, in many cases, by invading other tribes' settlements. Nevertheless, after the conflicts and wars, social structure was rearranged, resources were shared and people could live peacefully for certain period of time. It can be concluded that, the more population, the more complicated societies are, thus the governing system was established. In the past, those who possessed water resources could also unite their people, therefore, water has become an important tool for governing strategies. It is necessary to learn about human dimension in various aspects in order to understand clearly how water management has been developed to be more complex in later periods of any ancient towns. For this purpose, knowledge and methodologies used in research on Arts and Humanities subjects help obtain this set of information.

#### **3.4.2 Considering both cultural and natural settings.**

Since natural settings and cultural contexts of any settlements have collaboratively shaped water management techniques and relating structures and buildings in ancient towns, the understanding in changes in natural components of ancient towns provides factual information of the emergence of water management and its development in each period as seen from Tanabe's study of historical geography of the canal system in the Chao Phraya river delta. The study exemplifies that the natural character of the area was learnt through historical study which is a cultural subject, whereas the cultural issues including social structure and human activities contribute to the complication of water management. This perspective becomes crucial when considering water management in detail. When the need to occupy water resources went beyond the fundamental uses, the management of water resources might have aimed to control the accessibility of water transportation routes for monopoly trade. Additionally, states or kingdoms might want to expand their territory in order to seize other states or kingdoms' resources such as forest goods, precious stones, spices, etc.,

therefore, water management can be thoroughly explored when the understanding in cultural contexts of ancient towns is clarified.

#### **3.4.3 Including intangible perspective to enable a deeper understanding on water management system.**

In the old days, as water is one of the most important factors of human life, its management can be used to control and influence people mentally and spiritually through rituals and religious ceremonies, therefore, one can better understand how water was managed when considering this aspect. Examples are seen in rituals found in various ancient civilizations such as the worshipping and making offerings to supernatural beings i.e. deities, gods or spirits for the rain, or rainmaking rituals, are one of the most common rituals in the ancient times. The ritual demonstrates the cultural process on rain cultivation and storage. In addition, the belief in sacred ponds or sacred springs is another example of cultural intervention to nature in order to manage fresh water.

Remarkably, the intangible aspect embedded in water management continues even longer than the tangible parts. While water management techniques have evolved and developed due to the progress of relevant technologies such as sources of energy, changing environment, increasing population, etc. The intangible elements of water management including its sacredness continue until the present day as seen in the water blessing, which is widely practiced in several religions and beliefs.

#### **3.4.4 Considering the study area through temporal dimension, not at a specific time.**

The understanding on water management should not be concentrated on a certain period of time because it is an evolving process. It is proposed that the temporal dimension should be framed to cover a water management developing cycle. The understanding of water management in ancient towns is problematic when attempting to specify the period of the management. As this research aims to understand the subject that happened in the unknown past, which is a fluid subject by nature, therefore, instead of learning about

water management in a specific period, which cannot be clearly identified, the research should begin with how water management in any towns emerged, evolved, developed, and collapsed. Furthermore, although we may not be able to precisely and accurately specify the actual time of water management, the entire process of water management could still be perceived and understood.

#### **3.4.5 Concerning change as process of water management development, which is not static but dynamic and evolving.**

*The river of yesterday is not the same as the river of today.*

*The river of this moment is not going to be the same as the river of the next moment. So does life.*

- The Enlightened One – (Vandenberg, 2010)

As in the statement above, one should keep in mind that water management is ever-changing when studying water management in ancient towns. In relation to temporal dimension, water management has evolved over time as water is moving, gently or strongly. It is a powerful force that impacts wherever it flows through. It destroys one side of embankments while helps reclaiming land on the other side. Therefore, to manage water, one must always bear in mind the nature of water: change. The retaining or existing of water management is the result of previous changes. To understand how water has been managed in ancient towns, changes affecting the resilience of the urban form, hydrological infrastructure, social structure i.e. labour organization, agriculture, international affairs and demography should be considered. From the proposed principles of Landscape Integration Approach, it asserts that to understand water management in ancient towns means to explore its water management development cycle.



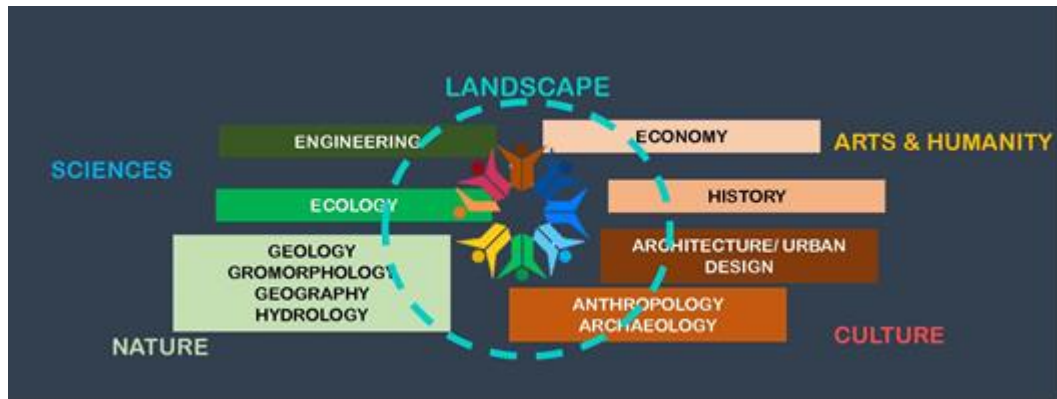


Figure 3.1 Landscape Integration Approach

Source: Author

### 3.5 Water Management Development Cycle

Based on the methodology used by Fekri as well as the landscape integration framework, the water management issues should be added in the timeline of global water history. The factors which form water management in a particular society include intangible factors such as natural settings and cultural transformation and exchange, and tangible or physical factors such as area or geographical location. To understand the emergence and development of water management in Southeast Asian Peninsular, the water issues in the wider scope should be considered in comparison with the regional circumstances. The matrix presented below is proposed to explore Southeast Asia's water management in a global context. According to Fekri as well as Bollig M and Bubenze O, it can be seen that water management should be considered from not only different angles of time but also space and knowledge which come from various disciplines. Therefore, another matrix is also created in order to show the relationship of time, space and various knowledge in order to answer the research questions.

The following Table shows the relationship between the issues of water management cycle and the disciplines or knowledge required for its understanding. From literature review in previous chapter and methodology review in this chapter, water management system that has been invented in all civilization around the world shares similar cycle ranging from the emergence of the system from some factors, development for better system, the achieving of

water management and the continuity or the fall of those systems by certain factors or circumstances. The proposed methodology to understand water management in the ancient towns should be able to provide explanation and clarification based on the following aspects of water management cycle. It is also proposed that each aspect needs various fields of knowledge from different disciplines to convincingly support its rationale.



WATER MANAGEMENT DEVELOPMENT CYCLE	MULTI-DISCIPLINES							
	SCIENCE	ARTS & HUMANITY						
	Geology Hydrology Ecology	Engineering Architecture Urban planning	History	Landscape Archaeology	Spiritual/Religious (Anthropology)	Linguistics and Oral History	Society & Economy	Polity & Governance
<b>Primitive lives:</b> Natural Water Resources								
<b>Early Settlements:</b> Emerging Water Management								
<b>Settlement Development:</b> Advanced Water Management Techniques								
<b>Peak of Civilisations:</b> Beyond Water Management Techniques								
<b>Fall or Continuity:</b> Collapsing or Sustainable Water Management								

Table 3.2 Development cycle of water management in ancient towns

### 3.5.1 Natural Settings: Natural Water Resources

From previous chapter, it can be seen that the water management in the earlier period at any part of the world is the result of human adaptation to geological or natural contexts of the area. When technology was still underdeveloped, man had to observe natural factors of his land in order to survive. Natural water resources were the important parts of human habitats, however, it was also necessary to learn how to cope with natural hazards such as flood, storm or earthquake. In some cultural areas, human could even take advantages from natural hazards, for example, in delta areas which are seasonally flooded, the soil is fertile because of the deposit from flood thus it became greatly suitable for agriculture, therefore, many of the ancient civilizations were developed in river plains.

Consequently, to understand how water management in ancient towns emerged, it is necessary to know the natural character of the areas that were chosen as settlements by the earlier groups of people. The knowledge and methodologies embedded in the disciplines related to natural science such as geology, geomorphology, ecology, landscape archaeology, etc. should be implemented. It is proposed that the natural features of any respective areas tremendously influenced water management of human in the early period after the end of hunting-gathering society according to the limitation of knowledge in hydrological technology which the communities expended and started settling down.

On the other hand, natural features are less influential to water management in later periods. However, the water management has still been affected from the changing natural settings which mainly were made by human.

In this study, research questions to explain about natural water resources of the ancient towns using the knowledge and methodologies of these disciplines are as follows.

- Did water management of any settlements before the emergence of any towns reflect their natural environments i.e. geological, geomorphological and ecological characters?

- What was water management? Were there any water management techniques?
- What is physical evidence of water management in the early period before the ancient towns were developed?
- How did human settlement look like and did communities have government system?
- What was the food and nutrition in this period?
- Were there any religions or beliefs?

### **3.5.2 The Early Settlement: Emergence of Water Management**

Water management became more systematic as the communities expanded and developed. The management was created in order to secure the resource sufficiency for everyone and during the dry season. In addition, the development of agriculture for food security also led to the innovation of water management for irrigation. Various kinds of water-related technology were created such as pumping equipments, water collection and storage devices, water control and water distribution systems. However, these inventions were rather simple. It is believed that the water management in early period was based on local intellectual rather than foreign influences and the water management knowledge was the results of accumulative learning from earlier times when man observed natural system by days, months and years. As a result, the natural system was imitated by man for instance, during hunting-gathering period, water was collected in lower areas such as ponds, big holes in rocky area and underground tunnels and simple tools were developed to take water from underground tunnels. City moats with earthen mounds or walls also began to be built in this period. It is believed that the moat was not intentionally built mainly for protection but for agriculture. The following research questions can help clarify the development of water management in this period in relation to the establishment of the ancient settlements.

- How were settlements/societies in this period? What was the governing system of the settlements? What was the demographic situation?
- Were there any change to natural settings of these settlements?
- What was the food production in this period?
- What were the innovations/functions of water management and how were they characterized?

### **3.5.3 Settlement Expansion: Development of Water Management Techniques**

Water was used for different purposes including spiritual functions thus the management became more sophisticated. Knowledge transmission and exchange with other cultures or civilizations were evident when the civilizations expanded thanks to the transportation technology. Systematic canalization was also developed in this stage.

The research questions to understand water management at this stage are as follows.

- Were there any change in governing system and how did it affect the society?
- Was there any evidence of cultural exchange on water management? If so, what are they and how to differentiate the local knowledge from foreign influences?
- What are the similarities or differences of water management in comparison to other civilizations or geo-cultural areas?
- Are there any traditions, literatures or rituals relating to water management?
- Did economy and agriculture transform or change, and for what reason?

### **3.5.4 The Peak of Civilizations: Advanced Technology of Water Management**

Water management was highly developed, especially the water distribution and transportation. During this period, the civilizations we see the expansion of power, and the domination of lesser states or kingdoms by the more powerful ones. To govern the extensive areas, highly efficient transportation was needed. The economy of the towns still depended on agriculture, but trade and commerce became more dominant due to the increasing

communication between civilizations. Canalisation played a crucial role in various aspects since agriculture was not only to feed the local population but to export as well. The knowledge on taking advantages from water was seen also in battle strategies. Natural features or geography was obviously altered to increase the efficiency of water control and irrigation, therefore, it was necessary to clarify the following questions to reconstruct the picture of water management in this period.

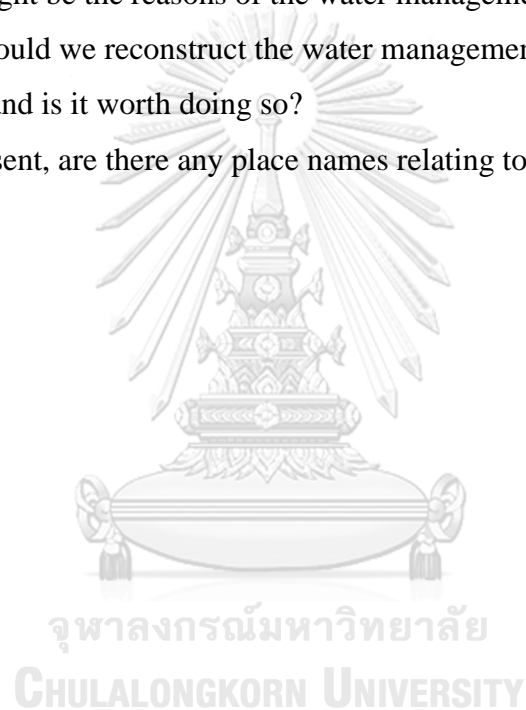
- What unique characters of water management in this period in comparison to the previous period?
- What factors e.g. governing system, social changes, geography alteration, increasing population, knowledge transfer from other civilizations , etc., made water management highly advanced?
- How did natural settings transform from previous time?
- Were there any evidence to demonstrate the high level of ingenuity in water management in this period?

### **3.5.5 The Fall: How Water Management declined or disappeared**

For this stage, it should be noted that the failure of water management and the fall of the towns or civilizations are considerably related. From literature review, it has been observed that many towns or even civilizations collapsed or disappeared due to water shortage or the failure of water management. However, there are many sources showing the continuity of water management from ancient times even though the civilizations or the original towns had fallen. It can be concluded that human adaptation still plays a key role for the survival of their civilizations or towns thus water management can continue functioning. On the contrary, there are many cases that the water management was abandoned and until it was no longer functioning after the towns were deserted because of several reasons or the civilizations were transformed, and the water management was no longer used. For this water management development cycle stage, these questions should be discussed.

- Does the water management in respective ancient towns still function?

- How did the governing system of the ancient towns change?
- Are there any physical evidences of the water management system that still exist? If so, what are they?
- Are water-related traditions or rituals still being practiced or transformed?
- Has the geography and natural setting of the ancient towns changed and how?
- If the water management system of the ancient towns did not work as its original state anymore, are there any recorded events or circumstances that might be the reasons of the water management failure?
- How could we reconstruct the water management system of the ancient town, and is it worth doing so?
- At present, are there any place names relating to water?





WATER MANAGEMENT DEVELOPMENT CYCLE	MULTI-DISCIPLINES							ARTS & HUMANITY					
	SCIENCE	Engineering Architecture Urban planning	History	Landscape /Archaeology	Spiritual/Religious (Anthropology)	Linguistics and Oral History	Society & Economy	Polity & Governance					
Geology Hydrology Ecology	Did water management of any settlements before the emergence of any towns reflect their natural environments?	Were there any changes to natural settings of these settlements?	What were the innovations/functions of water management and how were they characterized?	How were settlements/societies in this period? What was the governing system of the settlements? What is about demography of population?	Was there any evidence of cultural exchange on water management? If so, what are they and how to differentiate the local knowledge and the foreign influences?	What are similarities or differences of water management in comparison to other civilization or geo-cultural areas?	What was water management? Was there any water management techniques?	How did human settlement look like and was communities governed?	How did human settlement look like and was communities governed?	Were there any religions or belief?	Are there any traditions, literatures or rituals relating water management?	Did economy and agriculture transform or change? and for what reason?	Were there any changes in governing system and how did it affect to societies?
<b>Primitive lives:</b> Natural Water Resources	Did water management of any settlements before the emergence of any towns reflect their natural environments?	Were there any changes to natural settings of these settlements?	What were the innovations/functions of water management and how were they characterized?	How did human settlement look like and was communities governed?	What is physical evidence of water management in the early period?	Were there any religions or belief?	What was about the nutrition in this period?						
<b>Early Settlements:</b> Emerging Water Management	Were there any changes to natural settings of these settlements?	What were the innovations/functions of water management and how were they characterized?	How were settlements/societies in this period? What was the governing system of the settlements? What is about demography of population?	How were settlements/societies in this period? What was the governing system of the settlements? What is about demography of population?	What is physical evidence of water management in the early period?	Were there any religions or belief?	What was the food production in this period?	How did human settlement look like and was communities governed?	How did human settlement look like and was communities governed?	Were there any religions or belief?	Are there any traditions, literatures or rituals relating water management?	Did economy and agriculture transform or change? and for what reason?	Were there any changes in governing system and how did it affect to societies?
<b>Settlement Development:</b> Advanced Water Management Techniques	What are similarities or differences of water management in comparison to other civilization or geo-cultural areas?	Were there any changes to natural settings of these settlements?	What were the innovations/functions of water management and how were they characterized?	How were settlements/societies in this period? What was the governing system of the settlements? What is about demography of population?	Was there any evidence of cultural exchange on water management? If so, what are they and how to differentiate the local knowledge and the foreign influences?	Are there any traditions, literatures or rituals relating water management?	Did economy and agriculture transform or change? and for what reason?	How did human settlement look like and was communities governed?	How did human settlement look like and was communities governed?	Were there any religions or belief?	Are there any traditions, literatures or rituals relating water management?	Did economy and agriculture transform or change? and for what reason?	Were there any changes in governing system and how did it affect to societies?

Table 3.3 Water Management Development Cycle

WATER MANAGEMENT DEVELOPMENT CYCLE	MULTI-DISCIPLINES							
	SCIENCE				ARTS & HUMANITY			
	Geology Hydrology Ecology	Engineering Architecture Urban planning	History	Landscape /Archaeology	Spiritual/Religious (Anthropology)	Linguistics and Oral History	Society & Economy	Polity & Governance
<b>Peak of Civilisations:</b> Beyond Water Management Techniques	How did natural settings transform from previous time?	What unique characters of water management in this period in comparison with the previous period?	Were there any evidence to demonstrate the high level of intellectual in water management in this period?	Was there any evidence of cultural exchange on water management?	What factors i.e. governing system, social changes, geography alteration, increasing population, knowledge transfer from other civilisations and etc., made water management highly advanced?			
<b>Fall or Continuity:</b> Collapsing or Sustainable Water Management	Is the geography and natural setting of the ancient towns changed and how?	Does the water management in respective ancient towns still function?	If the water management system of the ancient towns did not work as its original state anymore, are there any recorded events or circumstances that might be the reasons of the water management failure?	Are there any physical evidence of the water management system that still exist? If so, what are they?	Are water-related traditions or rituals still practicing or transformed?	Are there any placenames relating to water?	How could we reconstruct the water management system of the ancient town and is it worth to do so?	How did the governing system of the ancient towns change?

Table 3.4 Water Management Development Cycle (cont)

### **3.5 Using landscape integration approach and methodology for the case study:**

#### **Ayutthaya**

Regarding the cycle of development using the landscape integration approach and methodology applied along with existing studies and researches on water management and water-related events shown in the almanac (Fig 3.2), the water management of Ayutthaya can be identified in five periods as follows.

1) Human Adaptation (before 1350 CE)

This period is a long span of time from the time when the location of Ayutthaya was unknown to the time before Ayutthaya was established in 1350. Water management in this early period includes the dependence of natural freshwater resources, human adaptation to cultivate water and minor inventions to balance water in dry and flooding periods.

2) Emergence of Ayutthaya (1350 -1569 CE)

When Ayutthaya was established, the traditional knowledge in water management was already more developed than in former time. Even the intangible aspect of water management existed as seen in royal ceremonies. It is evident that local wisdom might have been transmitted from previous settlements, wherever they were located. The exchange with nations beyond Chao Phraya river basin and its vicinity also influenced the development of water management techniques and structures.

3) Encircled Ayutthaya (1570-1767 CE)

The centre of the Kingdom's administration became perfectly formed as the City Island around 1569-1570 CE. The advancement of water management of Ayutthaya drew attention of foreign visitors. Several drawings and maps of this glorious capital city were produced and have become sources of information to study the water management of Ayutthaya city island.

4) Abandoned Capital (1768-1868 CE)

After Ayutthaya was defeated in 1767, this capital city was deserted, causing the abandonment of its infrastructure including canal networks connecting to other parts of the Kingdom. This period covers from the period when the centre of Siamese Kingdom was at Thon Buri to the reign of King Rama III of

Chakri Dynasty when Bangkok became the capital city of the Kingdom of Siam. It is considered that, during this period, Ayutthaya was not changed much even though the city wall and some buildings were taken down in order to reuse bricks from these structures to build the city wall of Bangkok. apart from these, no other remarkable changes were evident.

5) Continuation and Change (1868 CE - present)

After time passed, some people returned to settle in Ayutthaya city island, mostly in the outer area of the Royal Palace. Along the course of time, the landscape of Ayutthaya had changed naturally. It was in 1868 CE that Ayutthaya caught public interest again due to the national unification campaign during the colonization period. Later, from the 1960s onwards Ayutthaya city island has dramatically changed by several local factors, as well as impacts from the implementation of the National Social and Economic Development Plan.

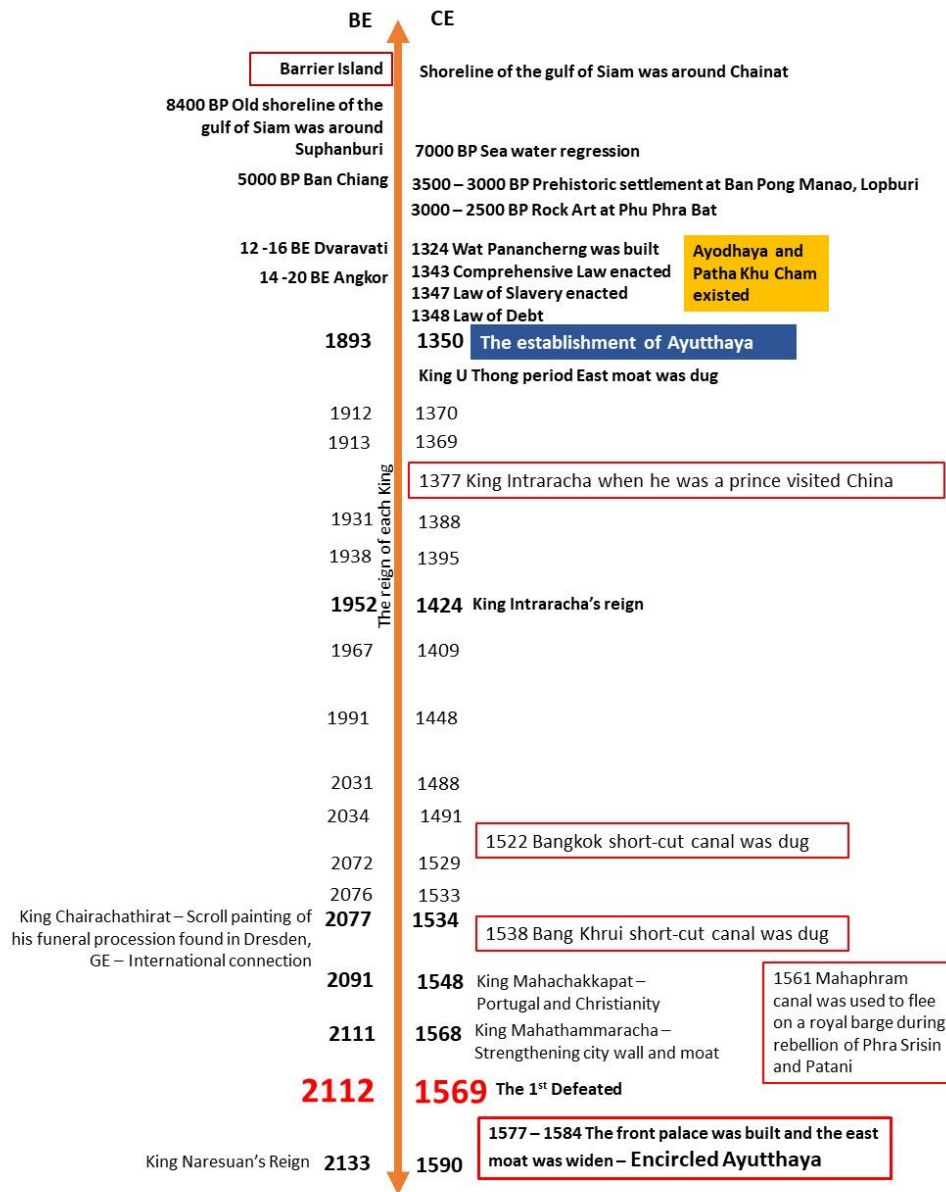


Figure 3.2 Almanac of Ayutthaya and its water management issues

Source: Author

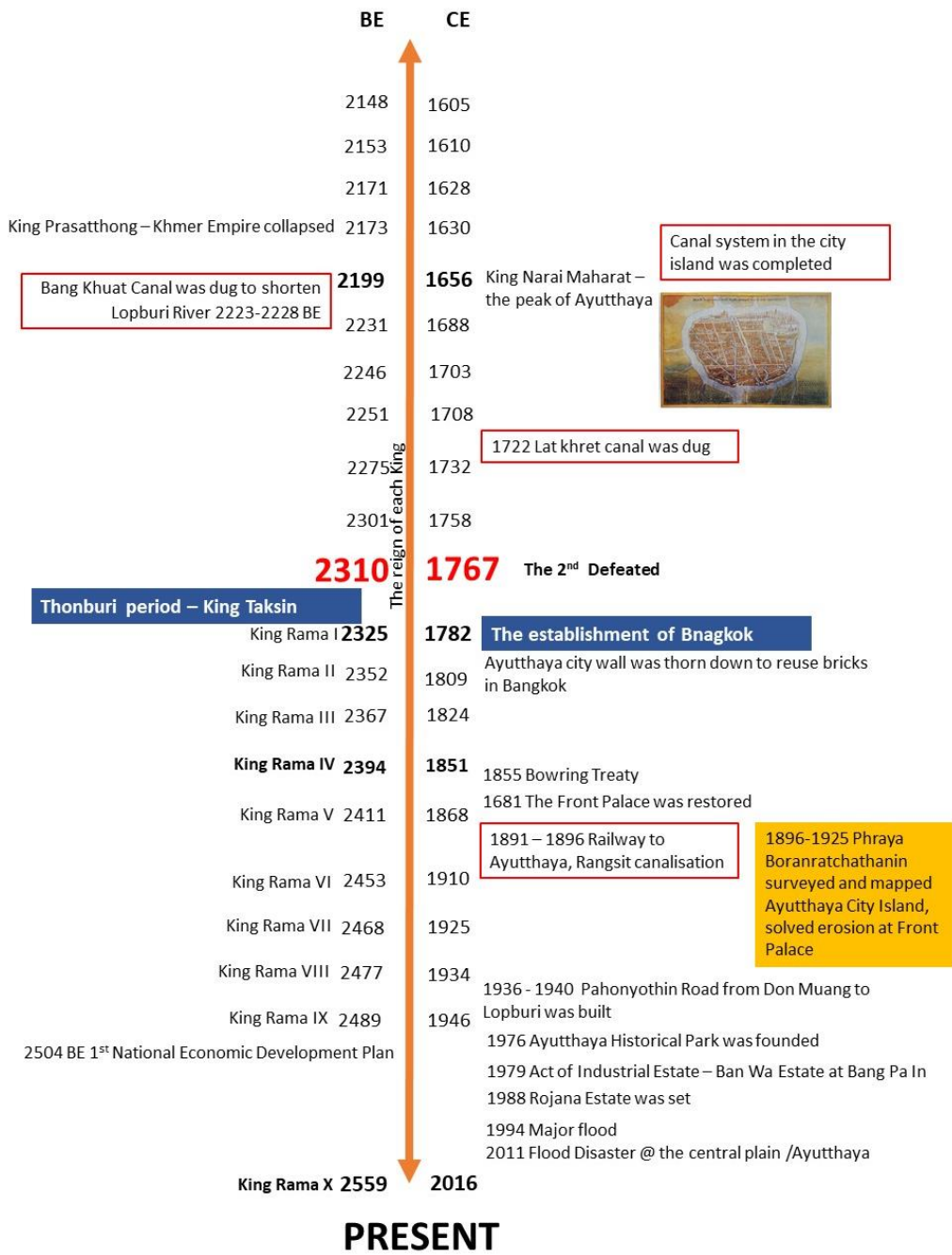


Figure 3.3 Almanac of Ayutthaya and its water management issues (con't)

Source: Author

<b>Disciplines</b>									
<b>Development Cycle</b>	<b>Period</b>	<b>Geology Hydrology Ecology</b>	<b>Engineering Architecture Urban planning</b>	<b>History</b>	<b>Landscape/ Archaeology</b>	<b>Spiritual/ Religious (Anthropology)</b>	<b>Linguistics and Oral History</b>	<b>Society/ Economy</b>	<b>Polity/ Governance</b>
<b>Human Adaptation</b> Before Ayutthaya- Early Settlement	Before 1350 CE	Did water management system of Ayutthaya reflect its geological, geomorphological and hydrological conditions?	How have these natural factors affected the water management system?	What was water management in Ayutthaya?  How was the management emerged and developed in this period?	What is/ are the evidence of water management in Ayutthaya?	Was the knowledge in water management in this period adopted or adapted from other towns/ civilisations?			What was the governing system of Ayutthaya in this period?
<b>Emergence of Ayutthaya</b> Transmission and exchange local wisdom and knowledge	1350 - 1576 CE		How have these natural factors affecting the water management system?	What was water management in Ayutthaya?  How was the management emerged and developed?	What is/ are the evidence of water management in Ayutthaya?  How did the management change the landscape?	Why was the water management built?  How did human in those days know how to manage water?	Are there any literatures, local tales or legends telling about water management?	What was the social structure that related to water management?  Does economic changes effect to water management	Was governing system of Ayutthaya in this period different from the previous time?

Table 3.5 Using landscape integration approach and methodology to Ayutthaya.

<b>Disciplines</b>									
<b>Development Cycle</b>	<b>Period</b>	<b>Geology Hydrology Ecology</b>	<b>Engineering Architecture Urban planning</b>	<b>History</b>	<b>Landscape/ Archaeology</b>	<b>Spiritual/ Religious (Anthropology)</b>	<b>Linguistics and Oral History</b>	<b>Society/ Economy</b>	<b>Polity/ Governance</b>
<b>Encircled Ayutthaya</b> The Glory of Water Management	1577 - 1767 CE			What was water management in Ayutthaya?  What were the water management technology and techniques?	What is/ are the evidence of water management in Ayutthaya?  How did the management change the landscape?	Why was the water management built?  Was the knowledge in water management adopted or adapted from other towns?	Are there any literatures, local tales or legends telling about water management?	What was the social structure that related to water management?  Do the occupations/ crops i.e. rice reflect the water situation in the past?  Does economic changes effect to water management system i.e. transportation, storage/irrigation ?	How did politics influence to water management i.e. state security, water sharing?

Table 3.6 Using landscape integration approach and methodology to Ayutthaya (cont')



<b>Disciplines</b>									
<b>Development Cycle</b>	<b>Period</b>	<b>Geology Hydrology Ecology</b>	<b>Engineering Architecture Urban planning</b>	<b>History</b>	<b>Landscape/ Archaeology</b>	<b>Spiritual/ Religious (Anthropology)</b>	<b>Linguistics and Oral History</b>	<b>Society/ Economy</b>	<b>Polity/ Governance</b>
<b>Abandoned City</b> The Fall of Ayutthaya	1768 - 1851 CE			What was water management in Ayutthaya?			Are there any literatures, local tales or legends telling about water management?		How did politics influence to water management i.e. state security, water sharing?
<b>Continuation and Change</b> Ayutthaya Revival: Continuing and Living	1852 CE - present	How geological, geomorphological and hydrological conditions has been changed?  Do the changes impact the water management in Ayutthaya?	How have the natural settings been changed?	What was water management in Ayutthaya?  What were the water management technology and techniques?	Are there any archaeological evidence or remains of the past water management?	Was the knowledge in water management adopted or adapted from other towns?	Is there any name place relating to water or water management?	Are people who live in Ayutthaya at present the same as who lived in previous time?	How did politics influence to water management i.e. state security, water sharing?

Table 3.7 Using landscape integration approach and methodology to Ayutthaya (cont')

## Chapter 4

### **Before Ayutthaya: Water Management in Early Periods**

Before 1350 CE, the history of Ayutthaya located at the lower plain of Chao Phraya delta is still mysterious, especially for general public. From the time that the Chao Phraya river delta emerged, circa 2000 -1000 BP or 200 -1000 CE to the establishment of Ayutthaya in 1350 CE (Hutangkura, 2014a) is a long span of time when comparing to other civilizations in other parts of the world which evolved, developed, and declined several times. At present, in Thai history, it is generally accepted that Sukhothai which was a kingdom with different culture, located in the lower northern region of present-day Thailand was a dominating state before the emergence of Ayutthaya, however, the information on Ayutthaya and its exact location prior to the establishment of the kingdom has not been clearly mentioned. Records and studies on specific issues such as water management, therefore, is even harder to find. This chapter aims to explore the water management in the area which was developed into Ayutthaya Kingdom, particularly the administrative centre of the kingdom known as Ayutthaya city island or *Ko Mueang*. From the proposed methodology, various information using various disciplines is collected and analyzed in order to reconstruct the possible picture of water management in this period.

This chapter is organized chronologically and addresses four main issues which subsequently culminate into the establishment of Ayutthaya and its water management system. It begins with how the Chao Phraya delta where Ayutthaya is located emerged and evolved, followed by the discussion on living condition of people in the early period when their lives relied on natural condition including water and food consumption. This part also provides the information on rituals based on local beliefs relating to the means of water management in proto-historical period. The next part discusses the early states or kingdoms founded in the area adjacent to or in the vicinity of Ayutthaya city island. Their civilizations, including the knowledge in water management were probably transmitted to or had influenced Ayutthaya in later period as seen from several evidences. The final part of this chapter proposes a town which is asserted as a prototype of water management system of Ayutthaya and discussed two previous settlements which became Ayutthaya in 1350 CE.

## 4.1 Emergence of the Chao Phraya Delta (6000 - 500 BCE)

### 4.1.1 Chao Phraya Delta

According to S. Tanabe et al, Chao Phraya delta was formed as the wide delta plain by river deltas including Mae Klong, Tha Chin, Chao Phraya and Bang Pakong flood plains (see figure 4.1). The delta system comprises delta plains composing of flood plains and beach ridges, river mouth flats, tidal flats, delta fronts and prodelta (Tanabe et al., 2003). From the studies of various scholars, the area where the present Sing Buri province is located, which is to the south of the present-day Gulf of Thailand was submerged in seawater as a result of the Holocene Maximum Transgression (Hutangkura, 2014b; Khaokheiw & Supajanya, 2005). It should be noted that, at present, it is accepted by scholars that the transgression did occur in this area, however, the specific period and duration as well as the boundary of affected area are still being discussed and scientifically proved by the scholars based on the new theories and technologies developed over time, such as landscape archaeology, pollen analysis, radiocarbon dating or Carbon-14, etc.

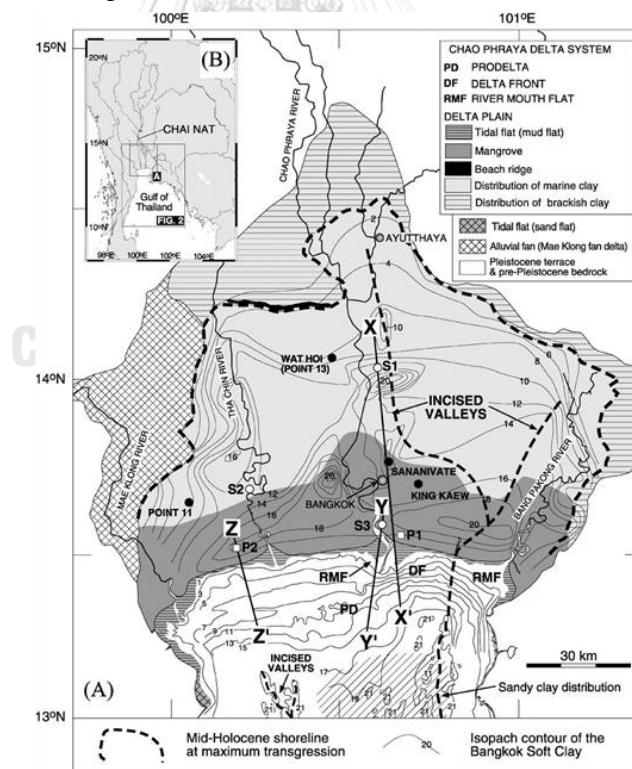


Figure 4.1 Chao Phraya Delta

Source: Tanabe et al (2003).

Considering the emergence of civilizations in the area of present-day Thailand, Chao Phraya river has played a crucial role in development of the hunting-gathering society to the formation of city states and kingdoms. The reason is believable to base on the fact that water is one of the most important factors of human existence. Originating from the mountainous area in the north of the mainland Southeast Asia in Thailand, the four rivers, namely, Ping, Wang, Yom and Nan flow southward. They join at the area known as “*Pak Nam Pho*” in Nakhon Sawan province where they become the Chao Phraya river, which flows southward to the Gulf of Thailand. It should be noted that, in Thailand a river may be named differently when it passes certain areas, for example, Noi river which is a branch of Chao Phraya river is called by the name when it flows through Chai Nat province, while it is called Sikun canal when it passes Amphoe Sena of Ayutthaya province. In case of Chao Phraya river, it was called *Menam* in “A Map of the Course of the River Menam from Siam to the Sea” shown in *Du Royaume de Siam* written by Simon de La Loubère (Loubere, 1688), a French envoy who visited Ayutthaya in 1687 CE (see figure 4.2). There have been various theories on the origin of the name “Chao Phraya river”.



Figure 4.2 A Map of the Course of the River Menam from Siam to the Sea

Source: Tangsirivanit, T(2006)

Regarding the character of the central plain of Thailand, the plain covers several river basins including Chao Phraya, Tha Chin, Mae Klong and Bang Pa Kong. It can be categorized into two main parts due to the geomorphology of the plain as follows (Takaya, 1969).

a) Upper central plain

The upper central plain is an undulating terrain which is 40-60 metres high above sea level. The plain covers the area around Sukhothai-Uttaradit provinces to *Pak Nam Pho*, which is the beginning of Chao Phraya River (see figure 4.3). Flood plain, terrace and swamp are the geological features found in this area.



Figure 4.3 Upper central plain of Thailand

Source: [http://210.86.210.116/chalengsak/m5/geography/unit/unit5/chapter13/M\\_topography.html](http://210.86.210.116/chalengsak/m5/geography/unit/unit5/chapter13/M_topography.html)

b) Lower central plain

This plain covers the area from Pak Nam Pho to Chao Phraya river mouth at the Gulf of Thailand. The area inclines toward the mouth of Chao

Phraya river. According to the geohistorical analysis of topographic and potamologic units by Takaya S (1969), the lower central plain of Thailand comprises three parts 1) Sing Buri Plain 2) Bangkok low land and 3) Phraek trough (see figure 4.4). Sing Buri Plain is approximately 5-15 meters above sea level. The plain covers Sing Buri province, south of Pak Nam Pho, NakhonNakhon Sawan province to Amphoe Ban Phraek district of Ayutthaya province. The area from Ban Phraek district to the mouth of Chao Phraya River is called Bangkok low land, situated at approximately 0-5 metres above sea level. There are several geological traces of the river flow such as the character of oxbow lake and meander scar. Other geographical features found in this plain include marsh, tidal flat, delta, beach, and sand bar.

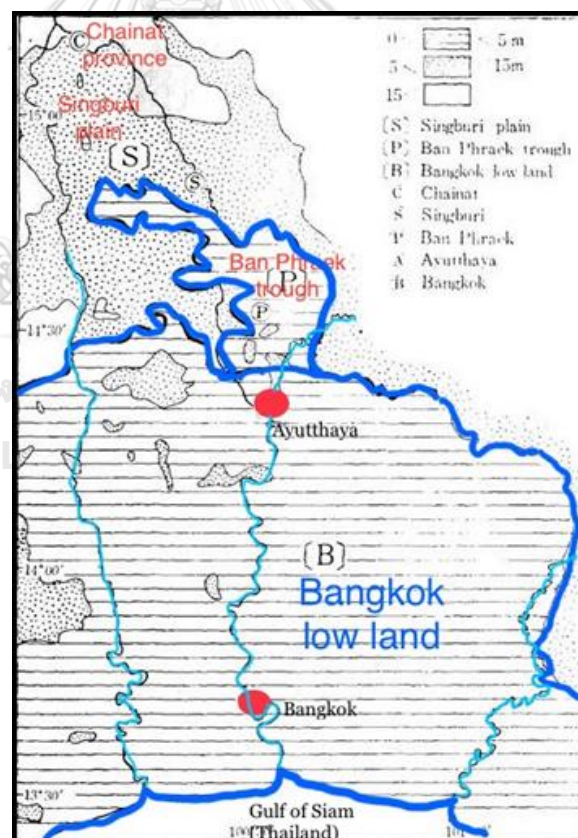


Figure 4.4 Lower central plain including Sing Buri plain, Phraek trough and Bangkok low land

Source: Takaya Y. (1969)

According to Hutangkura, the shoreline of the gulf of Thailand had changed over time since 8000-7000 BP when the seawater maximum transgressed into the land where Sing Buri province is located nowadays. Using the geomorphological analysis, palynology and calibrated radiocarbon dating, the changes of the shoreline of the gulf of Thailand can be reconstructed. In consequence, it also implies how the lower central plain of Thailand emerged. The Bangkok low land including the area which has become part of Ayutthaya had developed to emerge as Chao Phraya delta in five stages (Hutangkura, 2014b).

- Around 8000 - 7000 BP, Bangkok low land was a shallow sea which was about 3-10 metre deep. The mangrove covered the areas of Suphan Buri, Ayutthaya, Ang Thong, Nakhon Nayok and Prachin Buri provinces (see figure 4.5).

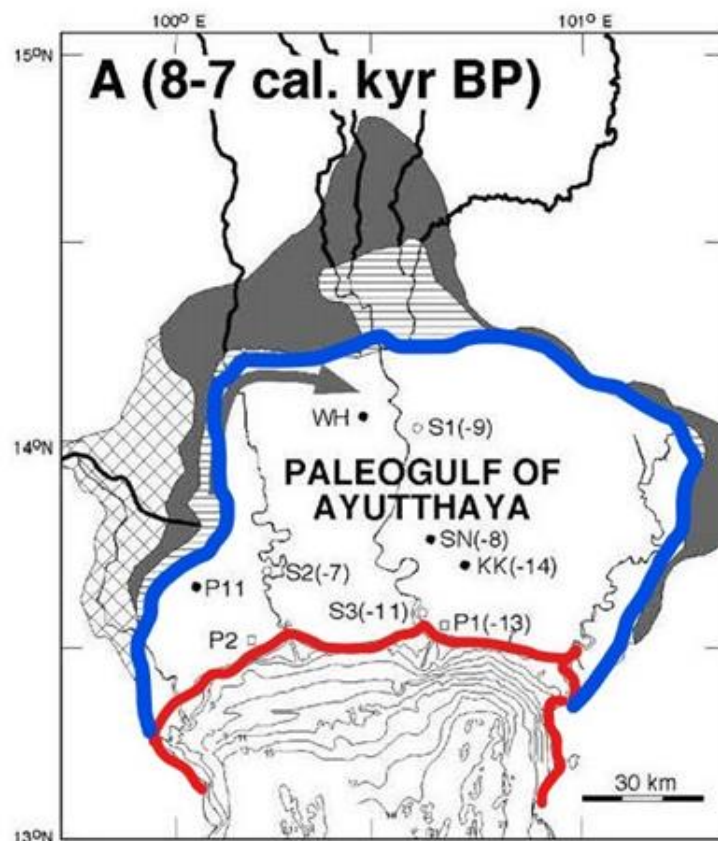


Figure 4.5 Paleo gulf of Ayutthaya

Source: Tanabe et al (2003).

Blue line is the proposed ancient shoreline. Red line is the present shoreline

- Around 7000 - 6000 BP, the seawater started receding. As a result, the coastal line moved down to the area of Pathum Thani province. (see figure 4.6).

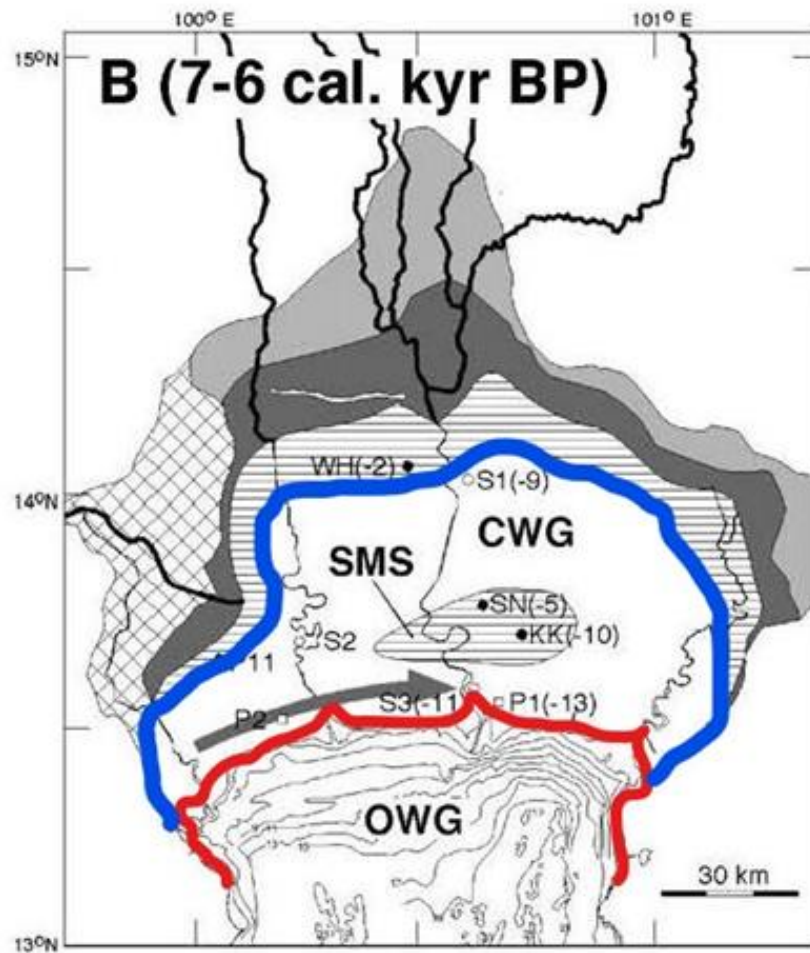


Figure 4.6 Chao Phraya Delta 7000-6000 BP

Source: Tanabe et al (2003).

Blue line is the proposed ancient shoreline. Red line is the present shoreline.



- Around 4000 BP, the coastal line moved southward from the previous period to the area of Nonthaburi province and the eastern side of Bangkok. It should be noted that the Khok Phanom Di archaeological site, , is evidently dated back to this period when the eastern side of the Gulf of Thailand emerged and was habitable, however, the area was still inundated thus the higher area or *Khok* was chosen for settlement. This implies that the surrounding areas might still be flooded seasonally (see figure 4.7).

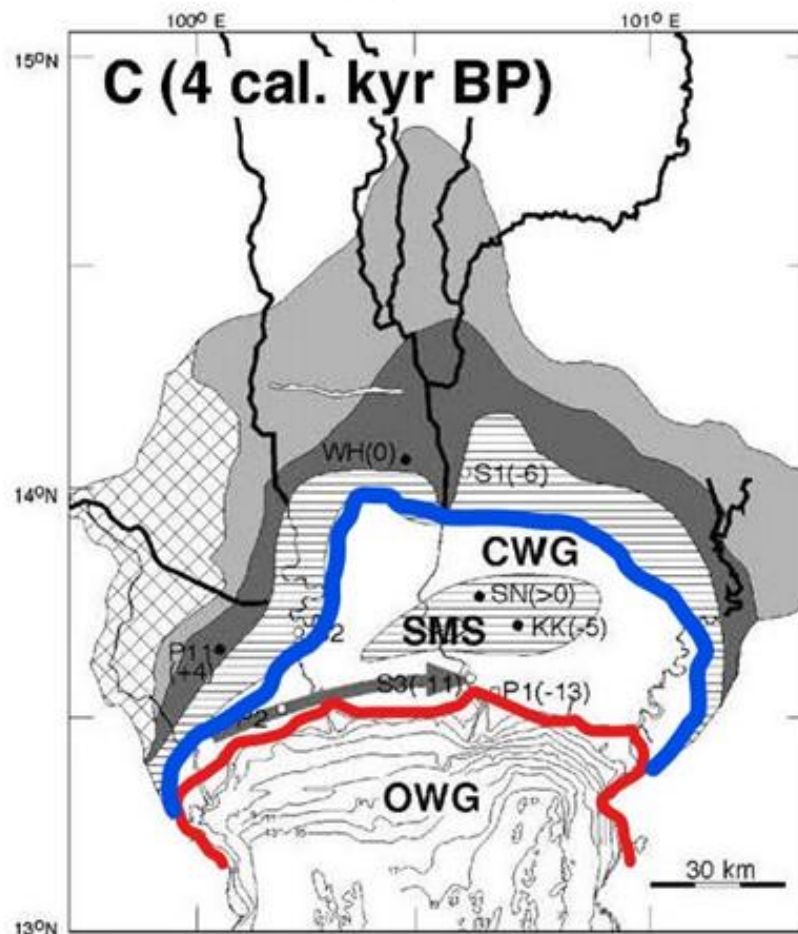


Figure 4.7 Chao Phraya Delta 4000 BP

Source: Tanabe et al (2003).

Blue line is the proposed ancient shoreline. Red line is the present shoreline.

- Around 3000 BP, the coastal line moved to the north of Bangkok according to evidence of early settlements found at Chachoengsao, Ratchaburi and Samut Sakhon provinces (see figure 4.8).

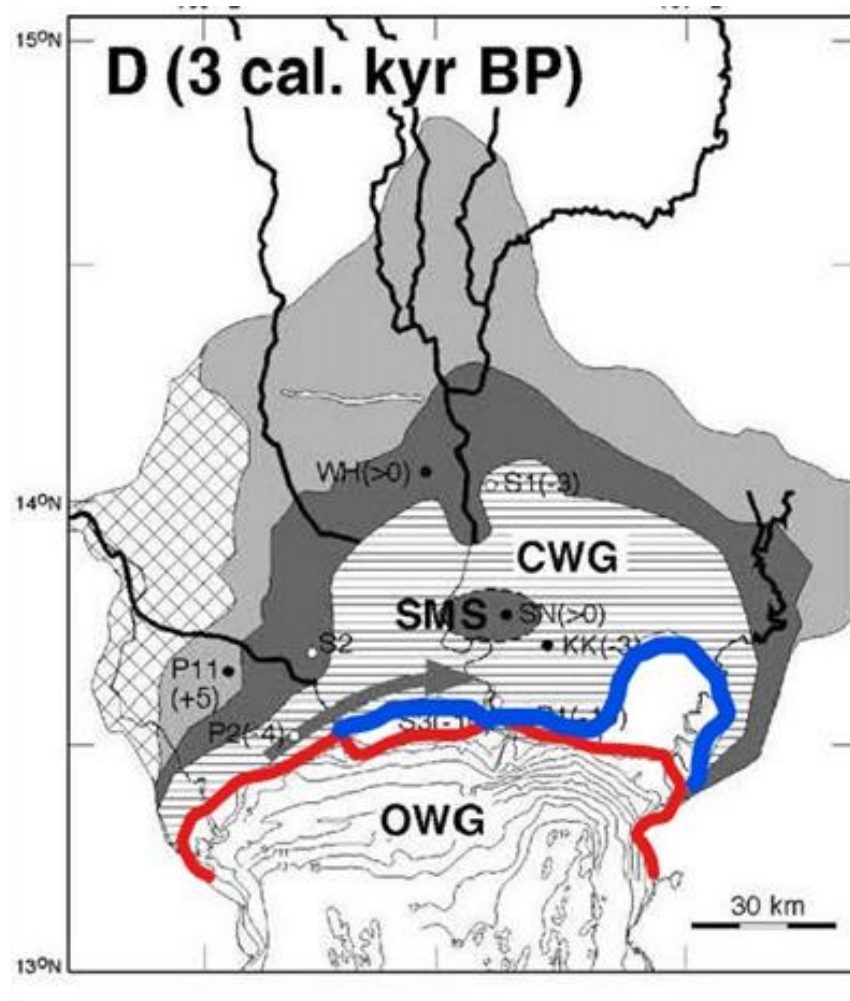


Figure 4.8 Chao Phraya Delta 3000 BP

Source: Tanabe et al (2003).

Blue line is the proposed ancient shoreline. Red line is the present shoreline.

- Around 2000 BP, the coastal line might have moved to Ban Phaeo and Khrathum Baen districts or Samut Sakhon province, the south of Bangkok as well as the north of Samut Prakan province. The flood plain area was very vast and full of natural ponds. During this period, it is believed that the city states of Dvaravati civilization such as U-thong and Khu Bao might have been founded at the areas on the rim of the Bangkok low land, approximately four metres above sea level (see figure 4.9).

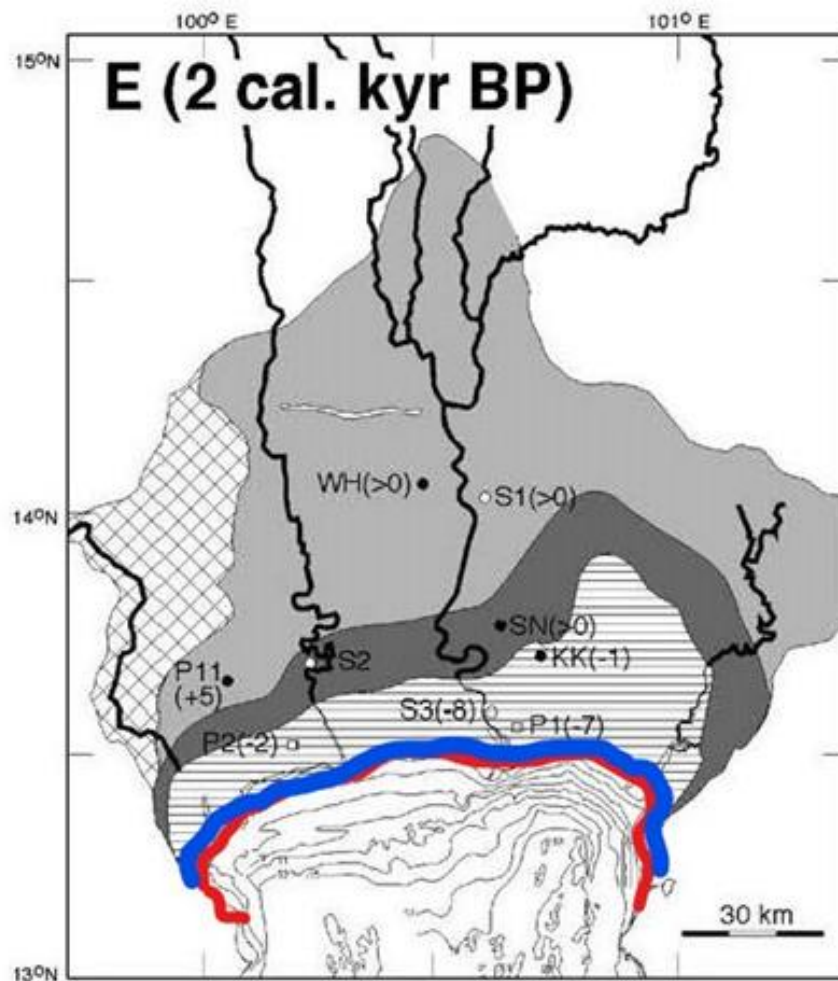


Figure 4.9 Chao Phraya Delta 2000 BP

Source: Tanabe et al (2003).

Blue line is the proposed ancient shoreline. Red line is the present shoreline.

From existing studies, all settlements of Dvaravati culture were founded at the areas of four metres high above sea level. Hutangkuru asserts that the inundation during 2000 -1000 BP might be too high to settle even along the levees, therefore, no evidence of settlements along the levees of Chao Phraya river from Sing Buri to the mouth of the river at the gulf have been found although the seawater had gradually retreated to the area where the shoreline is at present. It can be concluded that, there were no settlements founded until 200 – 1000 CE around the low land, the possible location which could have been developed into the city of Ayutthaya.

On the other hand, according to Takaya S (1969), another geological character of the possible natural condition of settlement at Bangkok low land is Barrier Island. The locations of Ayutthaya city island and Bangkok were identified as “the barrier islands” where higher mounds appear among lower land or swampy areas (see figure 4.10). It is asserted that the barrier island areas were chosen as settlements probably because they were higher than flooding level, whereas normally levees along Chao Phraya River should have been selected prior to other areas. Thus it can be said that the barrier islands were higher than levees, providing a habitat which was safer from flood than levees.

In fact, it is conceivable that, when the seawater recessed to the area southward from Ayutthaya, the first group of people came to settle in the area of the city island. Undoubtedly, the barrier island where Bangkok is situated was too close to the sea. In consequence, people might consider on the security aspect thus they chose to live at some distance away from the sea, for example, the Kampong Ayer in Brunei Darussalam. It is believed that the ancestors of the Bruneian moved to Borneo Island from the sea by boats, then they first settled down along the coastal area. Later, they might have experienced and observed natural phenomena and risks so they gradually moved to the inner land where their settlement was protected from sea-related hazards, ranging from storm surge to invasion from the pirates.

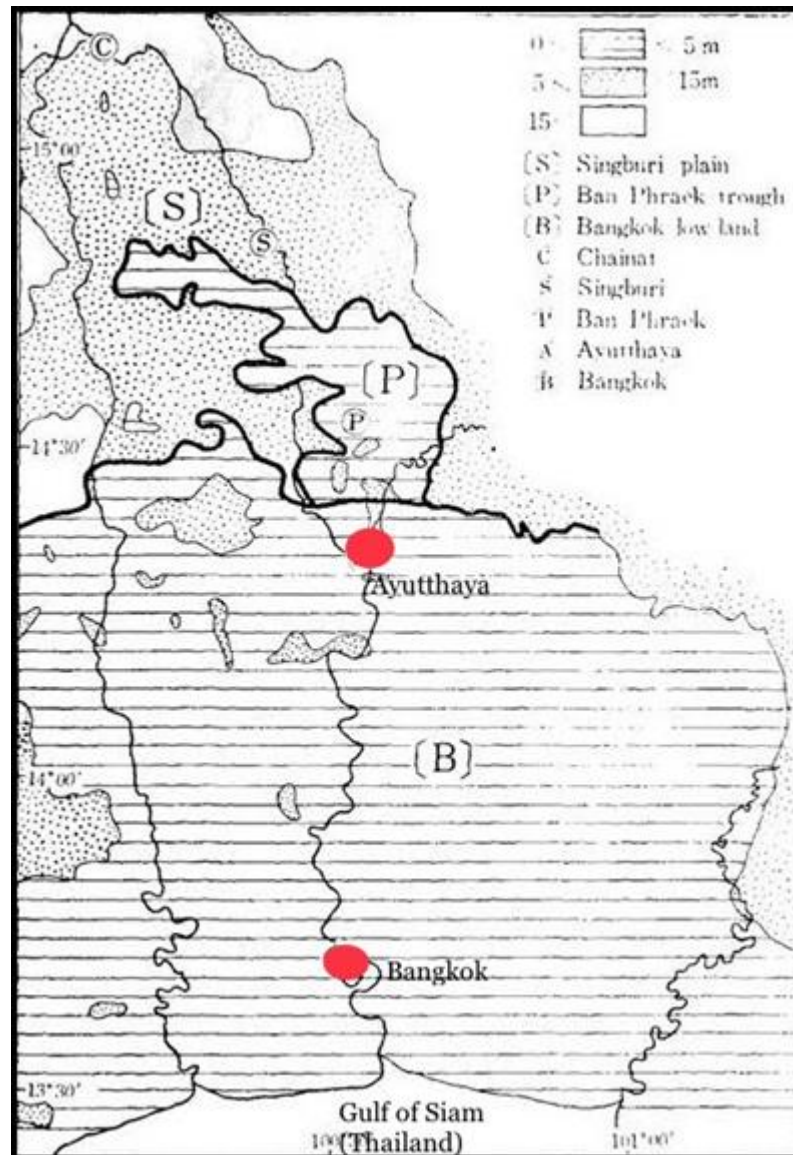


Figure 4.10 Old barrier islands where Ayutthaya and Bangkok are located

Source: Takaya, Y (1969)

Similarly, based on human instincts, the people who first moved to the low land of the lower central plain began from the inner land, they gradually moved down toward the mouth of the river and decided to settle at the barrier island where the settlement was developed from hunting –gathering society to a city state from 200 CE to 1000 CE.

## **4.2 Water from Mother Nature (500 BCE- 500 CE)**

### **4.2.1 Human adaptation to natural environment**

According to settlement and society development in all civilizations, natural condition is one of the most important factors for their survival and continuity. It is apparent that most water-related areas such as river basins, flood plains, deltas and riverine areas are homes of those civilizations. One of the reasons, which may be the most important reason is that fresh water is one of the fundamental needs for human living, therefore, living near the river or water resources can ensure enough fresh water for consumption. On the other hand, river plains, particularly in delta areas and the low land where river flow is slower are naturally more fertile than other geological areas because of the sediment composite. As a result, the phenomenon allows various kinds of sediments deposition. With enough water and fertile land, various kinds of vegetations naturally thrive in these areas, providing nutritional resources for man in early period. Furthermore, rivers were used as a main means of transportation because it was the easiest way to move from an area to another area. If the river connects to the sea, the area became more activated since people from various civilizations could access and exchange products as well as knowledge. Consequently, the sedentary settlements were formed and developed.

Since Ayutthaya emerged earlier than other areas in the lower part of Chao Phraya delta due to its geomorphological character as a barrier island, it was chosen to be settled down by people in that period and presumably developed from a small settlement into a big community. However, up to the present, there are not scientific proof of how people in the early period dealt with water surrounding the area of Ayutthaya. Nevertheless, it can be said that in that period, instead of managing the surrounding, people adapted themselves to their environment by observing natural phenomenon to understand and select a place to be settled down. Even though the existing studies and researches on the adaptation of people who first came to this area is still limited, some evidence from other archaeological sites of contemporary period may be a potential prototype of the settlement and human adaptations for survival which occurred in Ayutthaya.

**a) Fresh water resources: early lesson learned from nature**

In early period of any settlements, there are a great number of evidence found around the region and the world of natural water storages. Undoubtedly, people consumed water from surface ground water resources such as rivers, ponds, natural water reservoirs , etc. as well as underground water resources. For human beings, the basic requirement of drinking water is hygiene, therefore, it is unarguable that human learned how to find hygienic water resources for its survival. While the sources of water used for other purposed were varied. For thousands of years, the underground water has been brought up for the communities' consumption in some areas, particularly in where there is lack of surface water resources. It is found that the underground water is purified by natural filters formed in several layers above the underground water channels. For the purpose of underground water acquisition, the techniques and devices to pump up the water was developed. It can be seen that, in some regions the underground water channels are a large network, one of the most world-famous underground water network is found to extend across the region from the Middle East and Maghreb to the West of China, which is called by different names based on the areas and local languages. For example, in Iraq and Iran these networks are known as *qanut*.

On the contrary, in this period, it seems impossible to consume underground water in the lower central plain of Chao Phraya delta. The reason is that, considering the stratigraphy of the lower central plain of Thailand especially in Ayutthaya, the underground water table which is purified for consumption is found at the shale floor, approximately 20 to 120 metres deep, therefore, to pump up the underground water, it was necessary to drill through the shale floor which is obviously deep and difficult. Accordingly, due to the drilling and pumping technology at that time, it is believable that underground water was not used for consumption (anon., 2020).

On the other hand, it can be said that rainwater was the most hygienic water for consumption in the past due to the unpolluted environment, whereas surface water from rivers or ponds might serve other kinds of domestic uses.

In the higher land connecting to mountainous areas, around the lower central plain such as Suphan Buri and Lop Buri, natural springs or permeating waters were water sources found in several early settlements. The discovery of these water resources might be one of the important reasons that people chose to live there. In many cases, the origins of these settlements are suggested by place names, for instance, Sap Champa, an early settlement located Lop Buri in Lop Buri province, the term “*Sap*” literary means spring in Thai language (anon., n.d.-b). Thus communities or villages that have this term “*Sap*” in their names are expectable to have springs in their areas. In addition, there are ponds in Suphan Buri which have been considered sacred and still provide water used in royal rituals until today. The source of water feeding these ponds are natural springs found during the time before the establishment of Ayutthaya, evidenced by the information from the Royal Chronicles that the blessed water used in the Coronation ceremony of King U-Thong was taken from these ponds. In this period, it can be concluded that water for consumption and domestic uses were obtained from natural sources by simple tools and technology. As for settlement selection, surface water sources were one of the main factors of consideration so that the community could survive and develop into extensive community or town.

#### **b) Developing agriculture: rewards from nature**

When the lower central plain of Thailand emerged, the areas around the plain were already developed from agricultural communities to cities where food production was needed for their population (Fine Arts Department, 2018a). Considering the water storages or reservoirs discussed in 4.1.2.1, the water was irrigated by digging water channels to divert water to the cultivation areas. As the natural environment of the central plain of Thailand was very fertile and diversified, people could get food from natural environment while domestication of big animals, such as buffaloes and cows, was for labour in various purposes rather than for food. On the other hand, since these areas were close to rivers or ponds, freshwater fishes from those resources should be one of the main foods for people who lived there. Rice cultivation might also



be developed during this time. According to the settlement patterns of Dvaravati towns such as Fa Daet Song Yang town in Roi Et province (see figure 4.11), religious places were always located at the highest area close to the residence of the leader. It is generally seen that the lower areas inside and outside the city moat, were used for agriculture, especially for the wet-rice cultivation, which required large amount of water. For this method of rice planting, rice grains were sown in the inundated rice fields. It took around three to four months for harvesting.



Figure 4.11 Aerial photo showing settlement patterns of one of Dvaravati towns, Fa Dad Song Yang situated in Roi Ed province, taken in 2002.

Source: Fine Arts Department

Vallibhotama S argues that, even in the city state period which included Dvaravati and Lawo, social character of cities was still agriculture-based in which food was produced for their own populations while the international exchange in the latter period was for the exotic and precious goods (Vallibhotama, 1997). In addition, foreigners who came to Ayutthaya mentioned that agricultural cultivation in Ayutthaya, which is believed to be more developed than this period, was simple and easy. They said that the Siamese just threw the plant seeds into the water, probably the flooded areas, then some months later they would get the produce. Moreover, based on the previous statement, some scholars believed that the central plain of Thailand was developed from hunting-gathering society to urbanised city much later than other parts of the world. In conclusion, before 1350 CE the agricultural activities in the lower plain of Chao Phraya delta tended to be based on the adaptation of natural conditions of the areas using simple tools and techniques.

**c) Transportation: natural routes**

It is evident that when cities in the central plain of Thailand were being developed and expanded, there were communications with foreigners from the East e.g. China, Formosa , etc. and the West ranging from India, the Middle East to Roman cities verified by many findings from archaeological excavations such as Roman coins, glass beads, as well as the Chinese bronze mirrors and old documents in other languages, including Indian and Chinese manuscripts, which mentioned “the Land of Gold” or *Suvarnabhumi* or *Suphannaphum*. It is known that, most early settlements and cities in the ancient civilizations were developed on river-related areas i.e. the Nile river valley in Egypt, Ganga – Yamuna river basins of India and Yangtze river in China, however, most capital cities or major towns were situated in or near deltas where there were convenient accesses to the seas or oceans. As for the central plain of Thailand, towns, and cities of Dvaravati and Lawo cultures were located at several river basins such as Chao Phraya river, Lop Buri river, Tha Chin river, Mae Klong river and Bang Pa Kong river. While the well-known and main towns and cities were found near the coastal areas southward

to the direction of Malay peninsula such as U-Thong, Khu Bua, Nakhon Pathom, Phetchaburi, Chumphon, Chaiya, etc.

In recent time, the discovery of the Phanom-surin shipwreck in Samut Sakhon province which is part of the Chao Phraya delta strongly proved the international connection between Dvaravati city states and other parts of the world (see figure 4.12). Important evidence includes a large number of earthenware liquid containers used in sea ships called “amphora”. (see figure 4.13) (Guy, 2017). Considering the location of most cities, they were situated along the rivers. It can be seen from other early civilizations developed such as the Roman, Indian, and Chinese, rivers were the main transportation routes of those cities due to several reasons, for instance, rivers were natural routes of transportation apart from being sources of food. At the earliest time, they hardly need to be intervened apart from minor alteration to facilitate the transportation. Another reason is that water transportation between the cities located in the same river basin was easy and did not require high technology and advanced vehicles. In this era, evidence of waterways in these Dvaravati towns or between the towns and hinterlands are not obvious, which may be due to the limited studies and researches relating to Dvaravati period. According to Michael Wright, the duration between 1200-1350 CE is the dark age or a gap of Siamese history, however, it is an important transitional period of the settlements located in the central plain of Thailand from Dvaravati city states to Ayutthaya Kingdom (Wright, 2016). Apart from a rough information about governing system, trade and social condition of Dvaravati towns in earlier period which are known from historical documents recorded by foreign traders, the clear understanding about these towns is still limited (Krajaejun, 2019). This issue is problematic for the study and research on the emergence of Ayutthaya Kingdom in 1350 CE.

Considering the spoken language, the population of Ayutthaya can be categorized into two groups. The First group is the people whose language is Mon-Khmer language which were the population of Dvaravati and Lawo towns and cities who lived around the areas around Ayutthaya before it

emerged. The second group is people who spoke Tai-Lao language which was developed into the Thai language (Wongthes, 2018). From linguistic studies, these people were originated in the mountainous areas in southern China to the north of Thailand, later, they moved downward along the rivers and ultimately settled at the areas near the Gulf of Siam, or Gulf of Thailand nowadays. The chosen location for settlement was fertile enough to survive while providing means to trade with other nations. Thus, taking advantage from this strategic location, major cities in the lower plain of Chao Phraya delta could have commercial and cultural exchanges with global society as seen from above evidence.



Figure 4.12 The on-site excavated Phanom-surin shipwreck in 2017.

Source: [https://www.silpa-mag.com/history/article\\_13859](https://www.silpa-mag.com/history/article_13859)

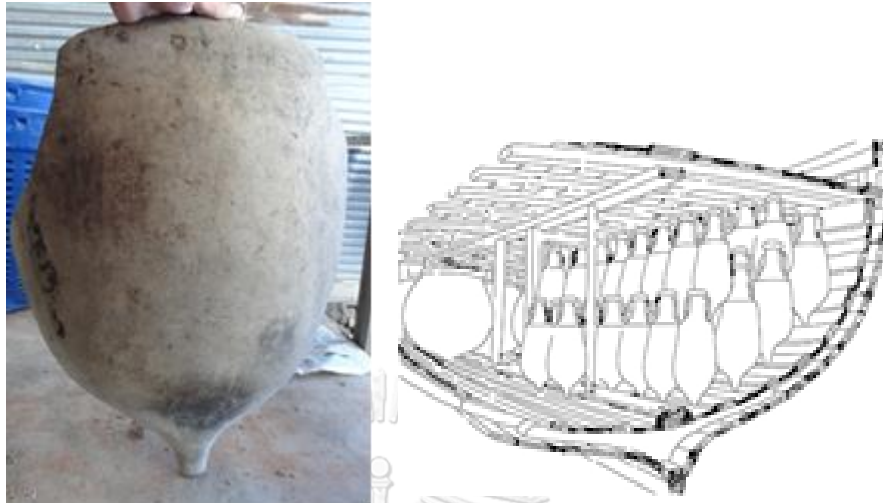


Figure 4.13 (Right) Amphora from Phanom -surin shipwreck. (Left) The drawing shows how amphora was placed in the ship

Source: unpublished report of the Fine Arts Department

International exchange brought a drastic change in the beliefs of local people and the governing system of the communities. It is believable that the increasing amount of benefits from international trade was one of the reasons that the monopoly system in commerce emerged and was adopted by the major and vigorous cities particularly those which were situated by the sea. In order to achieve the monopoly system, the control of natural resources and means of transportation were essential factors, therefore, the power expansion or invasion on other states to seize their natural resources and control the routes connecting cities and resources occurred. Simultaneously, religions including Brahmanism, Buddhism, both Mahayana and Theravada, were first introduced to mainland Southeast Asia. The religions did not actually replace local beliefs but were blended into the existing local beliefs, which have become another powerful tool for gaining people's acceptance and establishing reverence. In consequence, the governing system of towns and cities in mainland Southeast Asia were gradually changed from paternalism to kingship, or, on the other hand, from city state to kingdom (Fine Arts Department, 2018a).

#### 4.2.2 Integrating local beliefs to religions

It has been known that the mainland Southeast Asia is not the motherland of any main religions of the world, however, some religions especially Buddhism and Brahmanism have been established in this area since thousands of years ago and practiced until the present day. In the early time, Brahmanism followed by Buddhism came to this region along with the international maritime trading as discussed in 4.2.1 c) Transportation. On the other hand, on the Silk Roads, important cultural routes connecting China to the West, there were several sub-routes connecting to towns and cities along the main roads, one of these routes which led to Southeast Asian peninsula also brought Buddhism, presumably Mahayana Buddhism, to mainland Southeast Asia (Bradford, 2013; Charoenwongsa, 2013). While local beliefs, especially animism already existed, the religions introduced to Southeast Asia were blended with these local beliefs resulting in the religions, particularly in Buddhism and Brahmanism, of Southeast Asia which have unique identity in terms of practices.

##### a) Animism: respecting nature

In the earliest time, it is believable that water management was created based on human instinct of survival. Undoubtedly, in hunting-gathering society rainwater was the main source of drinking water due to its purity while other natural sources were for other domestic uses. When communities were developed and expanded, some interventions might be made in order to manage water for the expanded societies. One of the powerful tools for control or management might be the beliefs in nature gods, divines, spirits, or supernatural powers which were applied to explain natural phenomena. In some cultural areas, community leader was the one who claimed that he or she could contact those supernatural powers as a medium.

In general, the physical reflection of supernatural powers can be seen in some evidence, for example, the bronze drums in Don Son culture centred in the north of Vietnam to the south of China. From anthropological point of view, the bronze drums decorated with figures of frog which symbolize fertility

demonstrate the beliefs of people in nature gods in those days, however, it is still unclear how to use these drums but they are believed to have been used in rainmaking rituals. Emphasising on the ritual, in a gigantic rock painting in Guangxi Zhuang Autonomous Region in south China, the drums are shown in the painting of an unexplainable ritual (UNESCO., n.d.-f). In addition, the most important decorative figures found on the bronze drums are frogs, which are rain-related animal symbols (see figure 4.14) (Theerajaruwan, 2006; Wongtes, 2006).

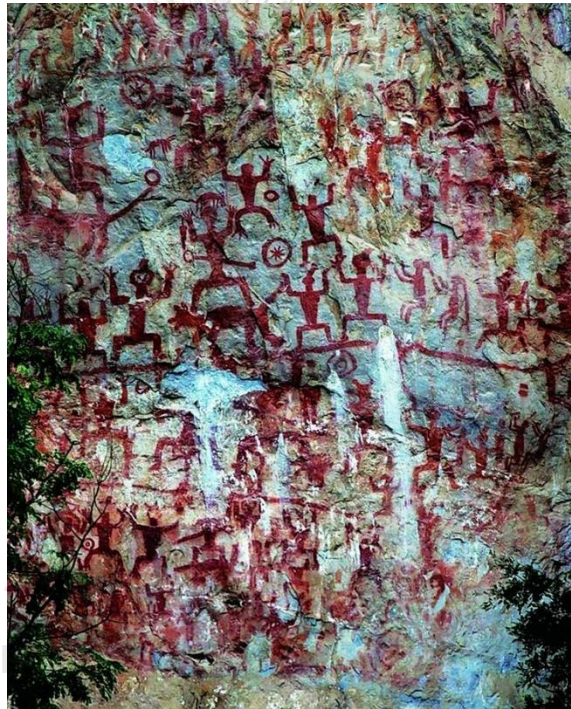


Figure 4.14 Zuojiang Huashan Rock Art showing rituals of Luoyue people  
Source: World Heritage Centre Website. <https://whc.unesco.org/en/list/1508>

Sujachaya S (2015) explains that the rainmaking rituals can be found in agrarian societies where rain is essentially needed. Even though it was argued that the rituals were invented on the basis of animistic beliefs, they have been practiced in the areas where rice cultivation is still the main occupation. It is obvious that the rituals are still practicing in northeast Thailand as well as in Laos. One of those rituals is Bang Fai or Rocket Festival in which traditional

rockets are made and shot to the sky as means to pray for rain from a local deity, Phaya Thaen, who controls the rain. The rocket is made of bamboo inserted with gunpowder balls. Another example of rainmaking rituals is *Hae Nang Maeo* or the cat parade festival. It has been observed that most rainmaking rituals as seen today are practiced by the Tai, a race of people who speaks Tai-Lao language which is the same family as the Thai language (Sujachaya, 2015). It should also be noted that the rainmaking rituals are related to agrarian society which could have been invented and developed at the areas where rainfall might be irregular or in the arid area, however, since the central plain of Thailand has abundant water and regular rainfall, the rituals might have been originated by the Tais who moved to the area where Thailand was developed in later period. Nevertheless, the rituals are continuously performed even in the area of the central plain of Thailand. It is clearly seen that animism became influential to water management of people in this period.

On the other hand, when Brahmanism came into Southeast Asian especially Chao Phraya river basin and its associated areas, “sacred water ponds” including *Sa Ket*, *Sa Kaeo*, *Sa Yamana* and *Sa Kha* have been originated and widely recognized (see figure 4.15). In fact, the belief proves that water has been used as a tool to express power of the head of community, which has become even more influential when Hinduism, another branch of Brahmanism, was introduced to this area in later period. However, it is believed that these four ponds located in Suphan Buri, one of the major cities of Dvaravati culture, were found and worshipped even before Ayutthaya was established (anon., n.d.-c). It can be said that the sacred water ponds demonstrate the integration of local beliefs or animism and the religions, especially Brahmanism in terms of practices.





Figure 4.15 Sacred water ponds dating back to Dvaravati period, including Sa Ket, Sa Kaew, Sa Yamana and Sa Kha at Suphanburi province

Source: [https://www.silpa-mag.com/history/article\\_30541](https://www.silpa-mag.com/history/article_30541)

#### b) Brahmanism or Hinduism

Due to the evidence of inter-trade between towns and cities in mainland Southeast Asia and India which can be dated back to around 200 BCE, it is believed that Brahmanism probably came to this region around the same time (Fine Arts Department, 2018) by the Brahmins who accompanied the Indian traders. In this early period, it seems that the religion did not have remarkable influence, particularly in the lower plain of Chao Phraya delta.

Later, physical evidence of Brahmanism such as statues of gods and deities, Shiva linga, etc. have been found around Thailand since circa 400 CE as Brahmanism and Hinduism are polytheist religions. By the expansion of Khmer Empire to the central plain of Thailand, Brahmanism became influential in the culture developed in this area, therefore, even in later period when Buddhism became the main religion of Siamese Kingdom, Brahmanism still played important roles especially in the administrative circle. The religion has been blended into Buddhism which focuses on the philosophical aspects

rather than on ceremony. It should be noted that, in this period, Brahmanism rarely played a role in governing system while paternalism influenced by Theravada Buddhism was dominant.

### c) Buddhism

Although Buddhism came to this region later than Brahmanism, it has played important roles in these towns and cities in various aspects as follows (Fine Arts Department, 2010).

#### - Governing system

From historical documents on the propagation of Buddhism to Southeast Asia written in later period, it claims that King Ashoka the Great, the Indian Emperor of Maurya Dynasty who ruled the Indian sub-continent around 268 to 232 BCE, sent two priests, Phra Sona and Phra Uttra, as the religious ambassadors to mainland Southeast Asia, known as the *Suvarnabhumi*, meaning the land of gold in order to propagate Buddhism (Fine Arts Department, 2018a). The mission aimed to introduce and disseminate Buddhism to the region. Like Brahmanism, it was not until 400 CE that concrete evidence of Buddhism such as the Buddha images, inscriptions, etc. were found. It should be noted that, in the central plain of Thailand before 1350 CE, there were two sects of Buddhism, Mahayana and Theravada. Initially Theravada Buddhism was introduced to Dvaravati city state and had influence on the governing system of the state through the Buddhist cosmography in *Traiphumikatha* or Book of the Three Worlds. At present *Traiphumikatha* is known as one of the oldest Thai literature written by a king of Sukhothai Kingdom. The literature was intended as a means to teach Dhamma or Buddhist philosophy to people. Phumisak C (1983) claims that the governing system of city state initiated in Dvaravati period was influenced by the idealistic system of Tavatimsa heaven, which is explained in *Traiphumikatha* (Phumisak, 1983). For water management system, even there is no physical trace of Buddhist influence, regarding the principle laid out in the text, the system would be based on the idea of equity, tranquility and

democracy. Therefore, water was presumably distributed to the population on sharing basis for the requirements in agriculture and consumption.

#### -Location and planning

Regarding the studies of archaeology and art history in Thailand, the establishment of Buddhism clearly marked the beginning of Dvaravati city state. Additionally, it can be proved that Buddhist temples were built in Dvaravati period with distinguished art style. Apart from temples found in the cities on the lower central plain of Thailand, temples of other contemporary cities were also located at the higher or highest location in town compared to residential areas, whereas agricultural areas were located at the lower land which was suitable for irrigation system.

On the other hand, this building concept had changed when the lower central plain of Chao Phraya delta emerged and started to form a settlement.

Apparently, temples were located along the rivers or canals, some of which were dug to facilitate accessibility. For the existing temples built before 1350 CE, an aspect of water management and Buddhism, using the local ingenuity in location selection can be seen from *Wat Phananchong, or Phananchong* temple. From the *Krung Kao Chronicles* written by Luang Prasoet, the principal Buddha image of *Wat Phananchong*, a Theravada Buddhist temple located to the south outside Ayutthaya Island was built in 1324 CE (Prasoet), therefore, it is believable that Buddhism was already established and the temple was already built when Ayutthaya was founded in 1350 CE. In terms of water management the influence of Buddhism in this period, may not be very clear and informative, however, from the location of temple, on Chao Phraya river bank, it can be concluded that the site selection for this temple was based on an excellent observation or knowledge in natural environment. The temple is located at the side that is not eroded from river force because the Chao Phraya river current does not crash this side of the river (see figure 4.16). It is worth to consider if this is a reason why this temple was not flooded in 2011, which is known as the most severe flood in the history of the central plain of Thailand.



Figure 4.16 Aerial photo of Phanachern temple when there was a severe flood in 2011

Source: <http://oknation.nationtv.tv/blog/sophon/2011/11/14/entry-1>

-Sema or border marker (see figure 4.17)

It has been a long-held tradition that when a Buddhist temple is established one of the most important tasks is the marking of specific area for religious practices of the temple within the maximum circumference as specified in the Vinaya Pitaka. The boundary must be made by markers, which can be hill, rocks, forest, river, other water bodies i.e. pond, sea and even termite hill (Chamniphrasat, 2016). In general practice, this area is demarcated around the Ubosatha or ordination hall within an enclosure of low partition walls. The border markers normally are placed at the corner of the ceremonial area. It should be noted that most border markers are made of stone. In Thailand they are known as *Sema* stones which have become border markers of typical style for all Buddhist temples.

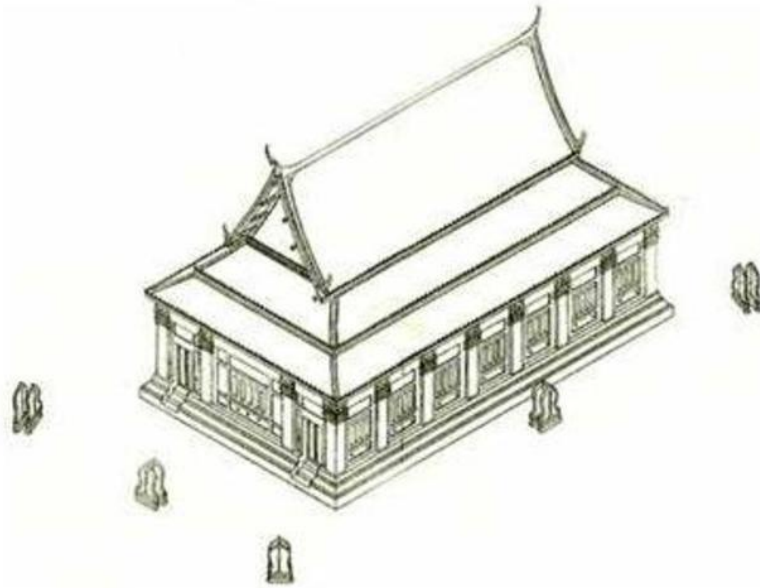


Figure 4.17 Typical location of sema stones at temple nowadays.

Source: <https://www.gotoknow.org/posts/515080>

Concerning the border markers, Vallibhotama S (2016) argues that the tradition of *Sema* stones is not found in India where Buddhism is originated, as well as in Sri Lanka where Buddhism has rooted for thousand years and was passed to mainland Southeast Asia. He believed that *Sema* stones derived from the megalithic culture for ritual or ceremony relating to animism practiced in northeast of Thailand (Vallibhotama, 2016), as clearly seen in Phu Phra Bat cultural heritage site on the mountain range, which is designated as a National Monument site and managed as a historical park. In Phu Phra Bat several groups of boundary stones are seen, set in systematic pattern to mark a boundary of a sacred space (see figure 4.18). The site is an evidence of the establishment of Buddhism in the area, in which the religion was integrated into the local practices and the boundary makers of *Sema* stones were developed. Furthermore, it is uncertain whether this Buddhist tradition were transformed in the central plain of Thailand where the area is surrounded by rivers and water channels. Therefore, the reason that temples in the central plain were located along or near the river may reflect the concept of using

water bodies or river as boundary markers of ceremonial area of a temple (see figure 4.19).



Figure 4.18 Sema stones placed in octagonal direction at Phu Phra Bat Historical Park, Udonthani province

Source: Photo taken by Rungroj Thamrungruang available at <http://sac.or.th/databases/thaiarts/artwork/165>



Figure 4.19 The mural painting at Wat Rachathiwas shows its ceremonial area marked by water element which could be seen at Mon temples in the past.

Source: [https://www.silpa-mag.com/history/article\\_17556](https://www.silpa-mag.com/history/article_17556)

#### **4.3 Knowledge transfer: early settlements and civilizations around lower plain of Chao Phraya delta (500 CE –1200 CE)**

From historical documents such as inscriptions, an assumption was made based on historiographical methodology that there were communities located along Chao Phraya River before the establishment of Ayutthaya Kingdom including the areas around Ayutthaya city island. On the other hand, existing researches and studies on other related civilizations or kingdoms which were founded earlier than Ayutthaya show that those civilizations had various means to manage water for different purposes. Since these civilizations had relationships with Ayutthaya in many aspects, it was possible that the knowledge in water management was transmitted to Ayutthaya. In fact, it is believable that kingdoms founded in later period, such as Ayutthaya would take knowledge in water management from these civilizations that were already proved efficient and effective, therefore, water management in civilizations of later periods can be hypothesized based on the characteristics of water management in the area before 1350 AD.

For the central plain of Thailand during 500 CE –1200 CE, people still relied on natural water sources with limited adaptation as in the former time. According to climate conditions and natural environment, water management main concerns were about how to keep water for dry season and how to live during the annual flooding period. It can be seen that around this area water management system responding to these two issues are found in cultures or civilizations of two races, 1) the Mon, who occupied the city states of Dvaravati around Mae Klong – Tha Chin river basin to the west of Chao Phraya river basin and 2) the Khmer, whose centre of the empire or civilization was in present day Cambodia but its sub-centre was founded in the central plain of Thailand at Lawo or Lop Buri, the present Lop Buri province, occupying the Pa Sak and Lop Buri river basins to the east of Chao Phraya river (Fine Arts Department, 2018a). The water management of these two civilizations gradually developed in the central plain of Thailand as discussed below.

#### 4.3.1 Moated cities (see figure 4.20)

“Dvaravati” has been academically discussed whether it should be identified as a civilization, culture, state, or school of art (Bhumadhon, 2017). These various aspects of Dvaravati have been studied historically and archaeologically. For this research, it is considered as city states founded prior to Ayutthaya period (1350 – 1767 CE). In relation to water management, evidence of continuity of these cities, especially in the central plain of Thailand in later period, were explored.

According to the Fine Arts Department (2018) Dvaravati city states were the result of the development of settlement in central Thailand from hunting-gathering society to agricultural village society and urban society and city state respectively. However, it is noticed by settlements patterns, archaeological evidence and objects that Dvaravati city states were also founded in the northeast and north of Thailand (Bhumadhon, 2017; Fine Arts Department, 2009).

Considering the water management of Dvaravati, as mentioned several times that the central plain of Thailand normally has enough water from various sources thanks to its geography, the main issues of water management in these cities were how to ensure that its population had enough water for domestic uses and consumption during dry season and how to live safely during inundation period. Starting from simple enclosed moated cities, the water management had developed over several hundred years. The basic concept of these moated cities, however, is unlikely to be intended as fortified cities enclosed by city moat and city wall (Vallibhotama, 2016). For the Dvaravati cities, it is clearly perceived that the moats were dug to mark the boundary of the cities and earthen ramparts built parallel to the moat were filled by the soil dug from the moat. Since the city states were founded and developed to its glorious time from 7th to 13th century, their water management was simply constructed to fit into the natural settings, then they were developed to be more complex due to the advanced technologies, which might have been transferred from the Indians or Chinese as well as being a cumulative knowledge learned by observing natural phenomenon.



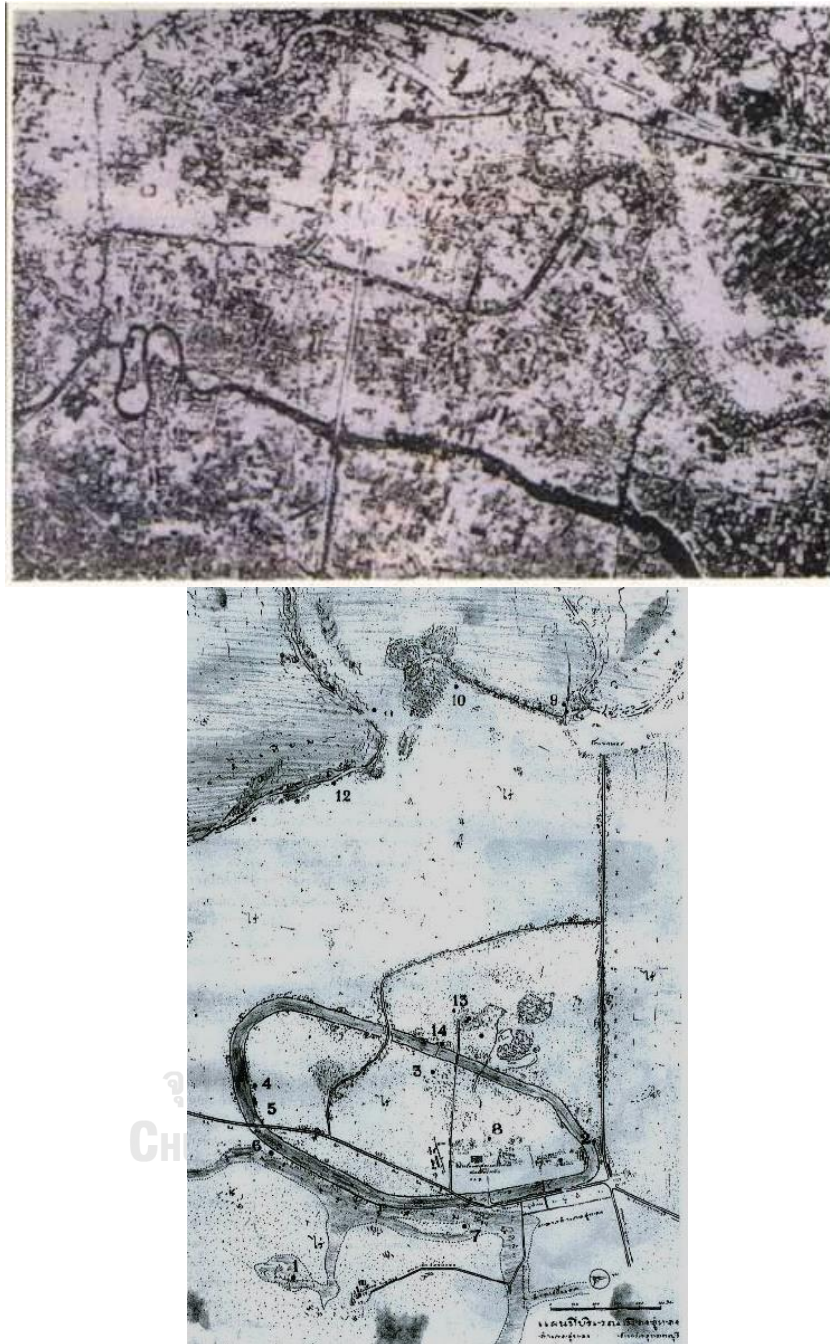


Figure 4.20(Above) Phra Pha Ton town, Nakhon Phathom province.

Source:[https://www.facebook.com/permalink.php?story\\_fbid=911109232281675&id=847549115304354](https://www.facebook.com/permalink.php?story_fbid=911109232281675&id=847549115304354).) (Below) Aerial photo of U-Thong, Suphanburi province.

Source: Vallibhotama, S (2016)

### 4.3.2 Baray

For Lawo city states, it has been known that the centre of this civilization was at Angkor in Cambodia which was founded around late 9th century and abandoned in 1431 CE (Engelhardt, 1995; Fletcher et al., 2008). While Lawo was originated around 7th -8th century and lasted until the 10th century, from the inscriptions found in Lop Buri, the ancient Khmer based at Angkor expanded its power to dominate most of the northeastern and eastern part of Chao Phraya river basin. However, the evidence of ancient Khmer civilization can be seen further to the west of Thailand evident by Prasat Mueang Sing in Kanchanaburi province. Accordingly, the remains of ancient Khmer cities, which normally had temples as the centres of the cities, could be found in the mentioned areas. It is obvious that in the area around these remains, gigantic rectangular water reservoirs were built. The reservoir or *Baray* is known as one of the most important components of the ancient Khmer's cities including the cities that was influenced or colonized by the ancient Khmer (Hang, 2014). *Baray* is part of water management system which comprises the earthen dike or *La Lom* to divert water flow direction to the reservoir (anon., 2008).

The location of Baray in each city normally depends on the orientation of the natural water source. At present, physical evidence of Baray around Lop Buri area has not been found, however, other cities such as Phimai, Mueang Tam and Sa Dok Kok Thom, have their own Barays (see figure 4.21) (Lertlum et al., 2019). It should be noted that, from a number of studies and researches, it is believed that the size of Baray is an indicator for estimating the size of the cities since the water kept in these reservoirs should be sufficient to serve the whole communities.

It should be noted that, evidence of Lawo civilization is also found in Dvaravati towns and cities. Stratigraphy and building layers verify that the evidence is from later period.



Figure 4.21 Phrasat Sa Dok Kok Thom planning including a big rectangular reservoir

Source: <http://www.qrcode.finearts.go.th/index.php/th/historic-site/hs-sra-kiao/sdokkokthom>

#### **4.4 Previous settlements before Ayutthaya (1200 CE -1350 CE)**

Nowadays, it becomes widely recognised that before the establishment of Ayutthaya, settlements might already exist according to several inscriptions, historical documents such as the Chronicles of the North, local legends, folktales and foreign records, as well as the remains of temples, which were presumably built before 1351 CE. As discussed above, many cities of Dvaravati and Lawo city states were situated in the river basins of the old delta at the Gulf of Siam or the Gulf of Thailand at present. Undoubtedly, Ayutthaya and its early settlements were influenced or developed from the city emerged during Dvaravati and Lawo periods.

#### 4.4.1 Ayothaya or Ayutthaya

At present, the debate on the name of the earlier settlement of Ayutthaya still continues. At present, it is generally accepted that Ayothaya, the city located to the east of Ayutthaya city island (see figure 4.22), was founded and developed to become Ayutthaya in later period. While Ayutthaya is the name of both the kingdom and its capital city known as Ayutthaya city island, it should be noted that these two cities emerged in different times. On the other hand, some scholars argue that the name “Ayutthaya” can also refer to the city built earlier (Vallibhotama, 2017a), thus it can be said that Ayutthaya and Ayothaya are interchangeable names for the same city. Due to an inscription engraved in the reign of Phaya Lithai of Sukhothai circa 1347 – 1368 CE, the name of a city called Ayothaya Si Ram Thep Nakhon is mentioned, whereas in other inscriptions from later period call the city Nakhon Phra Ram. In fact, Ayothaya or Ayutthaya are the names of the city of Phra Ram or Rama in the Ramayana, one of the two greatest epics of ancient India, written in Sanskrit, which reflect the influence of Brahmanism or Hinduism because Rama is an avatar of Vishnu, or Narayana, who is called *Narai* (in Thai), one of the three highest Hindu Gods. The names of the city remarkably demonstrate the changing of the beliefs in the central plain of Thailand from city states system to the monarchy. It is also noted that Ayutthaya was formally named Krungthep Thawarawadi Si Ayutthaya, from which the name of the present Thai capital has modelled. At present Krungthep or the City of Angels is popular name of the capital called by the Thais while foreigners still call Thailand’s capital city by the name of its original village of “Bangkok”.

On the basis that Ayothaya was the former town situated at the same place as Ayutthaya, it is believed that the center of the city was further from Chao Phraya river to the east. The remains of temples as well as living temples which still exist nowadays are testifiable that they were built in earlier period based on the art and architectural style as well as historical records, can be found mainly to the east of Pa Sak river such as Wat Ayothaya, Wat Kudi Dao, Wat Dusidaram, etc. The art and architectural style of these temples are believed to have derived from or influenced by Lawo culture. It can be seen that on the eastern side of Pa Sak river, the main canal is Hantra canal, which is the main course of Pa Sak river before the

east city moat was dug and widen during Ayutthaya period, resulting in the river flow direction to the new course, making the old water course smaller until it became a canal. As for the area along the Chao Phraya river to the south of Ayutthaya city island, there are many temples that still function such as Wat Yai Chaimongkhon, Wat Phananchong, etc.



Figure 4.22 Rectangular city plan of Ayothaya

Source: Drawing of Litchatupornchai S in Muang Boran Journal Vol. 43 No1  
January – March 2017

#### 4.4.2 Patha Khu Cham

From several royal chronicles, it is mentioned that when King U-Thong moved from his former towns due to an epidemic to settle down at an area where he found a large natural pond called Nong Sano, known as Bueng Phra Ram situated to the north of Ayutthaya city island. King U Thong temporarily stayed at the place called Wiang Lek which later became the location of Wat Phutthaisawan (see figure 4.23) for three years. After the founding of the city was completed, the King moved to the City Island and established Wat Phutthaisawan temple which has continually been used until the present day. Apart from Wat Phutthaisawan,

other temples remains and living temples are also present. Contrary to the eastern side of the area, it appears that Ayothaya - Suphannaphum art style or U-Thong style which evolved from Dvaravati culture are dominant as seen in the temples located around this part (Khemnak, 2019).

Remarkably, the networks of canals which seem to have been altered from natural water course are observed. In recent period, Khu Cham or Patha Khu Cham canal is identified (Khemnak, 2019). The mouths of this canal join Chao Phraya river (see figure 4.24). It is believed that this canal was the main waterway when King U-Thong stayed at Wiang Lek as it has connection to other smaller canals. Along the remaining part of Patha Khu Cham canal, archaeological evidence of canal-related elements have been discovered, including a small pier.



Figure 4.23 Wat Phutthaisawan (on the right side) where is claimed a location of palace, Wiang Lek, before the establishment of Ayutthaya Kingdom in 1350 CE

Source: <https://www.putthaijatukam.com>

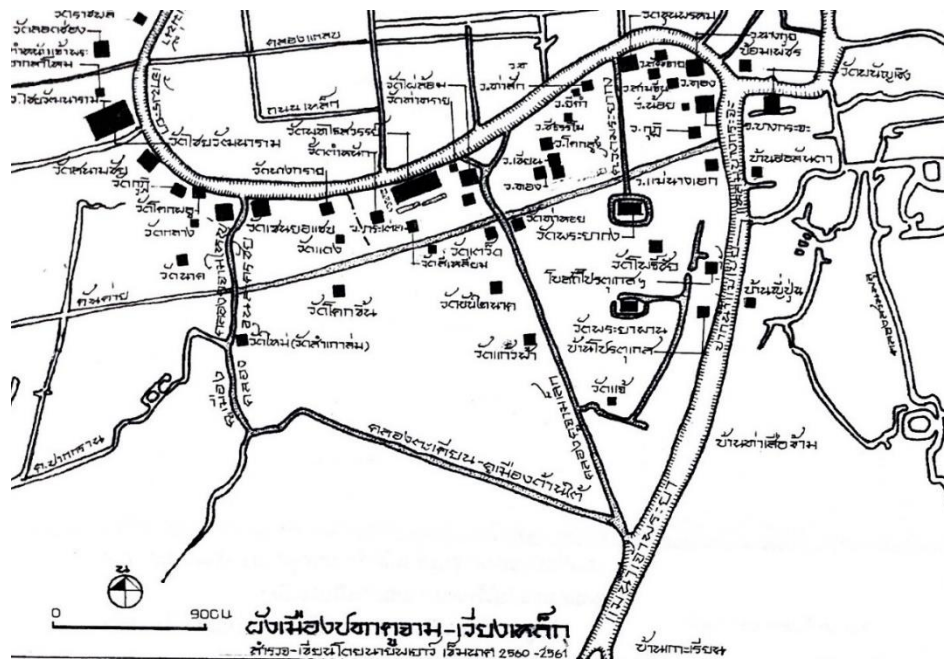


Figure 4.24 Ku Cham or Patha Ku Cham canal

Source: Khemnuk P. (2019).

#### 4.4.3 Prototype of Ayutthaya water management system: Inthra Buri (see figure 4.25).

According to the conclusion that water management system of Ayutthaya was developed from the previously existed cities and influence from Dvaravati culture and also, possibly, Lop Buri culture. An example is Ban Khu Mueang or Inthra Buri. Some scholars proposed that the water management system of Inthra Buri is a prototype for water management system of Ayutthaya.

Inthra Buri is an archaeological site located on a plain where Sing Buri province is located between Chao Phraya and Noi rivers. Based on the study of Boonchan Pariya in 2008, the city of Inthra Buri was square-shaped with rounded corners. Similar to other cities from Dvaravati period, it was encircled by a city moat and earthen rampart, physical evidence of which is still unclear. In general, earthen rampart is a by-product of canalisation thus it is still possible to find the rampart even though the report from an excavation mentioned that the city wall was not discovered. It could be argued that earthen rampart was not prominent as it might

not have been intended for protection purpose or defense since the cities in Dvaravati period were agricultural communities located in fertile areas. Therefore, the history of Dvaravati rarely mentions the conflicts or wars between these cities until the international trade came and expanded in this region. In addition, the earthen rampart, if existed, might have been used for water management purposes such as flood control or irrigation. Within and around Inthra Buri which covered approximately 10 square kilometres, a complex canal network exist which looks like a spider web, connecting canals, natural water channels and rivers. From archaeological survey, the area of within the city moat is approximately 3 metres higher than the average level of surrounding areas (Pariya, 2008). It should be noted that the location of Inthra Buri is at the old Chao Phraya delta which was habitable when Ayutthaya did not yet emerge from the sea. According to its water network and location, it is possible that people who lived there could travel to the sea through Chao Phraya river or Noi river and also to Lop Buri via this route. It is believable, therefore, that Inthra Buri should be one of the cities which adopted cultures of both Dvaravati and Lawo or Lop Buri. This conclusion is not based on the findings from archaeological excavation but the high potential of water transportation route which connected Inthra Buri to other cities to the east and west of the Gulf of Siam.

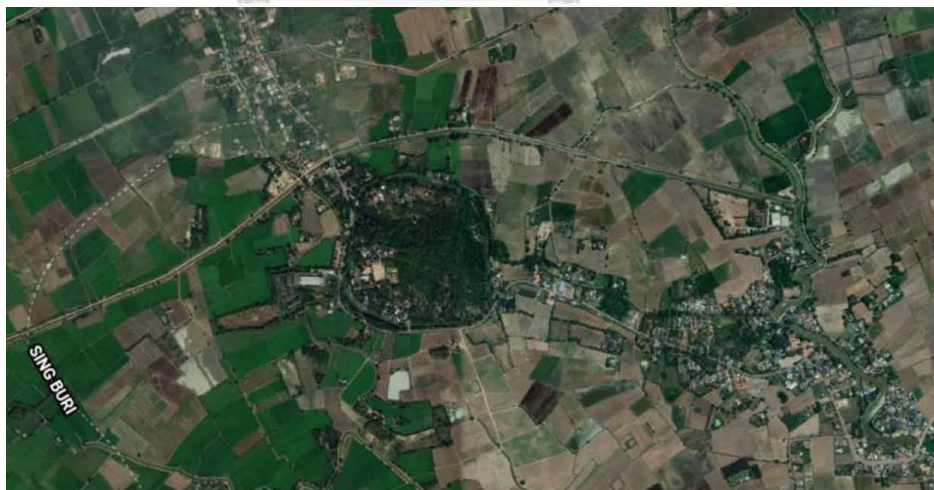


Figure 4.25 Aerial photo of Intra Buri

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors



Regarding soil character of this area, it is mainly silty clay which has low drainage capacity. From archaeological studies, the main concern of water management in Inthra Buri was the large amount of water flowing through the city since the city was surrounded by water while the drainage capacity of its soil type is very low. Consequently, several sub canals were dug in order to mitigate the problems as mentioned. Additionally, there were some interventions to the three main water channels including Khlong Ta Kaeo, Khlong Khai Lan and Lam Kha Rong.

Khlong Ta Kaeo, could have originally been intended as means to divert water from Noi river to the city. However, in certain periods, the amount of water might have exceeded the expectation, therefore, small water channels were built to share and reduce the amount of water. As for Khlong Khai Lan (see figure 4.26), it flows to the city from the higher land so water force might be too strong, causing damage and erosion to the embankments. Two intervention schemes were carried out to mitigate the impacts of the strong water current, the first attempt was to dig small canals in order to decrease the amount of water., and another scheme was to reclaim a piece of land in the river to make an islet in order to divide the water into two channels. As a result, the water force was decreased (Pariya, 2008). It should be noted that, from the interpretation of satellite map, in 2021 the trace of this canal is not clear due to changing landscape, which could have resulted from the newly man-made irrigation canal.



Figure 4.26 Khlong Khai Lan in the dashed line which is disappearing while Khlong Ta Khaew still exists.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

As for Lam Kha Rong, it was located separately, away from the city moat, therefore, a canal was dug to connect this water channel to the northern part of the city moat in order to help circulate the water in the city moat (see figure 4.27). It should be noted that Lam Kha Rong also joins the two water channels of Khlong Khai Lan which resulted from the islet. Another intervention was to construct a canal to connect Lam Kha Rong to the eastern part of the city moat. It can be seen that this intervention was aimed to facilitate the water traffic from Inthra Buri and Lam Kha Rong.



Figure 4.27 Lam Kha Rong on the east side of Intra Buri flows southward to meet Chao Phraya River

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

**Water management system before the establishment of Ayutthaya** (see figure 4.28)

Before Ayutthaya was officially established in 1350 CE, it is conceivable that the area had already been settled down and developed. In terms of water management, this implies that the water management was also developed in the same period as water is one of the most important elements of human's life. The sophistication of water management can reflect the degree of human development in various aspects ranging from the size of community, the progress of social development, beliefs, racial background to technological advancement. Considering the lower plain of Chao Phraya river basin, it can be seen that the area is a young delta, therefore, settlements emerged and were developed later than those which were located in the old delta area and further hinterland. Accordingly, the area southward from Ayutthaya which is closer to the sea developed even later. Therefore, apart from the early settlements and cities found at the old delta and areas above and around the lower plain of central Thailand, the settlements founded during Ayothaya period appear to reflect a clear

picture of Ayutthaya before 1350 CE. Concerning the water management system, this area was abundant with water from natural sources while agriculture was carried out for small-scale consumption which could rely on natural resources. The main purpose of water management, therefore, could be to facilitate transportation. However, due to limited construction technology but high cumulative knowledge in natural phenomenon, people who came to this area at the earliest time could have adjusted their way of life to fit the natural environment. In consequence, there may be minor alteration to suit their changing way of life and society and for intervention from outsiders. When changes exceeded the capacity of the settlements, major inventions as well as creation and innovation were introduced as response to changes for the continuity of the settlements. In case of Ayothaya, when the city faced the problems of increasing population, demography, trade, and city expansion, Ayutthaya with a new regime was established. On the contrary, for several civilizations, cultures or settlements, if they were not able to cope with changes successfully, they would ultimately collapse and disappear.



Figure 4.28 Canal network before 1350 CE

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

## **Chapter 5**

### **Emergence and Development of Water Management System Local Wisdom, Foreign Influence and Uniqueness**

This chapter is divided chronologically into three parts comprising the time before and after Ayutthaya was encircled by its city moat while the third part is the period from Ayutthaya was defeated in 1767 CE to the end of the reign of King Rama III of Chakri Dynasty in 1851 CE. Notably, the encirclement seems to be one of the most remarkable aspect for understanding the aptitude of water management of Ayutthaya. The first part of water management in Ayutthaya is the period that is unclear since there is no concrete evidence of how water was managed, especially on the features of its canal network, therefore, the characterisation of the environment and interpretation of limited historical documents and studies as well as comparative study with water management found in the other parts of the world, which had evident connection with Ayutthaya through multi-disciplinary perspective are the methods used to draw the picture of Ayutthaya's water management at that time. The water management system in this period is explained in three scopes: 1) the system within Ayutthaya city island, 2) the system in the adjacent areas around Ayutthaya city island and 3) the system in Ayutthaya Kingdom. Furthermore, the outstanding water management techniques are also discussed.

The second part describes water management from the time after Ayutthaya was encircled onward. It refers to several kinds of documents, researches, and studies of various disciplines, mainly the maps drawn by foreign visitors who visited Ayutthaya at that time such as Johannes Vingboons. During this period, it is believed that water management of Ayutthaya was technologically advanced as seen in the feature of Ayutthaya as an island with urban elements comprising internal canals and roads in grid system, as well as other water-related elements such as bridges, dams, water gates, etc. The water management system in this period is explained in two scopes: 1) the system within Ayutthaya city island and 2) the system in Ayutthaya Kingdom. It should be noted that the system in the adjacent areas is not included because it does

not much differ from the earlier period according to the existing information.

According to a number of historical documents written in this period, other evidence of water management can be also identified.

Finally, this chapter ends with the discussion about a short period after Ayutthaya was defeated in 1767 CE to the establishment of Bangkok in 1782 CE. It was believed that Ayutthaya city island and its associated areas were deserted until the early of Rattanakosin period around 1851 CE marked by the reign of King Rama III. However, several recent studies from various perspectives argue that Ayutthaya has never declined from its glory (Chutintharanon, 2019).

## **5.1 The Rise of Ayutthaya (1350 CE -1569 CE)**

### **5.1.1 Empirical observation to cumulative knowledge for settlement**

From Chapter IV, it is concluded that at least two settlements already existed on the location of Ayutthaya before the establishment of the Kingdom; one of which is Ayothaya situated on the opposite bank of Pasak river and the other is Patha Khu Cham located on the other side of Chao Phraya river to the south of Ayutthaya city island. It is generally accepted that King U-Thong or King Ramathibodi I is the founder of Ayutthaya, however, *U-thong* seems to be a generic title of the kings who ruled this area in those days. In consequence, various narratives and tales of the establishment of Ayutthaya Kingdom in relation to King U-Thong have been discussed. Champaphan K (2016) explains that, up to the present, there are seven historiographies of the establishment of Ayutthaya as follow (Chutintharanon, 2019) (see figure 5.1).



Figure 5.1 Drawing in the Triloka, Krung Thonburi version. It is claimed the earliest map mentioning Ayutthaya (Suarez, 1999).

Source: Suarez T (1999)

- 1) The migration from U-Thong, a town in Dvaravati civilization located at the area of present day Suphan Buri province.  
It is believed that King U Thong migrated from a town called U Thong which was located at the area of Suphan Buri province to the west of Ayutthaya because of an epidemic disease. According to city plan and archaeological evidence, U Thong was one of Dvaravati major towns in which flourished during 6<sup>th</sup> -11<sup>th</sup> centuries before it was abandoned whereas Ayutthaya was established in the mid-14<sup>th</sup> century, therefore, this historiography is not convincing due to the considerable time gap between the existence the U-Thong town and the establishment of Ayutthaya.
- 2) The migration of Chiang Sean royal lineage from the North of Thailand.  
Referring to the Singhanawat Legend, King U Thong is a descendant of the royal lineage of Northern Kingdom based in Chiang Sean. Later, he moved southward to several places before settled down in Ayutthaya.

- 3) A Chinese prince who was exiled from China.

As mentioned in the *Chronicles of Wanwalit* written by Jeremais van Vliet, a Dutch trader who came to Ayutthaya during 1633 – 1641 CE, King U-Thong was a Chinese Prince who was exiled from China. However, up to the present there is not any concrete evidence to support this assumption.

- 4) A prince of Ayutthaya who inherited the Kingdom from his father.

King U-Thong was a prince of Ayutthaya who was sent to rule Phetchaburi or Phrib Phri, a town situated to the south of Ayutthaya. When his father passed away, he returned to ascend the throne. This theory has no concrete evidence, on the contrary, evidences from historical documents, archaeological study and art and architectural style in Phetchaburi province indicate that Phetchaburi was contemporary with Ayutthaya.

- 5) The relocation from Ayothaya.

This historiographical hypothesis assert that King U Thong was originally based in Ayothaya which was located on the opposite side of Pasak river to the east of Ayutthaya. When the town faced the problem of an epidemic, he moved from Ayothaya to the area where Ayutthaya city island is located nowadays.

- 6) A descendant of Lawo royal lineage. วิทยาลัย

According to a Lanna historical document, *Chinnakanmalipakon*, King U Thong came from Lawo, or the present Lop Buri province to settle in Ayothaya from which he expanded his territory by invading other towns in the vicinity. This information implied that Ayothaya was Ayutthaya which was ruled by a Khmer descendent from Lawo.

- 7) Moving from Khmer Empire based in Angkor.

According to *Lawak Chronicles*, King U Thong was a successor of the Khmer royal lineage which was divided into two lines. This hypothesis is supported by Wright M, one of the well-known scholars in Thai history especially since the Khmer language were considerably used in the early period of Ayutthaya.



Until the present day, the Thai language, especially the Royal language still include many Khmer words.

However, as water is one of the fundamental needs of human, the availability of water resource is one of the most important conditions for all settlements. From various examples, most civilizations or towns in ancient time collapsed or were deserted because of water – related disasters such as flood, draught, water sanitation, etc. In consequence, apart from the lack of drinking water, food production, outbreak and inconvenient transportation might happen and led to several difficulties. At a certain point, people had to migrate to a new area where they could get sufficient resources, mainly clean water, and food. From the author's point of view, convincing and rational reasons to settle down at any place should be based on the fertility and security of the land. Thus, two historiographies which are related to water issues provide more reliable possibilities and worth to explore, considering the ingeniousness of King U-Thong and his people in water management for their settlement selection.

#### 5.1.1.1 Water-related epidemic

From archaeological and architectural evidence outside Ayutthaya city island (see figure 5.2), it has been found that temples in the area were built earlier than those in the city island, therefore, it is believable that, before Ayutthaya was established, the centre of Siam was at the area known as Ayothaya.

Furthermore, most historians accept that because of an outbreak, King U-Thong decided to move the administrative centre of the Kingdom from Ayothaya to the other side of Pasak river where the present Ayutthaya city island is situated. It should be noted that the earliest historiography proposed by Prince Damrong Rajanubhab pointed out that the outbreak happened in U Thong, one of the main towns of Suwannaphum before Ayutthaya was established. As mentioned, archaeological evidence indicates that the town of U Thong was already abandoned hundreds of years before Ayutthaya was founded (Wongthes, 2018).

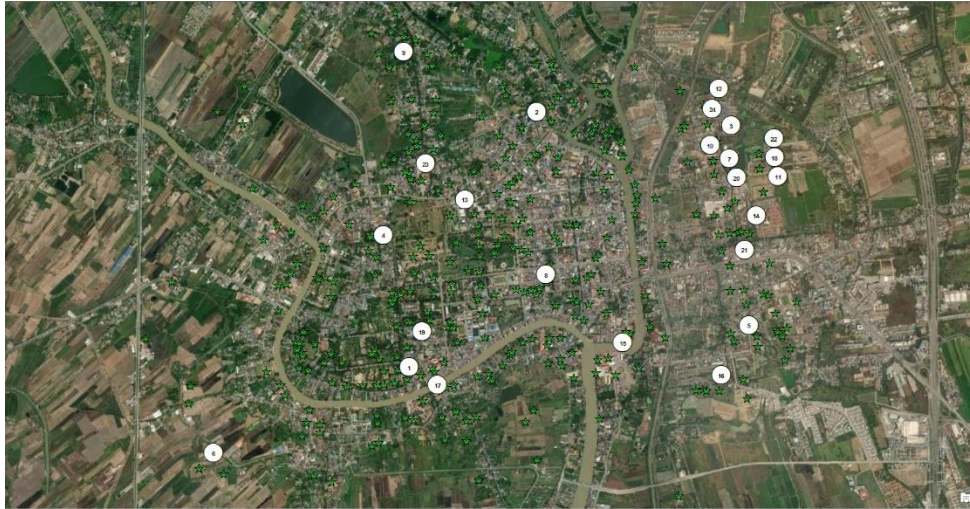


Figure 5.2 Map showing the locations of temples which are clearly found evidence such as arts and architectural styles, inscriptions and historical documents that they were built or have existed before 1350 CE.

Source: Fine Arts Department (2021)

It is not clear what specific disease occurred and forced people to move out. From Thai historical studies, severe outbreak in the past is called “*Ha*”, which could be any of the three diseases including cholera, smallpox and plague. It is obvious that, because of the lack of health protection and disease control, people tended to leave their towns and move to new settlements. According to Prince Damrong Rajanubhab, cholera spread in U-Thong, one of the most important cities of Dvaravati culture. As a result, King U-Thong decided to evacuate from U-Thong to settle in an area between Chao Phraya river and Pasak river. It can be said that the spread of cholera might have happened during dry and hot season, particularly when there was no rain for a long period of time. Besides, the incident could have occurred when the number of people in the affected area had remarkably increased, therefore, it was reasonable to find a new location which could provide a secure water resource for their settlement.

From recent historical studies (Laomanachareon, 2020), due to the global situation around 1346-1353 CE, plague or Black Death spread from China to Europe by wild rodents via maritime trade route. It is claimed that more than 50 percent of population in Europe were killed. This epidemic period

happened almost simultaneous with the time that U-Thong or Ayothaya was affected by the outbreak. Since the towns in Southeast Asia, including several port towns along the coast of the Gulf of Siam, had connection with China since the early time of the first millennium. It is possible that these towns might be affected by plague which could be one of the reasons King U-Thong moved to Ayutthaya. However, the type of epidemic is still debatable, both cholera and plague could spread particularly when the town was flooded as the rodents, the carriers of these diseases would come out. At that time, medical treatment was not much developed, many areas or cities around the world affected from the outbreak would be deserted to prevent their population from the infection.

Somehow, it is worthwhile to discuss about the settlement at *Wiang Lek*, also known as Patha Khu Cham, south of present-day city island near Phutthaisawan temple as it is believable to be another previous settlement of Ayutthaya. Champaphan K (2017) claims that the King might have settled at the place temporarily while surveying the area around *Nong Sano*, a large natural pond located in the city island, to ensure that the area was safe from the outbreak (Champapan, 2016). At that time, Wiang Lek was located on the opposite side of Ayutthaya city island away from Ayothaya. King U Thong chose to build the palace at the location that he could control the junction of Chao Phraya river and the downstream of Lop Buri river north of the city island instead of changing the direction of Pasak river flow. He also had a canal dug, which is now known as *Khu Ku Na*. Consequently, the new area and the old area were separated to avoid the spread of disease from Ayothaya.

Up to the present, it is accepted that the outbreak actually happened in U-Thong or Ayothaya but it is still questionable how people moved to Ayutthaya. Considering U-Thong as a previous settlement before Ayutthaya, archaeological studies carried out by various archaeologists since 1960s reveal that U-Thong was deserted around 200 years before the establishment of Ayutthaya in 1350. The move of people from Ayothaya is plausible since the area is not too far from the city island, however, it is still questionable since

stratigraphy and sherds found from archaeological excavation up to the present are not dated to the time earlier than 1350 CE. In addition, archaeological study conducted in Ayothaya is limited while the area has been intervened by later settlements and recent urbanisation. In conclusion, if Ayutthaya was the result of migration from Ayothaya, it is interesting to understand why Ayutthaya city island was not chosen for settlement instead of Ayothaya from the beginning.

From the discussion above, it is believable that the establishment of Ayutthaya was instigated by an epidemic which could have been either plaque or Black Death or smallpox and cholera which were common in those days. These diseases were related to the water condition and situation due to the carriers.

#### 5.1.1.2 Water transportation through Lop Buri river

Another historiography of the establishment of Ayutthaya in relation to water management is that King U-Thong might have moved from other city to the north of Ayutthaya, possibly Lawo or Lop Buri (see figure 5.3), along the Lop Buri river, which was the centre of Khmer influenced area in central Thailand. According to Vallipodom S (2017), the main transportation route between Ayutthaya and Lawo since around 12<sup>th</sup> -13<sup>th</sup> centuries was the Lop Buri river which flows southward to join Pasak river at the area near Phanachoeng temple located outside the city island to the south. The temple, according to an inscription, was built before the establishment of Ayutthaya (Phumisak, 1983; Vallibhotama, 2017b).

It may be concluded that, after the recession of sea level, people started to move to this area from the north of Lop Buri river to the south of the river and its branches, then people expanded along Pasak river to Chaophraya river south of the area which later became the city island. There are several archaeological evidences as well as ancient remains and living temples which are dated back to period before Ayutthaya.

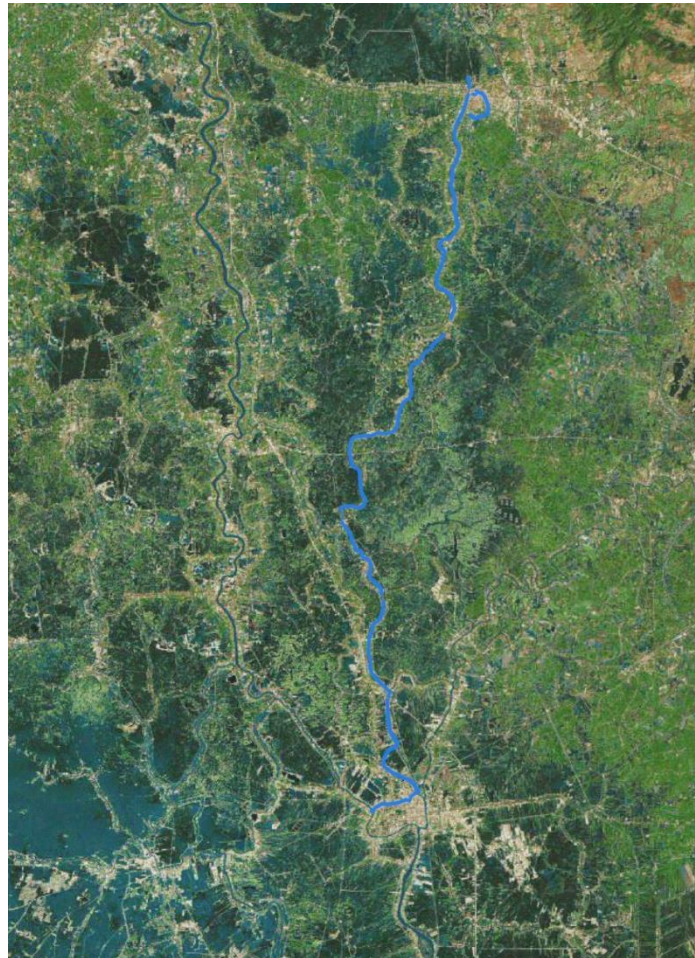


Figure 5.3 The map shows the waterway connection between Lop Buri and Ayutthaya.

Source: Baseline map captured from Google Earth aerial view

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These two historiographies may explain that Ayutthaya was selected as the administrative centre of Ayutthaya Kingdom, also known as Siamese Kingdom, because of the cumulative knowledge of people in the past who understood the following conditions for their settlement selection.

- 1) The settlement area should be along the rivers, the main routes of transportation in the past which were Lop Buri river, Pasak river, Chao Phraya river and their branches. The reason is that the levees along these rivers were suitable for living because they are always higher than the inner areas and safe from inundation.

2) The potential for connectivity with other states. The strategic location of Ayutthaya on the river junction can provide accesses to the sea and means of communication with other towns, many of which were also located along the rivers. On the other hand, the kingdom can control the connection between the sea route and the hinterland to the north which was full of natural resources, therefore, the monopoly trade system by Ayutthaya's court could be more effective and efficient. As a result, Ayutthaya developed to be a prosperous, wealthy and powerful Kingdom. Furthermore, the location possibly helped protect the city from the invasion of other nations that might come by the sea.

3) The availability of freshwater resources is a necessity. As for Ayutthaya, there is a natural pond which provides fresh water for domestic use from the past until today. It is also presumable that, during the tidal season, sea water can reverse to the inner part of Chao Phraya river. It should also be noted that the area of Ayutthaya was originally a mangrove forest, as stated in the Royal Chronicles (Fine Arts Department, 2018b; Phanchanthanumad & (Jerm), n.d.) that the Brahmin performed auspicious ceremony for the establishment of Ayutthaya under Man tree (*Cordia cochinchinensis Gagnepain*), which has become a symbolic tree of Ayutthaya. The Man trees are generally found in mangrove forest along the coastal areas, therefore, the area of Ayutthaya was believable to be a mangrove in the 14<sup>th</sup> century.

According to the records of foreigners who came to Siam in the past, the seasonal ocean wind and tidal current helped bring ships to Ayutthaya conveniently, otherwise it would be difficult since the ships had to travel against the river flow (Tachard, 1662-1699). For drinking water, this condition may not be the main concern at that time since drinking water could also be obtain from the rain and was kept in storage or containers. This issue will be explored in the later part of this chapter.

### 5.1.2 From reformation to transformation: governing system and local beliefs.

Like other civilizations, the transformation of beliefs of those in Chao Phraya river basin and associated areas was related to the reformation of governing system as religions are one of the most powerful tools to control the beliefs and mindset of people. Since the beginning of Ayutthaya, holy water had obviously played a crucial role in demonstrating the sacredness in royal rituals and ceremonies. The beliefs and practice were based on Brahmanism although the main religion of the Kingdom was Buddhism, which has continued until today. Apparently, the intangible aspect of water management was known since ancient times and has continued to exist even though it may be seen as a small element or overlooked aspect of the management, especially from scientific point of view, therefore, this aspect of water management including the resources and practices is to be explored.

#### 5.1.2.1 From City-State to Kingdom: Fraternity to the God King

Regarding Phumisak C (1983), the establishment of Ayutthaya as the capital city of Siamese Kingdom was a result of political reformation in order to strengthen the power of the state and leadership of the ruler. Before Ayutthaya emerged as a kingdom, Brahmanism, Buddhism and Hinduism were the main beliefs in Southeast Asian peninsula. Considering the names of rulers in the northern states and Sukhothai, it can be seen that two deities, *Indra* and *Rama*, were venerated. The city-states in Chao Phraya river basin and Kok river basin in the north where the people lived before moving southward believed in Indra as the highest deity based on the Brahmanist beliefs before Vedic period (800-300 years before Buddhist Era) similar to Theravada Buddhism. The beliefs might have reflected the concept of the city-states governing system.

According to Buddhist cosmology, Indra is the leader of 33 deities who hold the same status at the third level of Buddhist heaven which is divided into 33 sections equally. These deities are the rulers of each section. Therefore, the heavenly realm of Indra reflects the governing system of city-states which has peaceful and friendship or brotherhood relation rather than subjects-king or feudal system. Phumisak claims that the city-states governing system adopted

by Dvaravati city states of the Mon ethnicity demonstrates social equality within the states.

On the contrary, *Rama* is the hero in the Ramayana epic, which can be interpreted as the novelization of the fight between the Aryan and the Dravidian in India. Rama, the incarnation of Vishnu, could have represented an Aryan leader who fought with the demons led by Ravana, the demon king, representation of the Dravidian race. Eventually, Rama won, and the race of demons were demolished. The governing system reflected in Ramayana is clearly the god-king system. In Southeast Asia, the ancient Khmer centralized in Angkor adopted the god-king concept, which later influenced the city-states in Chao Phraya river basin through its sub-centre which was located at Lawo or present-day Lop Buri province.

The beliefs in Rama or god-king is clearly seen when Ayutthaya was developed, especially since the names Ayothaya or Ayutthaya both derived from the name of the city of Rama. Ayutthaya is another form of Ayothaya, and the full name of Ayodhya is Ayothaya Si Ram Thep Nakhon, which means the city of the God Rama. In 1350 CE King U-Thong named the new administrative centre of the kingdom “*Krung Thep Maha Nakhon Bowon Thawarawadi Si Ayutthaya*”, commonly called in short as Ayutthaya. Furthermore, King U Thong’s official throne name is King Ramathibodi I, supreme ruler of the kingdom. Consequently, rituals and ceremonies in Ayutthaya were based on the beliefs in Brahmanism. Furthermore, to demonstrate the sacredness, many of the kings of Ayutthaya were named Rama, who is the incarnation of Narai or Narayana (Vishnu), one of the three supreme forces or gods in Brahmanism and Hinduism. Accordingly, the king was a representation of the God, or a god-king. To strengthen his God power, rituals and religious activities were performed, some of the most important ones are water-related, especially the blessed water derived from India, the origin of these religions. Furthermore, in Sanskrit “Narayana” the name of the god is the combination of the word “*Nara*”, which means water and man, while “*Yana*” means vehicle or vessel. The coronation ceremony, for example,



is performed by pouring blessed water onto the head of the new king to symbolize that he changes from normal man into a god-king, which has been performed until today.

#### 5.1.2.2 Early city plan in relation to water management.

Apart from the adoption of Brahmanist practice in the royal ceremonies, it is believed that the city planning in Dvaravati and Khmer civilizations also derived from Brahmanist concept mentioned in its ancient scriptures. Ideally, the auspicious plan of Dvaravati town which was sunken into the sea according to Indian mythology, should be in a chess pattern (Laomanachareon, 2018). It is remarkable that the buildings and city planning of Dvaratavi towns are round-shaped while the Khmer ones are rectangular with chess pattern. On the other hand, the beliefs in Buddhist cosmology might be reflected in the early city plan of Ayutthaya when the main canals lying in north-south direction were dug and divided Ayutthaya into three main parts.

In the course of time, the canal network was gradually developed which might have been influenced by the water town of China based on historical record that Somdet Phra Intharachachao (reigned 1409 – 1424 CE) used to visit China when he was a prince. Accordingly, he might have been inspired by the canal network of Chinese water towns and, later, had it applied to Ayutthaya. Although there is not concrete evidence on how Ayutthaya's city plan was designed, it can be said that Ayutthaya's city planning is a mixture of influences from civilizations which had contacts with Ayutthaya in various aspects and occasions (Khumho, 2012).

#### 5.1.2.3 Sacred or Blessed Water: Oath of Allegiance

One of the oldest literatures written in the early period of Ayutthaya Kingdom, Ongkan Chaeng Nam (Curse on the Water) indicates that water was used as the medium in the Oath of Allegiance Ceremony for royal servants and soldiers to prove their allegiance to the King. The ritual, called Phithi Thue Nam Phra Phiphat Sattaya (Oath of Allegiance by the Water Ceremony) was

conducted by the highest royal Brahmin and presided over by the King. In the ceremony, attendants would drink water which was “cursed” by chanting the invocation from the Curse on the Water and piercing weapons into the water, believed that anyone who drank the water and betrayed the King would suffer calamity and death in various forms whereas the ones who were loyal would be blessed by the gods. It is believed that this ceremony derived from the blend of local beliefs or animism and Brahmanism in the Buddhist-dominant kingdom. In the past, the ceremony was conducted in various occasions including the coronation ceremony, auspicious events relating to the monarch as well as the military’s and royal servants’ oath of allegiance ceremonies twice a year until 1932 CE. At present, the ceremony is organized only once in a king’s reign as part of the Coronation Ceremony. This royal ritual is a means of power demonstration of the King and ensure security of the throne when his soldiers and servants swear loyalty by taking the oath (Bhiramyaaanukula, 2012).

#### 5.1.2.4 Sacred ponds

According to historical documents, in the royal law of Ayutthaya *Murathaphisek* (ceremonial water) was mentioned as part of the Coronation Ceremony. The law states that, in the ceremony, water taken from sacred wells and consecrated by the Brahmins would be poured onto the head of the new king, as a token of transfer of power or status from the higher powers to the king who would hold the absolute power of the kingdom. In Ayutthaya period (1350-1767 CE), the water was taken from the four sacred water ponds located in the area of present day Suphan Buri province, which is believed to be a town founded before Ayutthaya. These ponds are namely, *Sa Ket*, *Sa Kaeo*, *Sa Yamana* and *Sa Kha* (*Sa* means pond in Thai). Later, when the new administrative centre was moved to Bangkok after the fall of Ayutthaya in 1767 CE, King Rama I of the new dynasty, *Chakri*, had water from five rivers included, namely, Bang Pa Kong, Pa Sak, Chao Phraya, Mae Khlong and Phetchaburi rivers, which represent the Five Great Rivers in Indian beliefs (Aphiromnukun, 2018). In Chakri Dynasty, each king may consider bringing

the holy water from other ponds in the kingdom to demonstrate the kingship over the land and the participation of all people in the coronation.

Thus, it can be concluded that the tradition of bringing holy water from sacred ponds around the kingdom in order to show the new king's power is the ritual deriving from Ayutthaya period until nowadays. The names of four sacred ponds are clearly mentioned in Ayutthaya's royal law, however, practically water from other sacred ponds or water resources might have been included. Furthermore, it is believable that people in those days would observe and know how to select suitable water sources to be used in the royal ceremony. One of the remarkable features of the sacred ponds is that the areas around the ponds are not inhabited or disturbed by animals. For these aspects of water management, it can be seen that people in the past should have a deep knowledge in synergizing the beliefs of people through water. The sacred ponds concept could have derived from the fact that, in the past, hygienic water sources are one of the most important factors for survival. If the king can control the water source, it means he also control people's life. It should also be noted that the four sacred ponds mentioned earlier evidently exist before Ayutthaya was established (see figure 5.4).



Figure 5.4 The sacred ponds found in Suphan Buri.

Source: <https://pantip.com/topic/39485024/desktop>

### **5.1.3 Canalization in the early Ayutthaya: transferred technology or cumulative knowledge**

According to the Royal Chronicles (Fine Arts Department, 2018b; Phanchanthanumad & (Jerm), n.d.; Prasoet) it states that King Ramathibodi or King U-Thong had ordered to have a canal dug to separate Ayothaya from Ayutthaya, in other words, the old settlement from the new settlement, and to divert waterway of Pa Sak river. This canal has become the east city moat of the city island of Ayutthaya. However, some historians argue that this city moat was not dug until later period but it was only a small water course.

At this point, it is interesting to investigate how the knowledge in canalization, for instance, the building of city moat emerged. Considering from global perspective, the establishment of Ayutthaya in 1350 was close to the beginning of early modern era. Additionally, the canalization for irrigation in Mesopotamia, which is located in the area of the present Iran and Iraq, can be dated back around 4000 BCE., while between 2600-3000 BCE. the irrigation system and water storage were evolved in the Indus valley (ICOMOS & TICCIH, 2011). It is also found that the canal for transportation in China was built about 500-800 BCE, thus it can be seen that the knowledge in canalization can be found around the world since the early ancient times. This is not surprising, however, since water is essentially needed for the survival and existence of humanity. As a result, canals for irrigation and water storage were the earliest water management developed along with human settlement.

As for Ayutthaya, particularly in the city island and its vicinity which comprises a network of rivers, the early groups of people who moved to this area after the sea recession and the land was habitable already knew how to settle down in this natural condition. They probably have possessed knowledge from their experience in former settlements in other city states located in the central plain of present-day Thailand. Those city states were either encircled by round-shaped city moats of Dvaravati civilization or rectangular city moats for Khmer civilization. It is found that several round-shaped city moats of the Dvaravati influenced towns and other shared civilizations, for instance, the Pyu in Myanmar, rarely used the nearby rivers as part of their city moats. Other Dvaravati towns and cities mentioned in Chapter IV, are

such as Phrae (see figure 5.5) in the north of Thailand and Sri Ksetra (see figure 5.6) ancient towns of Pyu kingdom located along Irrawaddy river in Myanmar (UNESCO., n.d.-c). In the case of Sri Ksetra, the river flow is very strong especially during inundation period, therefore, people lived far from the river at a certain distance to ensure that their town would be safe from flood. This city planning concept is also found in Phare, which keeps a distance from Yom river. Furthermore, Vallibhotama S (1997) argues that city moat of Dvaravati towns was not the defense but irrigation system or the boundary marking (Vallibhotama, 1997). Accordingly, it can be seen that when Ayutthaya was established on the eastern side of the confluence of Chao Phraya river and Lop Buri river, these two rivers were used as the west and north city moats while the existing small waterway or swale between the new Ayutthaya and Ayothaya was identified as the east city moat. These rivers and swale aimed to mark the boundary of the new centre of the kingdom, thus the swale might not need to be deepened or widened if it was only for the boundary identification. Comparing to other previous settlements, the planning of Ayutthaya is unique because rivers were used as city moat. Accordingly, since the city is located close to the rivers, the drainage system of the city should be effective to avoid an impact from flood during inundation period. On the other hand, when the river is reaching low land near mouth of the river at delta area, it becomes more meandering and flows slower, therefore, it was considered safe enough to live near the river.



Figure 5.5 Phare, one of the Dvaravati moated town where is located along Yom River.

Source: [www.openstreetmap.org](http://www.openstreetmap.org)

©OpenStreetMap contributors accessed on 4 May 2021



Figure 5.6 Sri Ksetra, Myanmar, showing city wall and water bodies

Source: Department of Archaeology, Myanmar, 2017

LANDSAT image provided by Department of Geography, University of Cambridge

Wongtes S (2018) asserted that the technology in canalization of Ayutthaya was initially transmitted from China before it was later developed based on the knowledge brought by the European, therefore, evidence of Chinese influence in the early period should have been found (Wongtes, 2018). However, Phuthorn Bhumadhon argues that the Persians were those who played a major role in water management in Ayutthaya which might have adapted the knowledge from Indian civilization when Buddhism came to mainland Southeast Asia or directly to Ayutthaya in its early period with the Persian merchants who later became high-ranked minister. However, this aspect still requires further investigation.

For a clearer examination, the existence of this swale has to be discussed by various historians and scholars. It is a norm of canalization that the area chosen to dig canal should be the lower level so that it will be easier to collect water. Existing water channels and swales are one of the most potential areas to be dug because its own natural condition is more convenient for canalization. Thus, King U-Thong might consider this swale and planned to use it as the east boundary. However, the irrigation purpose of the moat is not convincible because the cultivation around Ayutthaya can take advantage from inundation. This will be explained later in this chapter.

#### **5.1.4 Canal system of the City Island**

It is believed that, when Ayutthaya was established, the canal system including city moat around the city island was already constructed. On one hand, it is evidently arguable since rationally the canal system should take a period of time to be completely constructed as seen in the maps drawn by various European visitors who drew a number of maps and pictures of Ayutthaya around 200 years later than the establishment. On the contrary, some canals, whether they are natural or man-made, should already exist for the necessary functions especially transportation, therefore, this research aims to explore how the canal system in the city island was during the early period of Ayutthaya. Based on the multi-disciplinary study, the construction and development of canal system in the city island can be discussed as follows.

#### 5.1.4.1 City moat and city wall

The development and transformation of the city moat and wall are shown in the map (see figure 5.7). The Royal Chronicles (Fine Arts Department, 2018b) does not mention about the features of the city wall when King U-Thong established Ayutthaya in 1350 CE. Considering other towns and cities of contemporary period, the city wall is believable to be an earthen rampart like Dvaravati towns which helped facilitate drainage system of the city. In later period, it was possible that timber fence was placed above the earthen mound. In addition, Thongmit W (2017) refers to Phraya Boranratchanin that Ayothaya city wall was an earthen rampart rather than brick wall (Thongmit, 2017). This implies that the city of Ayutthaya may have similar features with Ayothaya, however, it is still unclear whether the fence was built around the city island, as concluded in this research that the city was not completely encircled until some times between 1577 CE to 1584 CE.

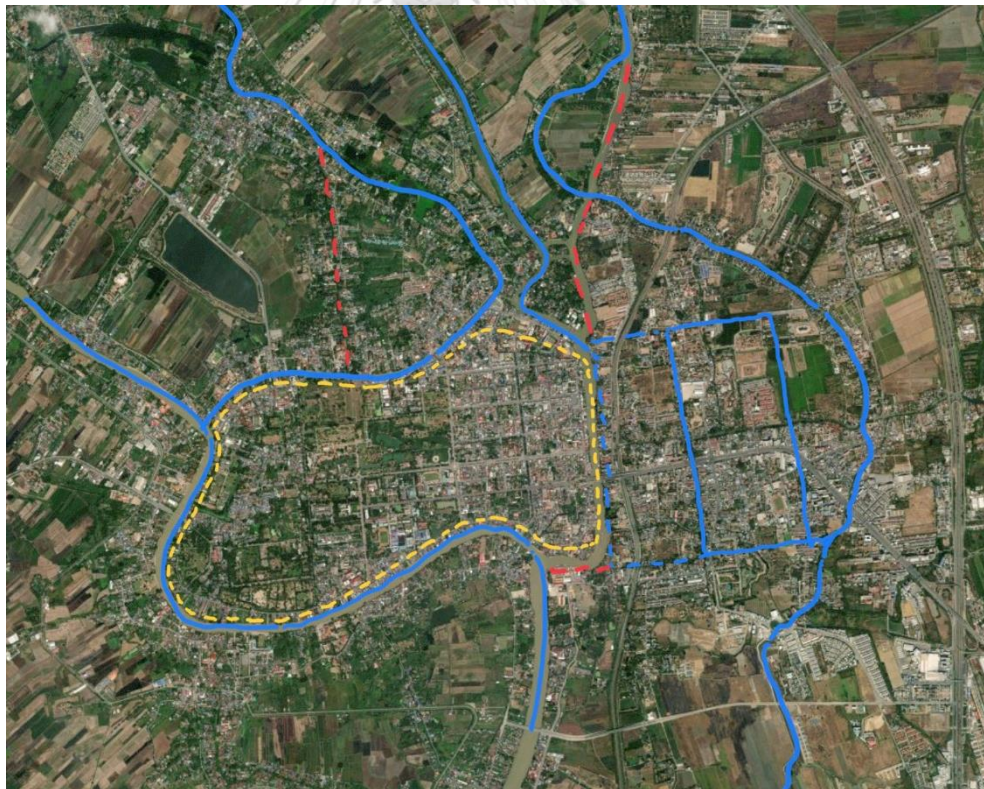


Figure 5.7 City moat of Ayutthaya in the early period.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors



#### 5.1.4.2 North-south canals: main waterways in the city

On one hand, in general, Ayutthaya city island and its surroundings is situated on the flood plain of Chao Phraya delta. This part of Chao Phraya river is a main water route which flows to the Gulf of Siam. By analysing the contour line of this area, even of a plain, the area to the northeast of the city island is lower than the western side which is a levee of the river resulting from sediment deposit along the river bank. Considering the annual inundation, the seasonal flood is likely a water plate covering the whole plain which flows southward to the mouth of the river at the Gulf of Siam or the Gulf of Thailand nowadays. For the area to be habitable, its drainage system must be very efficient, therefore, the canal lying in north-south direction helps drain the water which comes from the north to the south most efficiently. This is the reason that the size of the north- south canals are mostly wider than the East-West ones. Accordingly, regarding the size, it is clear that the north- south canals are the main canals within the city island.

##### a) Khlong Tho or Khlong Cha Krai Yai

The orientation of the North- South canals also demonstrates another aspect of how knowledgeable people was in the past on water management. As the Royal Palace was located to the north of the city island near the freshwater source, *Nong Sano*, known as *Bueng Phra Ram* at present. Presumably, King U-Thong could have preferred to live near Lop Buri river which is also the northern city moat for convenient connection and accessibility to Lop Buri, the centre of Lawo kingdom. At the same time, the king should be able to go the southern part of the city where the temporary palace was located at Wiang Lek. As a result, the north-south canals, especially the one which connected the Royal Palace and Wiang Lek, nowadays called Khlong Tho or Khlong Cha Krai Yai, was certain to have been constructed at the founding of the city (*Khlong* means canal in Thai).

Apart from Khlong Cha Krai Yai, other north-south canals which could have been built in the same period can be considered from the main urban

principals and fabrics such as arts and architectural styles of buildings and temples, functions connecting to places built earlier and locations which are accessible by waterways as follows.

b) Khlong Cha Krai Noi

The canal connects Bueng Phra Ram and Chao Phraya river to the south. Champaphan K (2016) points out that, at present, along this canal several temples are found. One of these temples is Singharam temple which is believed to have been built in the early period of Ayutthaya by its architectural style. This temple faces the canal, therefore, Khlong Cha Krai Noi should have been dug in this period or earlier.

c) Khlong Pratu Khao Plueak or Khlong Pratu Chin

It connects Lop Buri river and Chao Phraya river. According to historical document, the Testimony of Khun Luang Wat Pradu Songtham, there was a bridge made of laterite was constructed to cross the canal, which was located in front of Wat Phlapphla Chai and Pa Ma Phrao road and used as a passage between the Royal Palace where the king lived and the Front Palace where the crown prince lived regarding the explanation of Phraya Boran Ratchathanin (Champapan, 2016).

However, considering the material of the bridge, which is laterite, this canal should have been dug in early period because laterite was mostly used in the Khmer influenced towns of former period. In addition, this part of the city island should have a waterway to connect the north area and the south area for commoners as another canal, Khlong Cha Krai Yai, flowing through the Royal Palace, should not be accessible by general people. Therefore, the canals laid in north-south direction constructed between 1350 CE to 1577 CE or 1584 CE should be as seen in the map below (see figure 5.8).

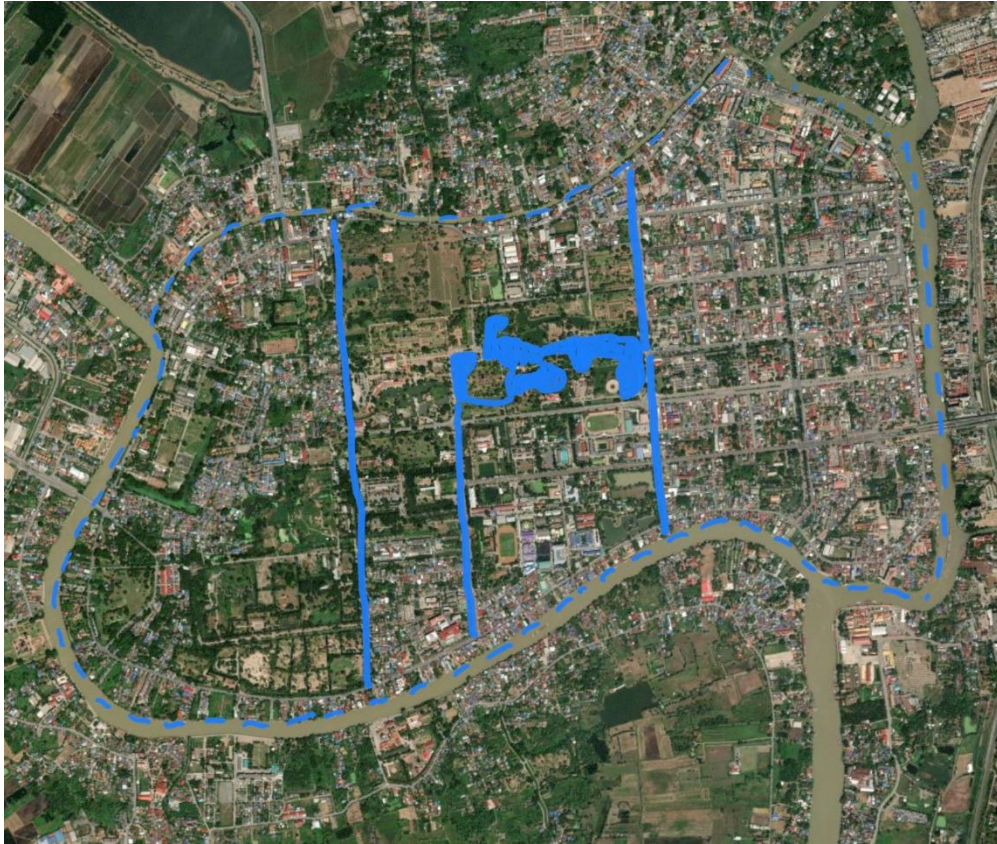


Figure 5.8 Internal canals lay in north-south direction constructed from 1350 - 1584 CE.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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#### 5.1.4.3 East-west canals: transportation feeders.

There are several canals lying in east-west direction(see figure 5.9).

Presumably, these canals were mainly aimed to serve the transportation purposes as they do not have potential for water drainage or irrigation. For example, Khlong Noi is a branch of Khlong Cha Krai Yai which connects Khlong Cha Krai Yai and a big pond, *Sa Kaeo*, in the Royal Palace. Khlong Noi provided accessibility of merchants to sell goods for the ladies who lived in the Royal Court.

In this research, temples built earlier than 1577 CE are mapped in order to demonstrate the east-west canals where these temples are located, which were probably constructed in the early period of Ayutthaya.

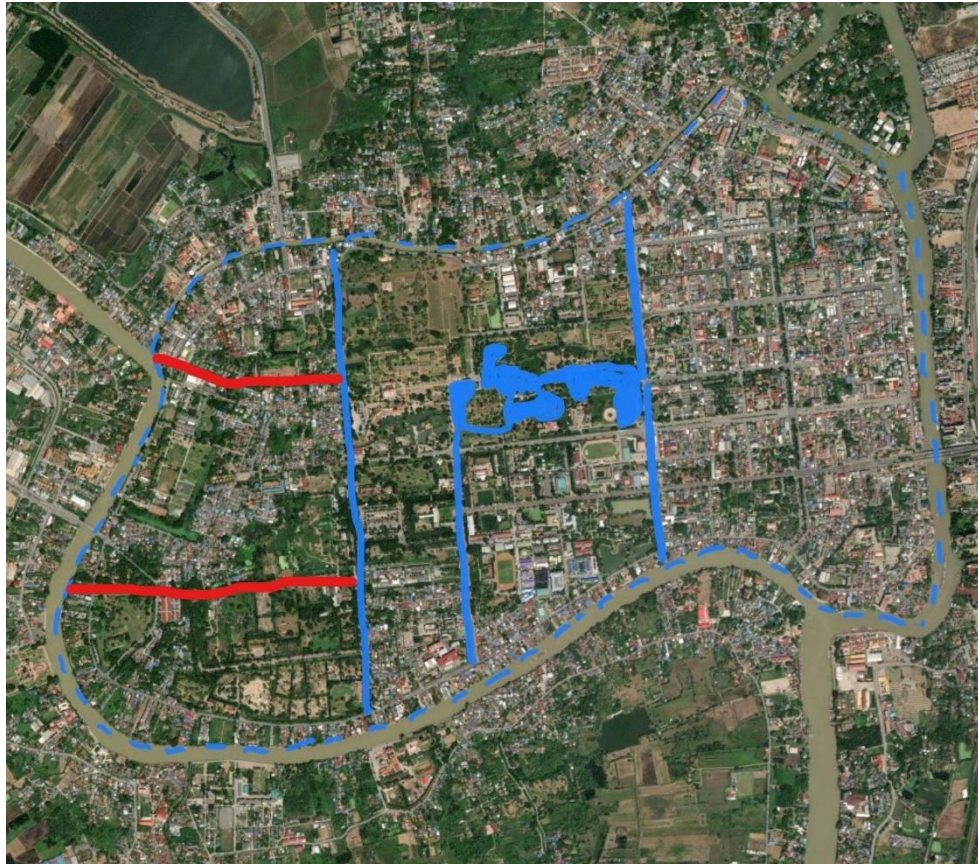


Figure 5.9 East-west canals (in red) in the City Island.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

©OpenStreetMap contributors

## 5.1.5 Water management around Ayutthaya city island

### 5.1.5.1 Canal network

Around the city island, the canal system developed mainly from natural river courses can be found. These canals exist since the founding of Ayutthaya as the centre of the kingdom because they are natural river branches, which indicate that people in Ayutthaya knew how to take advantage of these natural conditions with a limited intervention to shape these canals to meet their needs. Based on arts and architectural styles of temples, the following canals might exist before 1577 CE.

To the east of the city island (see figure 5.10), Khlong Hantra connects Khu Ku Na to Hantra river which flows to Khlong Ban Bat and joins Pa Sak river. This canal network shows the relationship of Ayutthaya in the early period

with other settlements along Pa Sak river basin. Khlong Suan Phlu is a short canal connecting to Khlong Hantra before joining Pa Sak river. Another canal in this area is Khlong Ban Khrod where the custom house was located since the earlier period. This exhibits how Ayutthaya obviously relied on the waterways.

To the north of the city island (see figure 5.11), Khlong Sa Bua was a short-cut canal from Lop Buri river around Na Phra Men temple to the Royal kraal of elephants further north. The canal then turns southward to Lop Buri river at Hua Ro. Khlong Hua Ro was the old course of Lop Buri river since the canal at the confluence of Lop Buri river and Pa Sak river was dug. As a result, the river flew to another branch nearer to the junction of the two rivers and left this branch of Lop Buri river narrower until it became the size of a canal.

To the west of the city island (see figure 5.12), Khlong Mahaphram can be seen to the northwestern side of the city island. Mahaphram canal was the main waterway which connects Chao Phraya river and Noi river, a branch of Chao Phraya river. In fact, it is believed that Noi river is the original course of Chao Phraya river which had changed after a short-cut canal around the northwest of the City Island was dug and the river was diverted to the new channel. Another custom house was also located at the mouth of the canal. This shows the canal network which connects Ayutthaya with the older cities to the north, being the transportation network before the new Chao Phraya delta emerged. It can be said that, in this period the canal networks around the City Island were developed, which might have been made to provide the accessibility to Ayutthaya by rivers and canals from other areas of former towns and settlements. From the art style of sema stones found at temples along this canal, it is believable that Mahaphram canal has already existed since the beginning of Ayutthaya (Khemnak, 2019).

To the south of Ayutthaya city island (see figure 5.13), it is certain that Khu Cham or Patha Khu Cham canal existed before the establishment of Ayutthaya as mentioned earlier. It is also possible that Khlong Takhian should have also existed. The northern part of this canal appears to be natural water channel while the southern part appears to be a man-made canal.

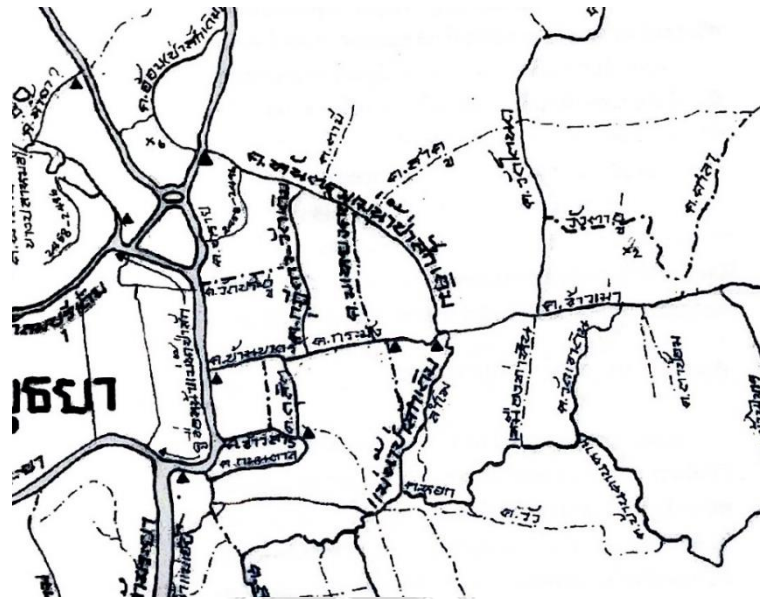


Figure 5.10 Canals at the East of Ayutthaya city island before 1577 CE.

Source: Khemnak, P (2019)



Figure 5.11 Canals at the North of Ayutthaya city island before 1577 CE.

Source: Khemnak, P (2019)

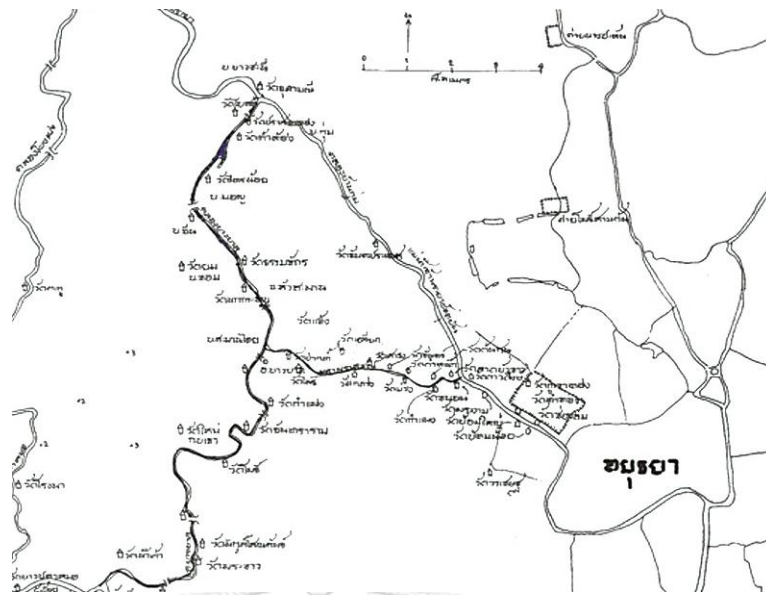


Figure 5.12 Canals at the West of Ayutthaya city island before 1577 CE.

Source: Khemnak P (2019)



Figure 5.13 Canals at the South of Ayutthaya city island before 1577 CE.

Source: Khemnak, P (2019)

### 5.1.5.2 *Thung*, flooded fields system

The water management system of Ayutthaya since this period or even earlier also included the surrounding fields of the city island (see figure 5.14). Since they generally were lower than other areas, these fields could have served several purposes as part of water management system. During inundation time, they served as detention areas of Ayutthaya city island so the water level in the internal canal network could be controlled, whereas the crops in agricultural area could survive during flooding season.

On the other hand, according to various chronicles of Ayutthaya, during flooding season, these fields were severely flooded. It was natural and regular event which was manageable, therefore, when Ayutthaya was attacked by other nations by land, invaders had to retreat to escape from the flood.

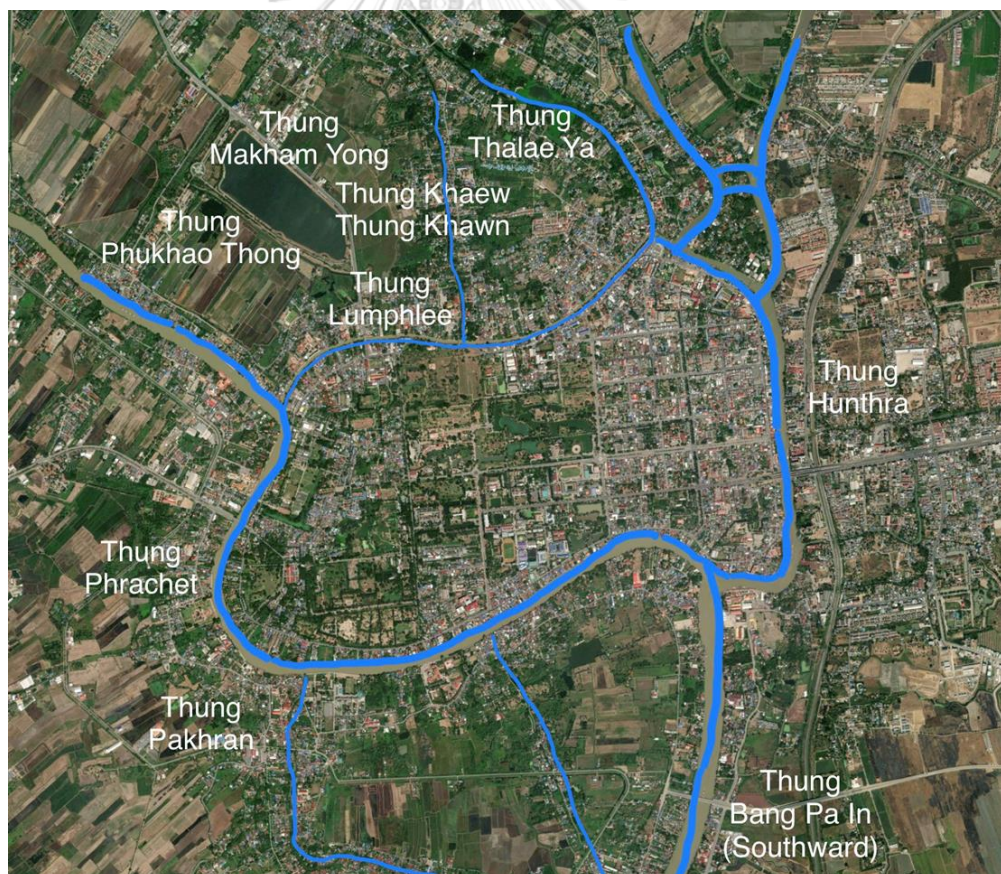


Figure 5.14 *Thung*, flooded fields system around the City Island

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors



### **5.1.6 Connectivity to towns beyond Ayutthaya city island: the efficient way of transportation**

Regarding the Royal Chronicles of Ayutthaya, apart from the issues on politics and social information related to the King and the monarchy, the water management of the kingdom is rarely mentioned. However, canalizations that required a considerable labour force are described as the King's order. It is believed that the short-cut canals were dug according to the policy of the king to improve transportation, mainly for trade and commerce. In the early period of Ayutthaya, three events of canalization are recorded (Songsiri, 2017a).

#### **5.1.6.1 Samrong canal and Thap Nang transverse**

Around 1498 CE, it is mentioned in the Royal Chronicles that King Ramathibodi II ordered to deepen Samrong canal which connects Chao Phraya river at Samut Prakan city to Bang Pa Kong river in the present Chachoengsao province, as well as Thap Nang canal which is a branch of Samrong canal which flows to the sea canals (see figure 5.15). Tanabe S (1971) calls this type of canal transverse canal. This canalization is mentioned as a repair work aiming to facilitate ships travelling to the eastern region and Khmer towns. Samrong canal is also a strategic canal for the protection of the kingdom on the eastern border, which implies that Samrong canal and Thap Nang canal already existed but was narrow and shallow. The dating of the digging of these canals cannot be precisely specified, however, from the author's point of view, Samrong canal might have been a natural water channel and was never intervened until 1498 CE. On one hand, the original form of canalization or canal construction was to dig or widen and deepen natural waterways or swales because it is the most convenient and rational means of work. Therefore, it is convincible that Samrong canal and Thap Nang canal may have originally been natural waterways. Nevertheless, there is no prove that these canals were intervened before the reign of King Ramathibodi II. For their characters, they are of straight line from Chao Phraya river to Bang Pa Kong river, which clearly shows that people in Ayutthaya period understood and knew how to use waterways for strategic purposes.

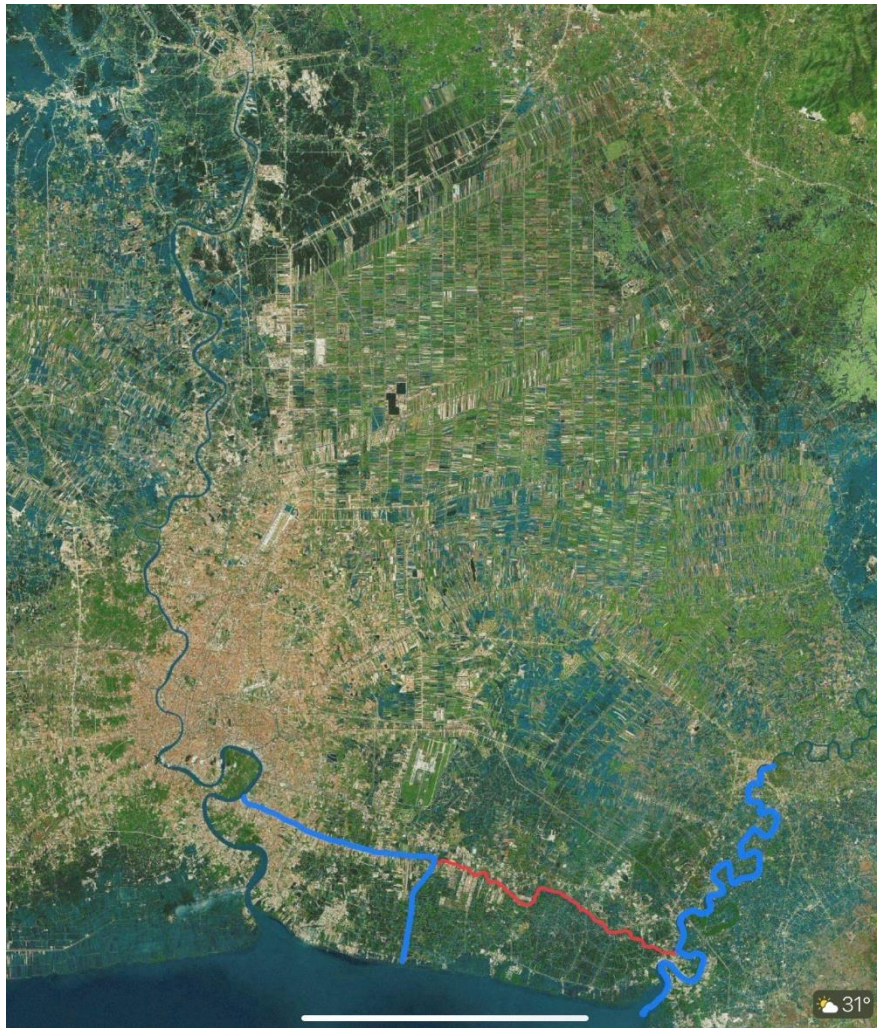


Figure 5.15 Samrong canal and Thap nang transverse canal

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

#### 5.1.6.2 Bangkok short-cut canal

One of the most well-known and culturally important canals in Thailand nowadays is the Bangkok short-cut canal, which was dug during the reign of King Chaiyachathirat between 1534 CE to 1537 CE. The canal was dug to link the areas where the mouth of Bangkok Noi canal is located and the mouth Bangkok Yai canal at the front of the *Wat Arun Ratchawararam* or the Temple of Dawn. The canal is approximately three kilometres in length. The digging resulted in the change of river flow that was diverted through this newly-dug canal more than its original course because the short-cut canal is generally

straight but the original water course was bending. As a result, the canal became wider than the original river while the river was narrower and became a canal by its size. (see figure 5.16)



Figure 5.16 Bangkok short-cut canal

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

At present, this original part of Chao Phraya river has been called by various names such as Bangkok Noi canal, Bangkok Yai canal, Chak Phra canal, Talingchan canal, etc. depending on the area where the canal passes by. Notably, there was already a settlement at this area which was divided by the Bangkok short-cut canal. In 1557 CE, this settlement was founded as a fortress city of the kingdom, which was named *Thonburi Si Maha Samut*. Later, during the reign of King Narai (1656-1688 CE) a place called Bangkok Fort was built at the location where Makkasan Battle occurred. In consequence, King Narai ordered the French troop under the administration of Constantine Falcon to

build two forts on the two sides of Chao Phraya river at this area in order to protect the kingdom from the invasion by the foreign navy. The construction was similar to the fortification system built in Europe as the fortresses were designed and supervised by a French engineer known as Monsieur de la Mare. After completion, the French and Portuguese soldiers stationed there. The forts were called *Pom Wichaiyen* or *Wichaiyen Fort* (see figure 5.17), followed the title of Constantine Falcon or Chao Phraya Wichayen, a Greek who became a high-ranked minister in the reign of King Narai (Suteerattanapirom, 2016).



Figure 5.17 Pom Wichaiyen or Wichaiyen Fort located along Chao Phraya River

Source: [https://www.matichon.co.th/prachachuen/prachachuen-scoop/news\\_1610309](https://www.matichon.co.th/prachachuen/prachachuen-scoop/news_1610309)

Concerning the Wichaiyen Fort, Phiphat Khrajaejan (2017) argues that the Wichaiprasit Fort, which was the fort built on the western side of Chao Phraya river already existed earlier than King Narai's reign built with the assistance of the Portuguese. Then it was rebuilt during the reign of King Narai. The name Wichaiprasit might have been given after this fort was restored by King

Taksin (1767-1782 CE) who moved the administrative centre of Siamese Kingdom from Ayutthaya city island to Bangkok, the west side of the river after he retrieved Siamese Kingdom from Burma. At present, the remains of the fort can still be seen at the western side of the river bank. In addition, the Wichaiyen Fort on the eastern side of Chao Phraya river bank, also known as Bangkok Fort, was dismantled during the reign of the following king, Somdet Phra Phetracha. Nevertheless, some archaeologists including Phiphat Krajaejun (2017) argue that it is believed that this fort had never been built because of the revolution in the late period of King Narai's reign (Krajaejun, 2017). Additionally, comparing to another fort, there are no remains of this fort whereas the archaeological evidence found during the construction of underground train of Mass Rapid Transit System of Bangkok has not been interpreted to clarify whether they are the remains of Wichaiyen Fort.

#### 5.1.6.3 Bang Kruai short-cut canal

According to the Royal Chronicles, this canal was built around 1538 CE in the reign of King Maha Chakkraphat. The canal starts from Wat Chalo at Um river to Wat Khi Lek which is located around Bangkok Noi canal nowadays. The canalization of Chao Phraya river at this part was aimed to shorten the Um River by three kilometres in distance. It should be noted that the current of this canal has not been strong enough to change the flow of Um River. (see figure 5.18)



Figure 5.18 Bang Kruai short-cut canal

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

### 5.1.7 Water control technique

#### 5.1.7.1 Poles to slow down river current or Ro

When Ayutthaya was established in 1350 CE, it is still unclear whether the east city moat was dug. However, according to historical documents from the Royal Hall, there are records that around the northeast corner of the city island where Lop Buri river meets Pa Sak river, there were timber poles of Palmyra palm trees installed into the riverbed and filled by clay which functioned as a bridge to the city island. The device was made by a Mon King of Hansawaddy or Bago kingdom who tried to attack Ayutthaya during Somdet Phra Maha Chakkraphat's period, circa 1556 CE. After the Mon troop left, this bridge was not dismantled and used by the people to cross the river when they entered the City Island. (see figure 5.19)



Figure 5.19 Raw is timber poles to slow down river current.

This picture is part of the mural painting describing a royal chronicle,  
drawn in the reign of King Rama V by Phra Kod

Source: [https://www.silpa-mag.com/history/article\\_16882](https://www.silpa-mag.com/history/article_16882) in  
<https://www.blockdit.com/posts/5ed217aa90e47a0cae4f477a>

This information leads to further investigation into whether the east city moat was intentionally dug in 1350 CE, if so the kind of structure would have been built to prevent more water flowing into the moat or Lop Buri river, which was the main waterway for the King otherwise it would be dried out. Instead, the mouth of small swale might have been deepened or widened in order to draw the river to flow into this swale. Another possibility is that the swale might have been dug to use the soil to build the earthen wall similar to other towns in the former periods in the central plain of the present Thailand. Consequently, it would take a period of time that the swale would be eroded and became widen and deepen naturally. This is a traditional way of canalization in the past which can still be seen in some area nowadays.

#### 5.1.7.2 Weirs or water gates



Figure 5.20 Weirs or water gates

Source: [https://www.alro.go.th/sakonnakhon/ewt\\_news.php?nid=389&filename=index](https://www.alro.go.th/sakonnakhon/ewt_news.php?nid=389&filename=index)

Using the same techniques as *Ro*, regarding the interpretation of Phraya Boran Ratchathanin (2007) on a historical document of Ayutthaya known as the Description of Ayutthaya, he explains about the water gates which were constructed at the mouth of canals in Ayutthaya city island. For further clarification, two rows of parallel timber poles were installed into the bed of canals, then the space between these rows was filled by clay (see figure 5.20). These water gates aimed to protect the city island when it was invaded as well as to maintain the water level of canal network for transportation during dry season (Boranratchathanin, 2007). In this period, it appears that the city wall was still an earthen mound around the city like the previous city states.



## 5.2 Encircled Ayutthaya – the Peak of Water Management System (1577 – 1767 CE)

This period is notable as that the time when the City Island of Ayutthaya was in its complete form as seen from the sources of maps and drawings of foreigners who came to Ayutthaya, as well as the fame of Ayutthaya as one of the cities with most advanced technologies in water management in the world at that time. According to the Royal Chronicles of Ayutthaya, Phan Chathanumat Version (Phanchanthanumat & (Jerm), n.d.), also known as British Museum Version, when King Naresuan, who was still the crown prince at that time, returned from being a hostage in Burma in 1584 after he declared independence of Ayutthaya from Burma, the attack from the Burmese army was expected. Therefore, King Maha Thammaracha (reigned 1569 CE to 1590 CE), decided to strengthen the city protection system for defensive purpose particularly on the eastern side of Ayutthaya city island where invaders usually attacked. In the Chronicles, it is stated that “... *and having the moat on the eastern side of the city dug wider and deeper so that the river completely encircled the Royal Metropolis.....*” (Vandenburg T, 2010). The King ordered to relocate the city wall to the east to be closer to the city moat and reconstructed the city wall from the earthen mound to be brick structure, encircling the city island in order to strengthen the protection system of the city island after Ayutthaya or Siamese Kingdom was defeated in the battle with the Burmese in the same year. Vandenberg T (2010) asserts that Ayutthaya was encircled completely in 1584 CE. In addition, according to the Royal Chronicles, Somdet Phra Phanarat Version, it can be argued that King Maha Thammaracha ordered to widen the city moat three years after the new Palace, Chankasem Palace, was completed. It is rational to believe that, as the new palace would be included into the city wall, the fortification should be constructed after the completion of the palace. While Champaphan K (2016) states that Chankhasem Palace was built in 1577 CE for Prince Naresuan (Champapan, 2016), who moved to Ayutthaya as the great viceroy or *Phra Maha Upparat*, the officially appointed successor of the king. Therefore, the city moat and city wall at this side should be built sometimes between 1577 CE and 1584 CE.

### 5.2.1 Emergence of the fortification system

#### 5.2.1.1 Widening city moat: lesson learned from the battles.

The discussion on the city moat when King U-Thong established Ayutthaya in above section that was not constructed as seen in the maps drawn by the European who came in the later period, it should be explored whether the city moat and wall were constructed and how they were. At this point, another issue comes into consideration when the city moat and city wall were transformed to be as it was in the map. Actually, in this period, the features of the city moat and city wall are clear according to various maps and drawings. In addition, from the remains of the city moat and walls at present as well as existing studies and research, these urban fabrics can be traced back partially, which also prove how precise and accurate these maps and drawings are.

In several versions of the Royal Chronicles of Ayutthaya, the issue of city wall when Ayutthaya was established is rarely mentioned. Physical characteristics of Ayutthaya are studied mainly through a historical document, that is the Description of Ayutthaya and archaeological studies. Besides, according to the Fine Arts Department (2018) in the beginning of Ayutthaya, archaeological excavations revealed that the city wall was an earthen rampart with timber footing structure, while the city moat took advantage of Lop Buri and Chao Phraya rivers as the city moat surrounding the north, west and south of the city island. For the east side of the city island, the city moat was adapted from an existing water channel which was around six metres wide which was dug to separate the new settlement in the city island and the old settlement at Ayothaya area. In consequence, during war time between Ayutthaya and other states and nations, the eastern side of the city, from the conflux of Lop Buri and Pa Sak rivers as seen nowadays, towards where Pa Sak river joins Chao Phraya river at Pom Phet Fort, was the weakest point that was always attacked by the enemies, therefore, King Maha Chakkaphat (reigned 1548 to 1565 CE and 1567-1568 CE) attempted to improve the city wall as well as to find means to cope with the new kind of weapons such as firearms and gun powder introduced by the Portuguese (Historical Archives Archdiocese of

Bangkok, 2018b). Consequently, the city wall was consolidated to protect the city from these new weapons. Wanlee Krachangwee (2015) claims that the rampart was initially changed to the brick wall during this reign especially from Ho Rattanachai city gate (Krachangwee, 2015) (see figure 5.21).

Unfortunately, the improvement plan could not be achieved because there were several consecutive battles until the Burmese army conquered Ayutthaya in 1569 CE. Notably, it is still doubted whether how much the city wall was changed from rampart to the brick wall and how many forts were constructed during this period.



Figure 5.21 Map showing the new part of the city wall.

Source: Baseline map captured from Google Earth aerial view

The Royal Chronicles also mentions that, in order to strengthen the defensive system of the City Island after the defeat in 1569, King Thammarachathiratchao or King Sanphet I, who succeeded Ayutthaya from King Maha Chakkaphat, ordered to widen the moat on the eastern side of the city island three year after he had a new palace built for his son, the Prince

who became King Naresuan who moved from Phitsanulok to Ayutthaya in 1577 CE. The rampart at this side was also replaced by the brick wall because the city wall on the eastern side was relocated to the new position to be closer to the city moat (see figure 5.22). Since the establishment of Ayutthaya, the rampart at this side ran pass the back of the area where Chankhasem Palace was located, while the area of the Palace was the deposited area outside the rampart and were formerly used as the elephant kraal.

At this point, the discussion seems to support the issue that the city moat to the east of the city island was not intentionally dug for defensive purposes at the beginning, however, after several wars with other neighbouring states and nations, this city moat and city wall were strengthened for the city security and protection.



Figure 5.22 The city moat and city wall before being enlarged (in yellow and white) and after the relocation (in red and blue).

Source: Baseline map captured from Google Earth aerial view

### 5.2.1.2 Fortification of Ayutthaya: the European influence

According to the Description of Ayutthaya or *Phumsathan Ayutthaya* (Landscape of Ayutthaya) (Boranratchathanin, 2007; Phongsīphān, 2008), apart from city moat and city wall, there were several forts strategically built around Ayutthaya city island for various purposes in this period. From the documents, *Phumsathan Ayutthaya*, as well as the Testimony of Khun Luang Wat Pradu, another main historical document of Ayutthaya, fourteen forts were constructed around the city island. For example, Pom Phet fort located at the conflux of Chao Phraya river and Pa Sak river to the south of the city island, which was built to control all accessibilities to the city island, the capital of the kingdom.

Although the remains of these forts can still be seen and demonstrate the glorious power of Ayutthaya nowadays, it can be said that the knowledge on history and development of the construction of these forts is extremely limited. It is questionable when and how the earthen rampart was transformed to the brick-structural wall with these forts as part of the city protection system. From the principle of construction and architectural style of this fortification, they are European-influenced structures. It should be noted that the fortification in other towns of Ayutthaya built in the reign of King Narai (1656 to 1688 CE) such as Lop Buri or Bangkok forts, were designed by a French engineer, Monsieur de La Mare. While the city wall of Ayutthaya, also European-influenced, was built around 1569 – 1590 CE during King Thammarachathiratchao's reign. If the fortification of Ayutthaya was carried out at the same time as the improvement of the city protection system, this means Ayutthaya fortification was built almost a century before those of the other towns.

Considering the period when the fortification was developed, the European who came to Ayutthaya at that period were the Danish and the Portuguese. The other foreigners who came earlier than these European nations and played a crucial role in development and history of Ayutthaya were the Chinese and Persian. From various historical documents, the Chinese and Danish focused

on commercial relationship with Ayutthaya while the Persian was world-famous in water management techniques especially for irrigation system due to its drought condition.

Focusing on the expansion of the Portuguese Empire to the Asia, during the 16<sup>th</sup> -17<sup>th</sup> centuries, the Portuguese Empire started colonizing the states along its sea-route exploration in Asia (Mitsuriya, 2019). Then the Empire set up its towns at those states, for instance, the city of Goa in India was built as a capital of Portuguese India in 1510 CE (see figure 5.23). Other Portuguese colonised towns are Melaka in present-day Malaysia (see figure 5.24) as well as several towns in Indonesia, the Philippines and Formosa or Taiwan. At present, the remains of the fortification of these towns can still be seen, in which certain similarities to the fortification of Ayutthaya are observed. However, for the architectural style, further comparative studies of these towns in the future are necessary to confirm how much the Portuguese actually played its role in the construction of fortification of Ayutthaya city island.



Figure 5.23 The city plan of Goa in India

Source: <https://www.colonialvoyage.com/goa-capital-portuguese-india/>

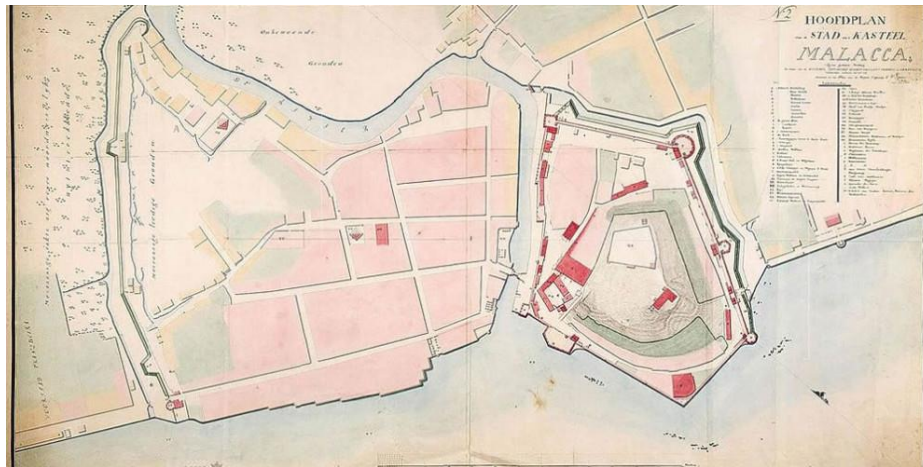


Figure 5.24 The city plan of Melaka in Malaysia

Source: <https://www.colonialvoyage.com/fort-malacca-portuguese-dutch-fortress-malacca-melaka/>

From existing historical information, it is known that because of the modern weapons including firearms, canons and gunpowder brought by the Portuguese since King Maha Chakkaphat's reign (1548 – 1565 CE and 1567 – 1568 CE), the city wall needed to be improved. Additionally, the Portuguese were also hired as mercenary soldiers, as recorded in Royal Chronicles about the death of Portuguese mercenary soldiers during the war between Ayutthaya and the Burmese in 1569. Therefore, it is believable that there was exchange or influence of war strategy from the Portuguese.

Furthermore, the article by the Historical Archives of the Archdiocese of Bangkok entitled “the Study of Ayutthaya from the Portuguese Historical Documents” states that various historical studies on the relationship between Portugal and Ayutthaya shows the Portuguese influence in Ayutthaya on several aspects including the modern weapons and the fortification construction using brick structure with lime plastering as seen in European countries as well as other Portuguese colonised towns in Asia (Historical Archives Archdiocese of Bangkok, 2018a).

## 5.2.2 Evolution of canal network in the City Island

### 5.2.2.1 Drainage system and flood control: north-south canals

From the map *Iudea* drawn by David and Johannes Vingboon in 1663 CE which is the oldest map of Ayutthaya city island, it can be seen that when this map was drawn there were already five canals lying from north to south direction. Therefore, from the early period of Ayutthaya to 1663 CE, in the reign of King Narai Maharaj, there were three canals existed as follows.

a) Khlong Pratu Thep Mi (see figure 5.25) connects Bueng Phra Ram and Chao Phraya river to the south. According to the style of bridges, this canal was built around or after the reign of King Naresuan (1590-1605 CE) as the architectural style of the bridge made of brick is Persian-influenced, which might have been built by the Muslim Persians who came to Ayutthaya in the late period of King Naresuan's reign as mentioned in historical documents.

Clear evidence of the relationship between Ayutthaya and Persia, present day Iran and Iraq, is found in the reign of King Narai Maharaj. The Persians who came to Ayutthaya at that time were led by Sheik Amad, originally for the purpose of trade. According to the archives of the Bunnag family, Sheik Amad came to Ayutthaya in 1601 CE. It is remarkably that Ayutthaya was called by the Persians "the New City" or "the Boat City" as water transportation was the main communication of Ayutthaya. Furthermore, the city was also known as the international trade port city which welcomed all foreign traders without any religious restriction.

Sheik Amad was the founder of Bunnag family which has continued its lineage until the present day. King Narai Maharaj granted royal permission for him to settle down in Ayutthaya for his business and also religious mission. Consequently, Islam was propagated in Ayutthaya and Sheik Amad served the royal court in commerce and foreign affairs in the following reign of King Songtham. From that time onward, his descendants had played significant roles in both the royal services and the Muslim religion from Ayutthaya to Thon Buri and Rattanakosin periods (Phaksathaporn, 2017). Consequently, the



Persian culture was introduced and popularized especially in the reign of King Narai Maharaj since the King favoured Persian attire and Persian cuisine, resulting in the spread of fashion among the court nobles as seen from the picture drawn when the royal envoy from Ayutthaya was granted an audience with Louise XIV of France. The envoy and his followers wore the Persian style attire. In terms of the Muslim settlement led by the Sheik, it is recorded that the number of Persians in Ayutthaya was as many as the Chinese, and their communities were located not far from each other.



Figure 5.25 the location of Khlong Pratu Thep Mi

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

On the other hand, in water management perspective, it is widely known that Persian technology in irrigation system is one of oldest and most efficient technologies developed in the ancient times and has still worked in some areas until the present. According to existing studies on Persian influence on Ayutthaya, water control technique for the city moat and garden in the Royal Palaces in both Ayutthaya and Lop Buri to where the administrative centre

was temporarily moved during the reign of King Narai Maharat, were adopted from the Persians. These aspects are explored and discussed in the next parts of this chapter.

b) Khlong Nai Khai or Khlong Makham Rieng (see figure 5.26) was constructed in order to facilitate Chinese community transportation because in the early period of Ayutthaya, the Chinese community was located outside the city wall on the opposite of side of the Chao Phraya river. Later, the Chinese was allowed to live in the city island, which is a privilege over other foreigners, therefore, the community extended from the other side of Chao Phraya river into the city island. It should be noted that the extension of Chinese Community might happen when Krom Tha Sai, one of the governmental departments controlling the foreigners from eastern countries i.e. China, Japan, Vietnam, etc. was built along this canal in the later period because the Westerners started coming to Ayutthaya.



Figure 5.26 The location of Khlong Nai Khai or Khlong Makham Rieng

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

The main objective of canalization in north-west direction still required further investigation. It is certain that the connection between important places located in the city island such as palaces and temples is considered one of the purposes. However, according to the linear pattern of the canal in this direction, it can also indicate the drainage purpose. From natural condition, the city island and its surroundings are situated at the so-called lower flood plain of Chao Phraya River Delta. Therefore, it is impossible to avoid inundation during flooding season even the City Island is built on the old barrier of the Chao Phraya delta. For this logical argument, it can be said that the linear canals help push water inundated from the north to pass through the city island as quickly as possible before the amount of flooding water increased to dangerous level. Moreover, the water level control structure installed was also help maintain water level in the canals at the certain point for facilitating the city (Siriphatthanakun, 2020). Thus, any damage from flooding to the city island in this period had never been mentioned in either the chronicles or other historical documents. The structure developed in this period is already discussed in 5.2.2.3.

#### 5.2.2.2 The efficient connectivity among communities: east-west canals



Figure 5.27 Map shows the east-west canal network.

Source: Tangsirivanit, T. (2006)

According to section 5.1.4.3 temples built earlier than 1577 CE are mapped to identify the temples built in the early period of Ayutthaya which helps figure out which of the east-west canals were built before 1577 CE. Since temples must be constructed after the existence of the canals they are located along. In consequence, it can be claimed that the rest of canals which are seen in the map drawn in 17<sup>th</sup> century, were dug after 1577 CE. Furthermore, the logical interpretation for the canals built in this period should take urban expansion into account. As it is known, since King Narai Maharaj ascended the throne, Ayutthaya was opened to various foreigners who came to Ayutthaya for different purposes. Consequently, settlements in Ayutthaya city island were enlarged. It is obvious that only Chinese and Persian communities were allowed to live in the city island or, in other words, inside the city wall. As for the European and other Easterners including the Japanese, they were allocated to settle down outside the city island on the opposite side of the surrounding rivers. Thus, the east-west canals dug in this period might have aimed to increase the accessibility to these new communities. It is also believed that the detailed information from the maps and other sources are not enough to show all these canals as described by the European that Ayutthaya was Venice of the East and the remains of the canals are also limited to be traced, however, it can be claimed that the density of communities and the follow-up urban structures such as markets can reflect how many canals were dug while this dissertation is intended to map the east-west canals built in this period as many as possible (see figure 5.27).

#### 5.2.2.3 Water diversion structure or *Ro*

Actually, *Ro* had been used since the early period of Ayutthaya, especially at the northeastern side of the city island (see figure 5.28) where the junction of Lop Buri river and new course of Pa Sak river or Khu Khue Na is located. As already mentioned, the Mon troop built this breakwater poles, which was turned into a bridge by placing wood panel on top when the troop attacked Ayutthaya in 1556 CE, according to historical document from the Royal Hall. The Mon Troop aimed to build this structure as a bridge, then it was

continuously used by people of Ayutthaya as a bridge to connect the city island and outer part. However, it is interesting to explore when Ro was first used for diverting the river.



Figure 5.28 Map shows the location where the timber poles or Ro were built.  
Source: Andrews J.'s drawing entitled A Plan of the City of Siam or Juthia

From the author's point of view, it cannot be proved that people in Ayutthaya did not have the knowledge in building the diversion structure even though it is mentioned in historical documents that the diversion structure to the northeast of Ayutthaya city island was built by the Mon. Considering the former city states and other towns relating to Ayutthaya, Sukhothai and Lawo, for instance, the water control technique to divert water channel had been developed for decades earlier and Ayutthaya might have transmitted or shared various kinds of knowledge from these city states to the north of Chao Phraya river basin. In Sukhothai, the earthen ridges were found in the mountain range at the Southwest of the town where *Khao Luang*, the sacred mountain, is situated and where the river source flowing down to the town starts. The earthen ridges, therefore, were built to divert water channel to the reservoir of the town (Sihamat & Chaopreecha, 2014; Vallibhotama, n.d.). In U-Thong, another City State that was believed to have been the origin of King U-Thong,

similar technique is also discovered as seen in *Kok Chang Din*, an earthen ridge, is found at the mountainous area outside the enclosed town of U-Thong. It was used to divert water to reservoir of the town as well.

For Ayutthaya, due to the different geography and natural conditions, this technique might not be needed but the knowledge and understanding how to control water flow might have already existed similar to the canalization in the towns of Sukhothai and U Thong. In fact, when *Ro* was used to divert water flow of Lop Buri river and Pa Sak river, presumably the east city moat, *Khu Khue Na* was not planned to be the city moat in 1350 CE. On the contrary, it is more convincing to consider that, when King Thammarachathirat ordered to widen the moat to the east of the city, especially at the northeast corner, people in those days may realize or observe that water from Lop Buri river and Pa Sak river would flow to the new city moat rather than to the west side which was the existing course at that time. On the other hand, it is known that Lop Buri river was strategically important as the main transportation route for the king so the water running to Lop Buri river had to be maintained. In consequence, *Ro* or diversion structures were installed in place to divide water running to the west and east sides of city moat equally. In summary, it can be said that this knowledge was developed to function as water diversion no earlier than 1577 CE to 1584 CE when the city island was completely encircled.

#### 5.2.2.4 Water gates: the indigenous knowledge or cultural exchange (*see figure 5.29*)

As discussed previously, since the early period of Ayutthaya, a traditional knowledge in water level control techniques might have already existed. From the historical document “*the Description of Ayutthaya*”, some water gates at the mouth of canals particularly north-south canals are mentioned. In this period, it is quite clear to see the standing structures at the mouth of each canal from the old maps. However, after 1577 CE Ayutthaya was opened to foreigners from various countries. It is questionable whether the knowledge

and experience sharing from these countries were influential, applied and adapted to the water management system of Ayutthaya.

Accordingly, Phraya Boran Ratchathanin refers to the historical document, one of the most accurate explanation, when comparing to his field work that there were 11 water gates around the city island including Pratu Khao Plueak, Pratu Thep Mi, Pratu Ho Rattanachai, Pratu Nai Kai, Pratu Chin, etc. (*Pratu* means gateway). In order to explore how the water gate was invented, an example is selected, which is Pratu Khao Plueak Fort as it is one of the most unique water gates found in the city island (Boonthongmai, 2010). Pratu Khao Plueak Fort is located to the north of the city island. The structure is, in fact, a fort which also functioned as a water gate. From several articles, this fort was located between the city wall and Khao Plueak canal, a water channel which connected to Lop Buri river. This fan-shaped fort might have stood on both sides of the mouth of the canal while the water could flow through the tunnel of the fort. From the recent archaeological excavation, the slots for wood panels were found. In terms of structure, this fort was made of brick with lime plastering. Considering the water tunnel (see figure 5.30), the arch structure is clearly seen, which was probably influenced by the Middle East or European architecture. However, comparing to the Persian architectural style found at the palace of Lop Buri, this arch structure is somewhat different, therefore, it can be concluded that the architectural style might have been the European intervention. In addition, since the European who assisted in fortification construction was the Portuguese, this fort including the water tunnel should be constructed by its building technique.



Figure 5.29 Water gate in Ayutthaya period.

Source: <https://www.77kaoded.com/news/samrit/782837>





Figure 5.30 Water tunnel within the city moat seen at Pratu Khao Puerg Fort

Source: [https://www.matichon.co.th/entertainment/arts-culture/news\\_991027](https://www.matichon.co.th/entertainment/arts-culture/news_991027)

It is still unclear how the water gate functioned because the archaeological remains as seen in the slot for wood panels can be explained in two possibilities. The first one is that, if the wood panels functioned like the gates, they must be lifted when opening as there is no evidence of hinges, however, the lifting device or pulley are not present. Moreover, it could not be understood how this wood panel can control water in the canal while allowing access by boat. Another possible hypothesis is that this wood panel could work as a sluice similar to the functioning of the *Ro*. It was probably a temporary water gate used when the protection from flood or enemies was needed, the panel would be put in the slot and the space between each panel

would be filled with clay. Furthermore, as temporary water gate, it was flexible to be set at any height to control water level in the internal canal so that during dry season the water in the canal would be maintain for boat transportation. From the author's point of view, the second hypothesis is more rational and convincing.

Therefore, it can be said that the water gates built at city forts in the city island were influenced by the European architectural style with the traditional water control technique. The integration of indigenous and foreign wisdom then became the Ayutthaya's ingenuity and uniqueness in water management.

#### 5.2.2.5 Bridges: evidence of cultural diversity in Ayutthaya.

Considering that some canals already existed before 1577 CE -1584 CE, bridges should also be constructed in the city island as one of the necessary elements of the network pathways of canal cities. According to historical documents, mainly *the Description of Ayutthaya*, bridges located in the city island were made of various materials ranging from brick, timber to laterite, and in different architectural styles. As mentioned, some bridges were constructed earlier, but others were built in this period which reflected the cultural diversity. In Thai language, the word for bridge is "Saphan".

One example of bridges that demonstrate the Persian culture in Ayutthaya is Saphan Pratu Thep Mi (see figure 5.31) situated on Khlong Pratu Thep Mi. The Persian vault is clearly seen from the remains of the bridge. In addition, it is located at the former Persian community founded since King Narai's reign. Therefore, this bridge is believable to have been built no earlier than King Narai's reign by the Persians who came with Sheik Amad. Another example is Saphan Chang which was located on Khlong Pratu Khao Plueak. This bridge was made of laterite for higher load-carrying capacity than other bridges as it was used by the elephants. Unfortunately, no remains or physical evidence of this bridge is found thus it is not possible to discuss on its character and architectural style whether it was influenced from Lawo. However, it can be hypothesized that the bridge might have been constructed in Ayutthaya style

but used laterite as building material, which was normally popular in and the Khmer-influenced cultures.

Another kind of bridge was the lifting bridge which was similar to the bridge found in the Netherlands and the more recent period of Rattanakosin, which was influenced by European architecture. The bridge could be lifted by metal chain with a brick structure base. Even though it was mentioned as one type of the bridges found in the city island, no physical evidence or further explanation has been found up to the present. Phraya Boran Ratchathanin proposed that this bridge should be located near the palace as it can be lifted so that whenever the enemies invaded or any hazards occurred, the palace would be safe.



Figure 5.31 The remains of Saphan Pratu Thepmee.

Source: Author's collection

### **5.2.3 Greater Ayutthaya: the efficient water transportation**

In this period the canalization beyond the city island was obviously developed in relation to the increasing power of Ayutthaya Kingdom. The population of Ayutthaya at its most glorious time during King Narai Maharaj according to several historical

documents, nearly reached 1 million. Therefore, several development projects were done to facilitate trade and prosperity of the kingdom such as the construction of short-cut canals along the main rivers.

#### 5.2.3.1 Exchange-hub: connecting the Capital of the Kingdom to its resources.

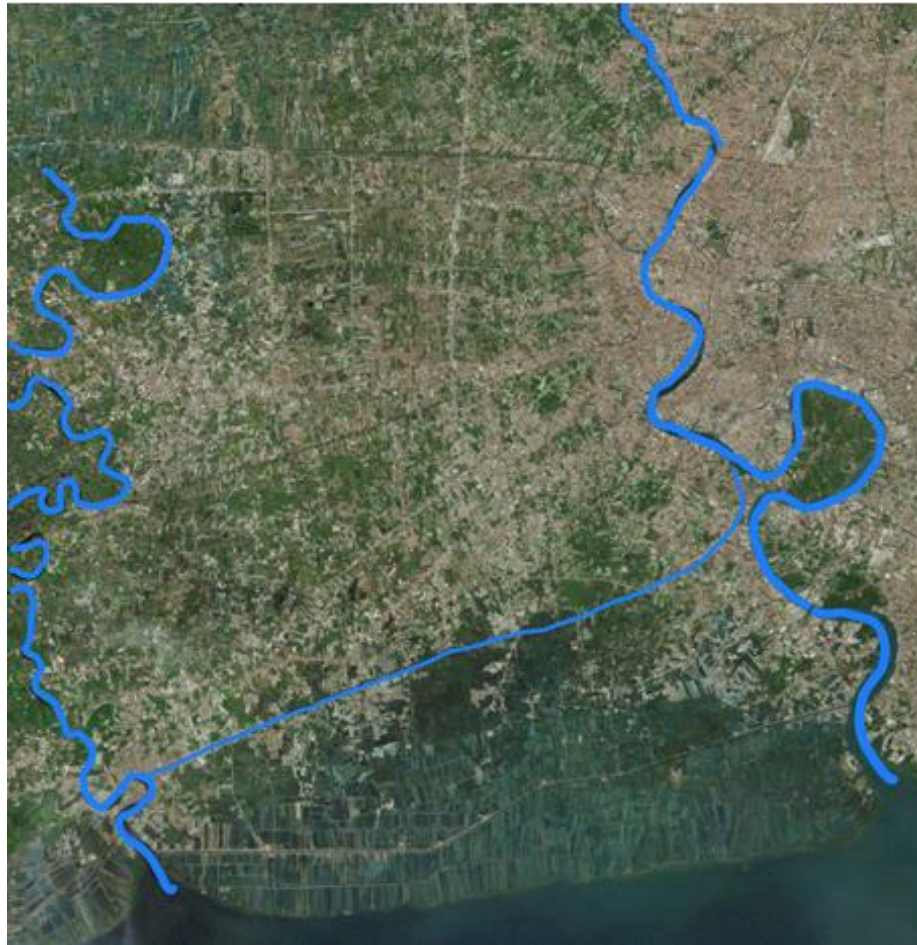


Figure 5.32 A transverse canal, Khlong Mahachai.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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In former period, the transverse canals, Khlong Samrong and Khlong Thap Nang were dug to connect Chao Phraya river to the east (see figure 5.32). Later, in 1645 CE, King Prasat Thong expanded his kingdom to the west by digging another transverse canal, Khlong Mahachai. According to the Royal Chronicles, around 30,000 labours were conscripted to the project. However, only 1/5 of the planned canal was completed when King Prasat Thong passed

away. Later, in 1707 CE the canalization resumed and was completed in 1722 CE as part of Chao Phraya river at Thon Buri, which connects Tha Chin river at Samut Sakhon, the canal is approximately 30 kilometres in length.

Tanabe S (1971) explains that the construction of this transverse canal was different from Samrong canal which already existed, probably because it was a natural water channel. Mahachai canal is a very straight man-made canal. The modern method of measurement, a European surveying technique, was implemented for the first time particularly in the canalization on regional scope. Tanabe claims that this canal flows from Chao Phraya river to the mouth of Tha Chin river at the gulf of Siam. From his opinion, because it passes the areas of brackish vegetation, so this canalization did not aim to improve agricultural area but to connect transportation of the coastal cities and Malay Peninsula. This statement is convincible although, generally, this type of areas is fertile for orchards rather than rice, especially around Thon Buri where this canal starts, which has been famous for the fruit orchards since Ayutthaya period. Consequently, the productions from the areas along this canal would be shipped to Ayutthaya more conveniently.

#### 5.2.3.2 Canal networks for the Kingdom's expansion

There were also several short-cut canals built in this period, which aimed to shorten distances and facilitate the troop when moving for the battles or suppressing its colonies. Based on the documentary evidence, these canals are as follows (see figure 5.33).

##### a) Khlong Bang Pla Kot

The canal was dug to join Chao Phraya river and Noi river in 1590 CE when King Naresuan was still the viceroy and moved the army to fight with the Burmese. This canal also facilitated the troop when moving to the cities to the west such as Suphan Buri and Kanchanaburi. It was around 10 kilometres long.

##### b) Khlong Lat Kret Yai

This canal shortened Chao Phraya river from Sam Khok to Chaing Rak in the present Pathum Thani province. It was dug around 1607-1608 CE. The length is five kilometres. Eventually, this canal became the main course of Chao Phraya river.

c) Khlong Lat Mueang Non

It was dug around 1635 A.D. or 1636 CE, approximately five kilometres long. This canal now becomes a part of Chao Phraya river that flows through the city of Nonthaburi.

d) Khlong Lat Pho

This one-kilometre-long canal was dug around 1722 CE. It was intentionally aimed to shorten Chao Phraya river which was much meandering at Phra Pa Daeng in the present Samut Prakan province because Chao Phraya river in this area is closed to the Gulf of Siam. Unexpectedly, it has become problematic when the sea water bolsters to the inland of Bangkok. The water of Chao Phraya river thus became too salty, especially in the dry season when the amount of freshwater from the upstream in the north which helps push away the salty water, reduces. However, once this short-cut canal became shallow, another attempt to solve this problem was carried out recently which will be discussed in the next chapter.

e) Khlong Lat Kret Noi or Pak Kret was dug in 1722 CE. It shortened another meandering part of Chao Phraya river at the mouth of Khlong Bang Bua Thong. The canal is two kilometres long.

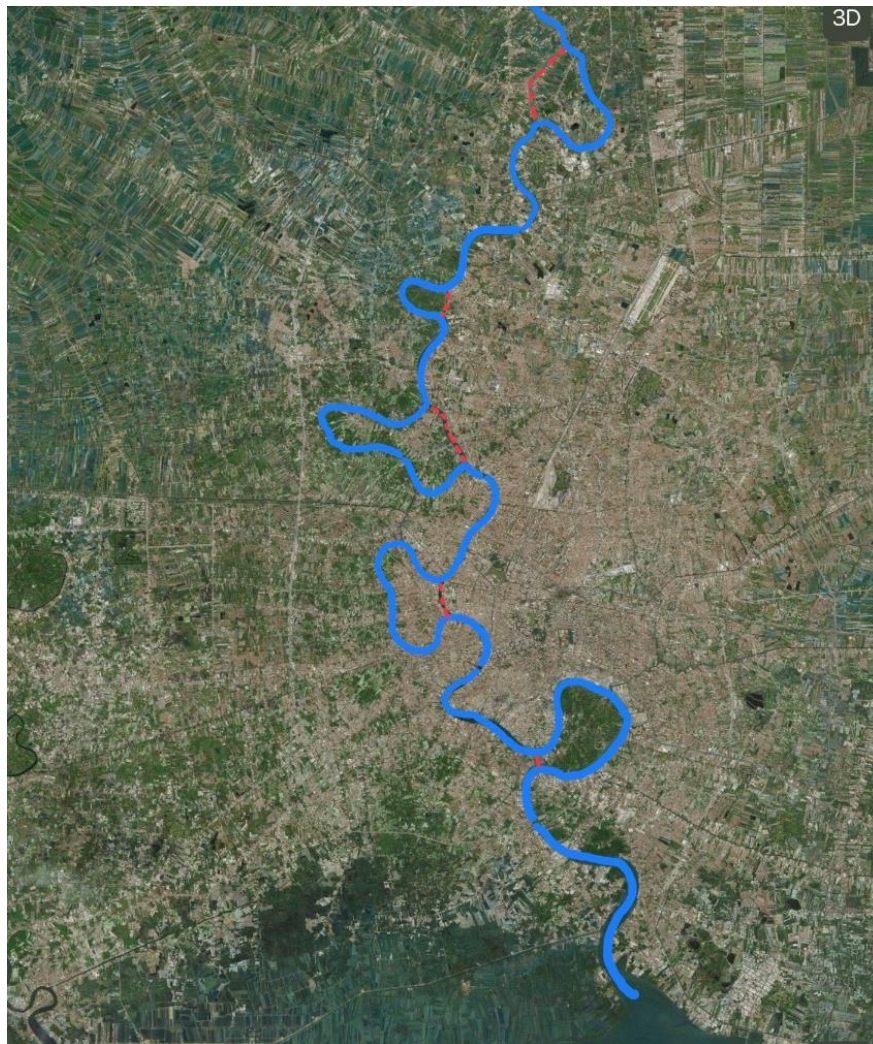


Figure 5.33 Short-cut canal network connecting the administrative centre to the other part of the Kingdom.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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In fact, many short-cut canals or man-made water channels were dug to connect or shorten the rivers in lower central plain of Thailand. This research may not be able to identify the exact times when these canals were dug due to the limited records and the canals have changed over time. However, from the canals dug during Ayutthaya's glorious time which are evidently seen at present, they can demonstrate the intellect and knowledge of people in those days on using canalization for various purposes.

### 5.2.3.3 Lop Buri, the second capital city and political strategy: taking advantage of understanding the natural characters of river.

During the reign of King Narai Maharat (1656 CE – 1688 CE), the King was mainly based at Phra Narai Ratchaniwet, the Royal Palace in Lop Buri which was previously the centre of Lawo kingdom. Accordingly, the city was also known as the second capital city of Ayutthaya or Siamese Kingdom or a real administrative centre in his reign. Besides the water resources, fresh air and good ventilation, according to the interview with Bhudhorn Phumathon, a well-known historian in the history of Ayutthaya especially concerning King Narai Maharat period, King Narai always chose to use Lop Buri river (see figure 5.34) for his trip from Ayutthaya to Lop Buri although this river is narrow, meandering and has many islets in the river because it would be difficult for his enemies to follow or track him due to internal political situation. It can be seen that the King or his people have deep understanding and cumulative knowledge in the character of each river in the central plain of Siam so he could select the proper river as his main water route when traveling. It should be noted that, Lop Buri city as well as its architecture and other elements in the palace were planned by the European thus they were inter-cultural influenced. On the contrary the knowledge on the river was certainly the local intelligence of Ayutthaya people since foreigners might not have enough information on Lop Buri.





Figure 5.34 Lop Buri River which is the northern city moat connecting the Royal Palace to other area including to the second capital city.

Source: Baseline map captured from Google Earth aerial view

#### 5.2.4 Domestic uses

Regarding the water management system, the water for domestic uses should be included as a small scale of water usage comparing to other functions as it is related to household affairs. For Ayutthaya, this scope of water management is rarely mentioned in any studies and researches comparing to irrigation, drainage, transportation, and defense. However, it should be one of the most necessary concerns for survival of people since water consumption was mentioned earlier in this research as one of criteria of settlement selection when Ayutthaya was established. This issue is discussed at this period, not previously, because evidences found from the limited

studies and archaeological excavation show that the domestication was highly developed in this period.

Considering the natural environment of Ayutthaya, it is located at the flood plain of delta area surrounded by several rivers and their branches while its climate type is in the tropical monsoon zoning. Therefore, plenty of water comes from the annual monsoon season as well as from rivers thus the main issue relating to domestic uses of water is how to keep the water for uses in various purposes during dry season and how the water could be hygienic for consumption.

Since water is one of the most important factors for the survival of humanity, all civilizations had developed the knowledge and technology to keep water depending on natural conditions of each society. Ayutthaya, presumably, might gain the knowledge of water storage mainly from Dvaravati and Lawo which were the developed cultures prior to Ayutthaya. For Lawo, one of the Khmer-influenced civilizations, rectangular reservoir or *Baray* is its dominant feature that indicates the propagation of the civilization. In some towns situated far from rivers or water resources, Baray can keep rainwater for use in dry season while other towns close to the rivers or water resource would also divert water into the Baray besides keeping rainwater. Later on, the sacred ponds which probably derived from Brahmanism then Hinduism of Khmer civilization was adopted in Ayutthaya kingdom. In fact, these open-air reservoirs might have existed since the early period of Ayutthaya, but ground water had sanitation problem so it was more suitable for agricultural irrigation than domestication. The issue continued from the time before the city island was encircled. Therefore, in the reign of King Narai Maharaj, the Europeans introduced the new technology relating to water management including water consumption system and gardening decoration to Siam as mentioned in the Royal Chronicles. Nevertheless, details of these elements were not explained while other historical documents about Ayutthaya focus more on other issues such as politics, warfare, trades, diplomacy, etc. Fortunately, there are still some remains of the water management from King Narai's period which can still be studied from the archaeological evidence above ground and the excavation done in the recent time.

#### 5.2.4.1 Water consumption in the palace: Foreign influences

According to archaeological studies using non-invasive techniques, geophysical survey (Branigan & Merrony, 1999), in the Royal Palace at the city island of Ayutthaya, the modern system for water consumption was installed. In the Royal Chronicles, during the reign of King Narai, the King had tried to improve the water supply system in the palace. His attempt was not successful until the Italian and French engineers visited Ayutthaya around 1682 CE. It was mentioned that the system was first constructed at Narai Ratchaniwet Palace in Lop Buri because of the scarcity of water in the city. In comparison to the remaining royal garden in the royal palace at Lop Buri and the foreigners' notes, it claims that similar water supply system could have also been built in the Royal Palace in Ayutthaya. From archaeological report (Phengtako, 1989), the water supply system in the Royal Palace comprises three main components a) water storage b) water Wheel and c) pipes (see figure 5.35).

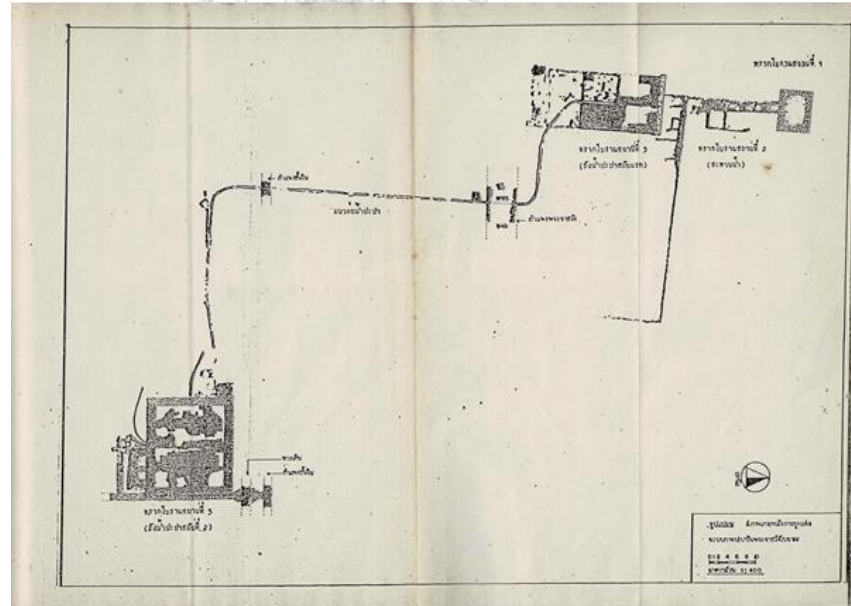


Figure 5.35 Lay-out plan of water supply system at the Royal Palace of Ayutthaya from archaeological study.

Source: Phengtako P (1989)

a) Water storages (see figure 5.36)

From archaeological evidence, Phengtako P (1989) explains that the remains of two water storages or water tanks were found. They were made of brick structure with lime mortar and plaster. One of the remaining water storages which was probably constructed earlier than the other is found on ground. Its size is around 13 metres wide and 18.50 metres long. In fact, this water tank is located outside the Royal Palace but near the Lop Buri river. The location is far from another storage built later at approximately 23 metres in distance.

It is still unclear why this storage was dismantled and rebuilt at the palace, however, from Phengtako's opinion, it was possibly because the Lop Buri river became narrower, so the water level decreased. As a result, relative evidence of water wheel, as believed, was also moved into the river.

Another water storage located within the Royal Palace can still be seen. It was rebuilt after the first one was removed. Similarly, this water tank was made of brick with lime mortar and plaster, its top part, which should be covered for sanitary reason, is disappeared. Several pieces of terracotta roof tiles were discovered from an archaeological excavation. It is believable, therefore, that the roof structure was timber which was perishable and was already gone. The remaining structure of this water storage is around 19 metres wide and 21 metre long. The height of this structure from the ground level to the top of the remains is around 5 metres. The reconstruction of the storage was done but the actual height is still unidentified (see figure 5.37). Notably, these water storages are the same rectangular-shaped as another one located near Wihan Phra Mongkhonbophit.

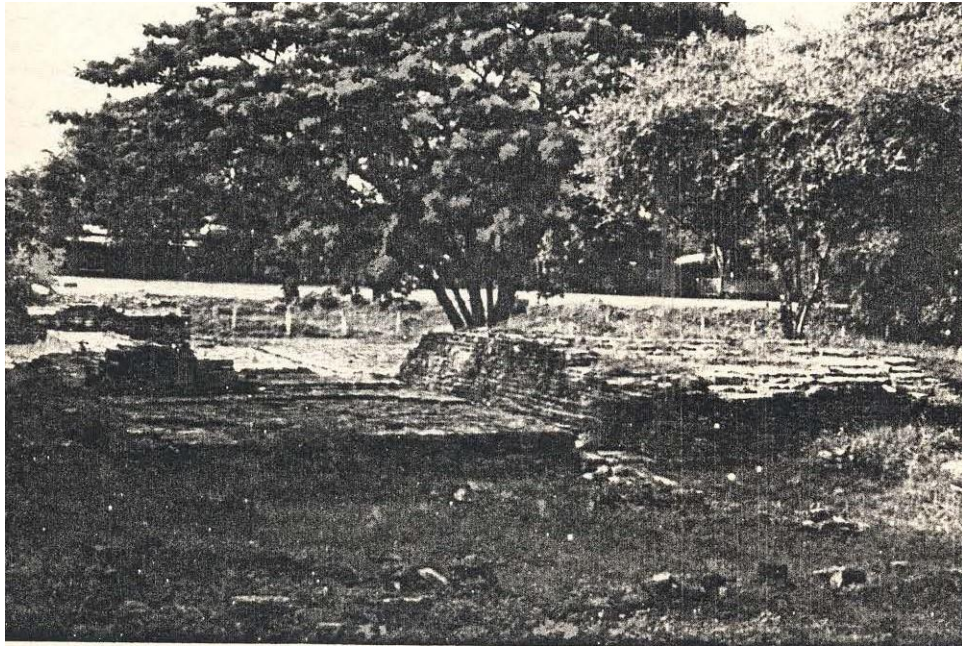


Figure 5.36 The remaining of water tank built earliest.

Source: Phengtako P (1989)

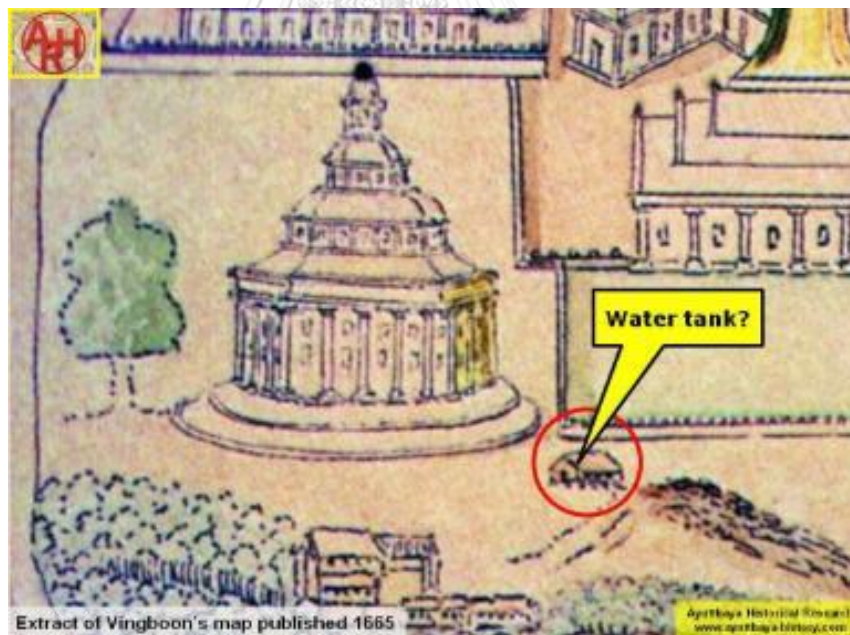


Figure 5.37 The water tank located in the Royal Palace of Ayutthaya.

Source: Vandenberg T (2010)

b) Water wheel (see figure 5.38)

From archaeological excavation report, remains of a rectangular brick structure, around 7 metre wide and 9 metres long, was found near water level of Lop Buri river to the north of Ayutthaya city island. Its location was about 2.50 below average ground level of the city island in 1989 CE. Phengtako P (1989) claims that this remains is the foundation of a building relating to water wheel or a base of water wheel. Brick ruins in linear shape with higher curbs along the line were also found. It continued from the remaining structure of water wheel to the ground level and was identified as the water bridge carrying water from the water wheel to the storage.

According to several scholars, water wheel was mentioned as an instrument to bring water into the water supply system in the Royal Palace during its glorious past but no more explanation and evidence are present, whereas, according to the Royal Chronicles, *Rahat Nam*, meaning water wheel, is referred to a bridge located southward from the water wheel, along Lop Buri river on the way from the Front Palace to the Royal Palace. Phengtako assumed that there are possibly three kinds of water wheels used at that period.

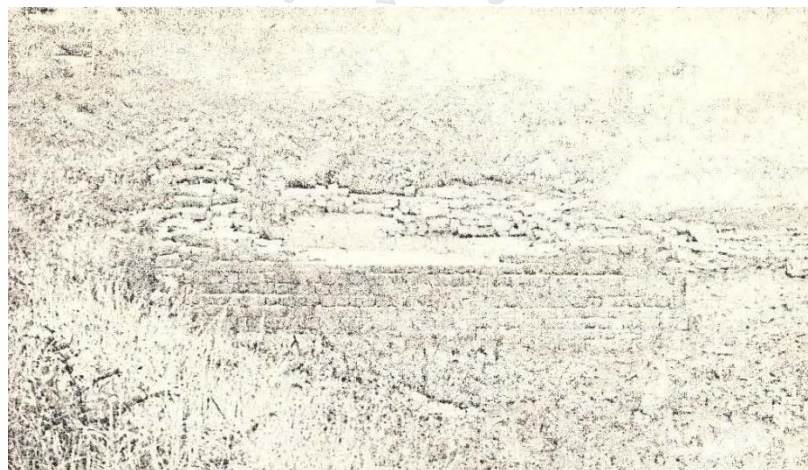


Figure 5.38 The evidence claimed to be a base part of water wheel.

Source: Phengtako P (1989)

1) Traditional water wheel is known in local word “luk” which is still used nowadays in the north of Thailand which is a mountainous area (see figure 5.39). However, it can be argued that this water wheel works well in the sloping area while Ayutthaya is located on a plain area.

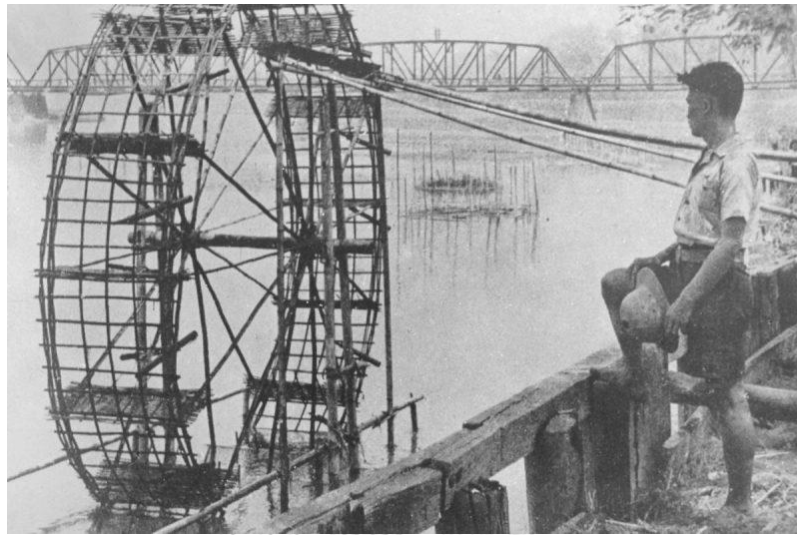


Figure 5.39 “Luk” a simple water wheel found in North of Thailand.

Source: <https://www.chiangmainews.co.th/page/archives/1045389/>

2) Horizontal water wheel using in the central part of Thailand is called “Boxing water wheel” (see figure 5.40). This wheel normally used manpower to draw water into a rice field. But in the past, it used only manpower, so it was not able to apply the technique to bring the water from the river to the palace (anon., n.d.-f).

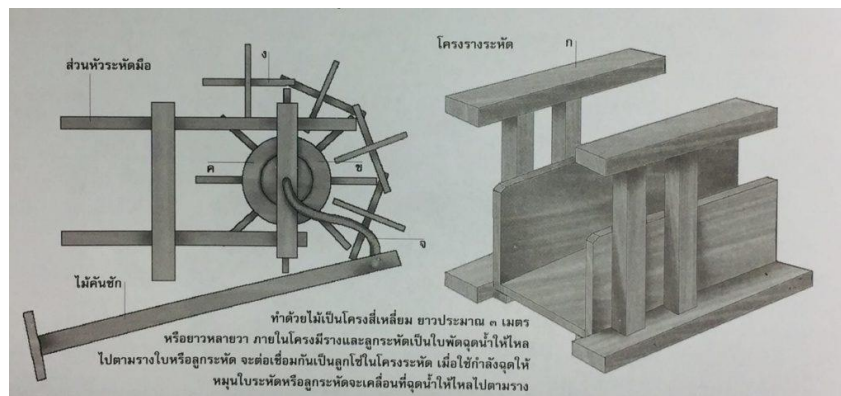


Figure 5.40 Example of boxing water wheel.

Source: [https://www.silpa-mag.com/history/article\\_38125](https://www.silpa-mag.com/history/article_38125)

3) Windmill is the third possible assumption because the Dutch who already arrived in Ayutthaya could introduce this kind water lifting machine.

From the author's point of view, the windmill seems to be impossible since there is no clue that the water wheel used in Ayutthaya at this period could be the Dutch windmill. For "luk", even though it is known as the traditional water wheel in the north of Thailand, but the technique might have come from China where this water wheel was invented in 31 CE (Hansen, 2004). Then it was highly developed for irrigation system and water distribution. Around 1221 CE this Chinese innovation was introduced to other neighbouring countries. Therefore, this lifting equipment might have been brought to Ayutthaya through the connection with China directly or through the northern states of the present-day Thailand where ethnic groups who moved down from the south of China have settled down.

c) Pipe (see figure 5.41)



Figure 5.41 The excavated pipes.

Source: [https://www.matichon.co.th/news-monitor/news\\_572004](https://www.matichon.co.th/news-monitor/news_572004)



From archaeological excavation, water pipes were found which are made of two types of materials: terracotta and bronze. For terracotta pipes, various sizes of the pipes were discovered. It was also interesting that some pipes were covered by brick tunnel, which could have been built to protect the pipes which were quite vulnerable. The terracotta pipes were short, probably due to the limitation of production technique, each piece of pipes was attached to the other by lime mortar. For the bronze pipes, each pipe was 0.45 metres long and only 11 pieces were found. They were also attached to the terracotta pipes. This is questionable why two materials were used in the same system. The first consideration is that it was an experiment on using bronze pipes. In European countries e.g. Italy and France, around this period, bronze was used in the Royal Palace's garden which reflected the prosperity of the King, therefore, this material might be used by the Italian and French engineers who came to Ayutthaya during King Narai Maharat's reign. However, it might not work efficiently because the material was imported and the technician was as familiar to its production as building. Another consideration is that different materials are for different purposes. The bronze pipes might be used for fountains in the palace while the terracotta ones were for the other domestic uses. However, it is still unclear for this assumption as the excavation area was not the royal garden and the fountain heads were not found. On the contrary, the area was deserted for hundreds of years, so it could have been intervened since the fall of Ayutthaya. For example, after the Burmese left in 1767 CE, people came back to dig for the treasures buried underground, therefore, the evidence could have been moved from their original locations.

#### 5.2.4.2 Fountains: water management adaptation for appreciation

It is mentioned in the Royal Chronicles that King Narai Maharat ordered to build a pleasure garden in his Lop Buri Palace, *Narai Ratchaniwet*, as well as the Royal Palace at the city island. At Narai Ratchaniwet, apart from irrigating water from the reservoir located at the mountainous area outside the city, the

Persian garden was created as seen in various historical documents (see figure 5.42). After several years of attempts, the irrigation system depended on the gravity was successfully done by an Italian priest namely P. Thomas Valgarnera and a French engineer (Branigan & Merrony, 1999). Then King Narai sent the Royal envoy and artisans to France to learn about fountain construction, building technique, gold and silver works and so on. Later, the King also imported the pumping machine to replace the gravity system in Lop Buri.

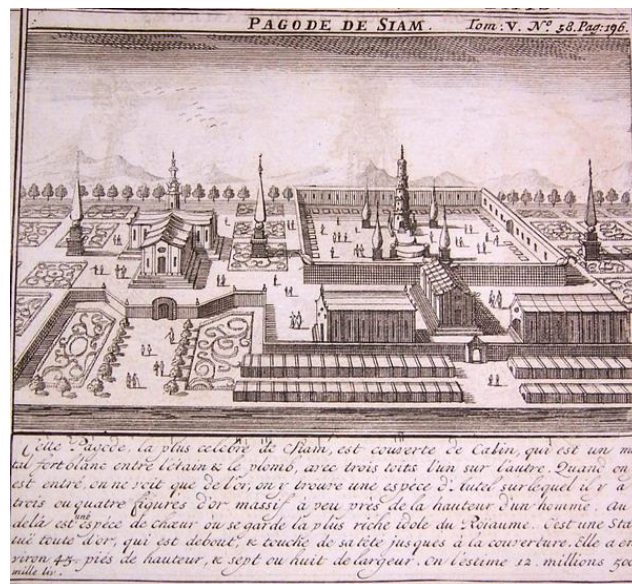


Figure 5.42 The Persian garden at Narai Ratchaniwet in various historical documents

Source: [http://www.theeditorsociety.com/2016/tag/Lop Buri-palace/](http://www.theeditorsociety.com/2016/tag/Lop-Buri-palace/)

Similarly, but less evident than historical documents, the Royal Palace at the City Island had a fountain garden as well (Champapan, 2020a). Branigan K and Merrony C (1999) did a non-invasive investigation at the Royal Palace in 1977 CE to find out the evidence of the fountain garden at the Palace by magnetometer and resistivity survey which are geophysical techniques. As the result, the evidence was interpreted that the garden was found in the women quarter of the Palace. It was a formal pattern garden which comprised flower beds, brick platform, paved walkways, man-made pond, which probably

included fountains as the water conduit was also found. However, Branigan K and Merrony C strongly recommended that the archeological excavation needed to be done to confirm their interpretation. From the creation of these fountain gardens in both cities of Ayutthaya Kingdom, the water management techniques obtained from various countries e.g. China, Persia, France and Italy was adapted appropriately to the natural conditions of the cities of the Kingdom. It highly demonstrates that water was used beyond the physical purposes but mental appreciation.

#### 5.2.4.3 Jars Culture: Local simplicity

As mentioned in sections 5.2.4.1 and 5.2.4.2, the domestic uses of water management in Ayutthaya are related to its royal palaces. It should be further investigated how water was managed for domestic uses in the ordinary people's houses. This section focuses on the water consumption for their daily life. In comparison to how people in Bangkok lived in the early period Rattanakosin around late 18<sup>th</sup> century after the fall of Ayutthaya, as well as the way of living in the central part of Thailand, it is clearly perceived that Ayutthaya city island is located among rivers and their branches while in terms of climate type, it is in tropical monsoon area. Unlike some other parts of the world, this area is always full of water from both surface water sources and rain. As a result, in this period people certainly used water from the rivers and canals for domestication and household affairs except for drinking.

Considering the environmental condition which was not polluted, rainwater should not be contaminated and clean enough for drinking. The water was probably kept in terracotta jars which were produced in villages around Ayutthaya city island (see figure 5.43). Besides, the river water could be also stored in the jars, then alum was put to make water clear. Without concrete evidence, but scientifically, it might be boiled for the drinking purpose.

Accordingly, each house had several jars to collect water particularly for dry season. It should be noted that the remains of several kilns producing these terracotta jars can be found along rivers in the central plain such as Noi river while Khlong Sa Bua, the canal to the north of the city island, has been the

production site of terracotta products until nowadays. This way of life had continued until recent time especially during dry season of Thailand. It should be noted that ground water has been pumped up for consumption in the area of Chao Phraya delta for a long time when drilling technology for ground water at deep level was introduced to Thailand only in the early 20<sup>th</sup> century (anon., 2020). In addition, traditional ground-water wells have been found in arid areas, but water is pumped from unconfine aquifer which is shallower than and not as pure as ground water from the deeper ones, confined aquifers, which need advanced techniques and tools (see figure 5.44).



Figure 5.43 (Left) Reproduced terra-cotta jar. (Right) Archaeological kiln site produced terra-cotta jar since the reign of King Narai Maharaj.

Source: <https://www.thailandtopvote.com>

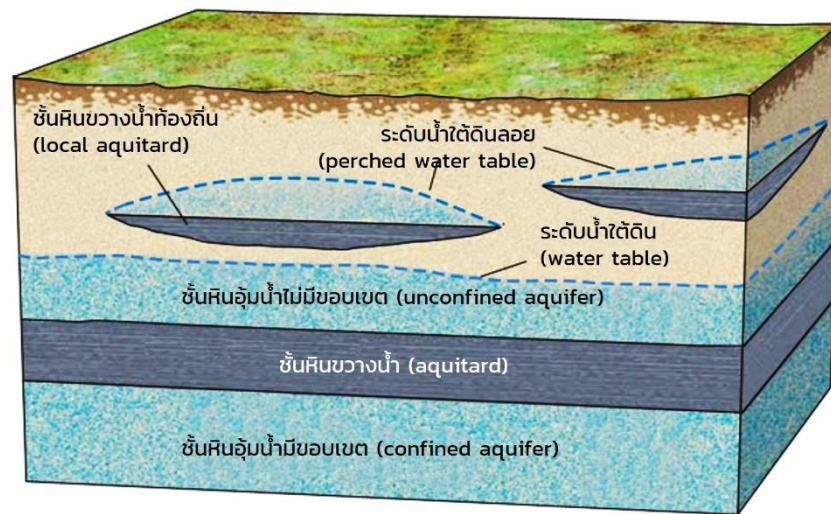


Figure 5.44 Ground-water structure

Source: <http://www.mitrearth.org/9-2-groundwater-movement/>

### 5.2.5 Architecture

From architectural perspective in relation to water management, it is noted that the social studies on residential architecture of Ayutthaya are very limited while architectural studies have been mainly focused on the classical architecture such as palaces and temples, which are not surprising because the remains of these architecture can still be seen especially above ground. The reason is that the building structures were made of brick, so this material is more durable than wood which was used for upper parts of the building and for building people's house. Furthermore, there are no evidences of bamboo or thatch used for building temporary houses or dwellings of the poor people. However, those studies are inclines on the design and history whereas this research explores various kinds of architecture in Ayutthaya which shows responses of the residents in Ayutthaya to their watery surroundings in order to explore another knowledge in water management in this period.

### 5.2.5.1 Temples

In terms of their initiation and continuous supporters, temples in Ayutthaya could be categorized into 1) the royal temple or *Wat Luang* initiated and supported by the King and 2) the ordinary temple or *Wat Rat* initiated and supported by residents who were generally the rich people such as noble people and merchants. This tradition to support Buddhism has been practiced until today in Thailand. Therefore, the number of temples could reflect the prosperity and wealth of the King, his kingdom and people. According to historical studies and research, it is clearly recorded that in this period, Ayutthaya city island as well as the surrounding areas, hundreds of temples were constructed. Some temples evidently existed before the establishment of Ayutthaya while others disappeared after the fall of the city and become archaeological remains at present. However, many temples have continued. They were reconstructed or have been restored when the city island was rehabilitated a few years later. The Fine Arts Department (2008) registered 326 temples including both the ruins and living temples in the city island and the surrounding areas known the Greater Historic City of Ayutthaya named in the Master Plan for the Development and Conservation of the Historic City of Ayutthaya as the Ancient Monuments which are cultural heritage with national importance (Faculty of Architecture Silpakorn University, 2010). Even though it is still difficult to count the exact numbers of the temples existed in this period, considering the whole Kingdom, the number of temples might be uncountable. Focusing on the temples located in the city island and its surroundings (see figure 5.45), it can be seen that how the temples demonstrate their response to water management at that time through the following aspects.

#### a) Location

Obviously, all temples built in Ayutthaya in this period (1350 CE -1767 CE) were located along the canals. It is exceptional for the temples located in the royal palace which were parts of the palace compound, which was also situated along the canals. The royal temples as well as the temples

built before the establishment or in early period such as Wat Phananchong, Wat Phutthaisawan and Wat Chai Watthanaram, were constructed along the main canals or rivers which were the main transportation routes in that period (Na-Paknam, 1997; Vallibhotama, 2017a), while some temples built in later period are located at sub-canals as seen nowadays. Furthermore, other temples still exist but the canals they have been located along, were silted, or already disappeared. At present, these temples have become evidences of the vanished canals.

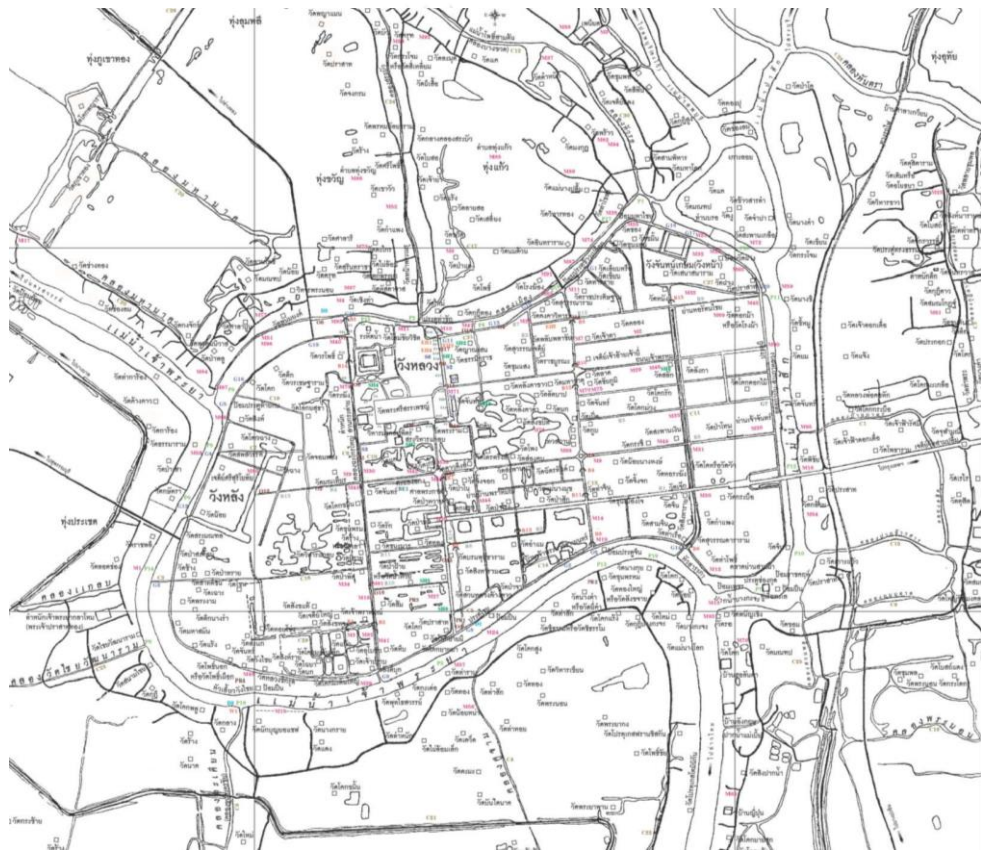


Figure 5.45 Temples in Ayutthaya city island based on the survey map of Phraya Boranratchathanin and adapted by Wongtes S. et al (2010).

Source: Wongtes S. et al (2010).

#### b) Planning

Considering the planning of temples, the Buddhawas section, where the religious activities are performed including the ordination hall, vihara, stupa, etc. was surrounded by a small moat to mark its boundary. For instance, the small canals around the remaining of Buddhawas of Wat

Chaiwatthanaram, except the eastern side which is Chao Phraya river, can still be seen when it was under restoration in the recent period. This can be discussed that, when the temple was built, the Bhuddhawas section or buildings located within this section would be constructed on the landfilled area, therefore, the land in the temple might have been cut to fill in the Bhuddhawas section probably to protect the main area of temple from inundation. From the other point of view, in Buddhist Tripitaka, monastic boundary can be marked by several elements ranging from water body to boundary stone which is a traditional practice up to the present. Due to the distance of resources and the city, stone was not a popular material in this period while water body like canal or moat was more conveniently applied.

c) Buildings

From the remaining archaeological ruins in Ayutthaya city island and the living temples, buildings located in Bhuddhawas were generally made of brick with lime mortar and plaster and timber roof-structures. It can be seen that, in 2011 CE when the central plain of Thailand was flooded which was the most severe water-related disaster in the country's history, the flooding level was not higher than the functioning level of these buildings. Several pictures taken during the time show that various household appliances were moved onto the remains of these buildings to be safe from water. Another example is Wat Chaiwatthanaram, which is located at the other side of Chao Phraya river to the southwest of the city island, has never been flooded above the first-floor level which is its functioning level (see figure 5.46). Thus, these examples may be able to prove that it was known how high the buildings should be constructed but more detailed research is essentially needed. It should be noted that, for the Sangkhawat or monks' residential section, buildings were made of wood similar to elevated houses which will be discussed in the next issue.





Figure 5.46 Wat Chaiwatthanaram during the disastrous flood in 2011

Source: Collection of HRH Princess Maha Chakri Siridhorn

#### 5.2.5.2 Houses

##### a) Elevated house

According to the historical documents written by European visitors (Heeck, 1654-1655; Kaempfer, 1690-1692; Tachard, 1662-1699), from their observation houses of Ayutthaya were remarkably diverse. In this period, especially since King Narai Maharaj welcomed all foreign visitors to Siam, various house styles depending on races and social status were built. Simon de La Loubère who came to Ayutthaya in 1687 CE as a French envoy described in *Du Royaume de Siam*, a record about Ayutthaya Kingdom including customs, society, living condition, etc., that the house of Siamese was simple and compact in a spacious land (Loubere, 1688). For middle class people, the house was mainly made of bamboo structure and enclosed by basketry panels and roofing. The single-floor house of the Siamese was elevated above flooding level (see figure 5.47). He was surprised that this kind of house could be built within two days. Similarly, Engelbert Kaempfer, a German engineer who came with the Dutch East India Company in 1690 CE, stated that for normal

class people their houses were simple and made of bamboo with a rough craftsmanship. Besides, betel palm was also used as building material.

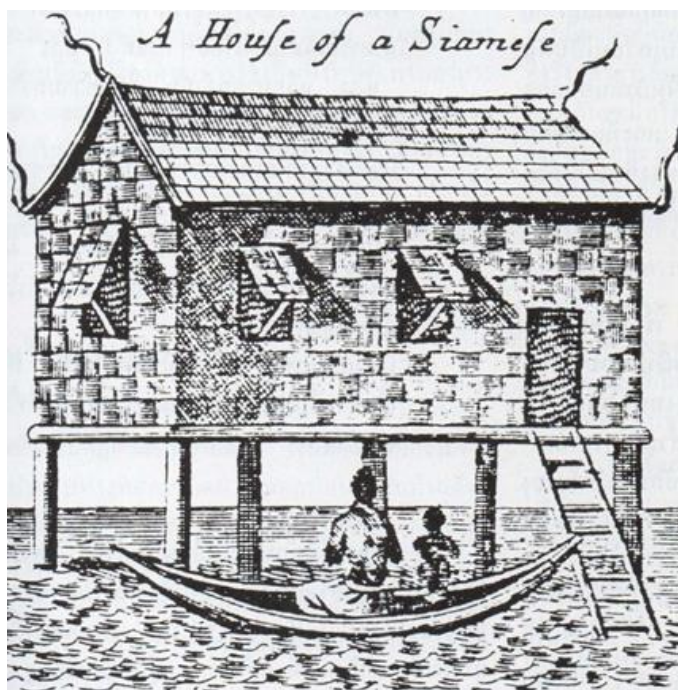


Figure 5.47 Example of elevated house

Source: Du Royaume de Siam by Simon de La Loubère

On the other hand, the noblemen or wealthy people lived in elevated timber houses usually along the canals or rivers. Some houses were made of brick similar to houses of the European, Persian and Chinese. For the timber houses, the building technique was of delicate and highly skilled in traditional carpentry. Each part of the house was made separately and assembled by traditional jointing techniques within a few days. This kind of houses are still built in central Thailand nowadays and known as the *Thai house* (see figure 5.48). In addition, each house had its own pier as boats were necessary as main vehicles. Obviously, it can be said that the elevated house demonstrates the interaction of Ayutthaya people or Siamese to its water-related environment. They understood how to build the house suitable for the inundation because living close to water was

prestigious and comfortable. Furthermore, the timber house is movable so it can be taken apart, moved, and reassembled.



Figure 5.48 Classical Thai house that still exists.

Source: Jumsai na Ayudhya S (1986)

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b) Raft house

From various maps, particularly in Vingboons' map, Iudia (see figure 5.49), a remarkable number of raft houses gathered around the canals and port areas. In historical document from the Royal Hall, it claims that there were 20,000 raft houses in estimation floating around Ayutthaya city island and other 20,000 raft houses outside the city island. Similar to houses on land, the raft house was built from bamboo with grass roofing. Vallibhotama claims that in Ayutthaya period, the land was very valuable for rice cultivation. It belonged to the King while the hinterland was still

forest and undeveloped. As a result, most peasants lived on the rivers as seen in Vingboons' map.



Figure 5.49 The picture of rafting houses floating around the port of Ayutthaya city island.

Source: Jumsai na Ayudhya S (1986)

This way of life continued in Rattanakosin period when the centre of the kingdom was revived in Bangkok. According to Frederick Arthur Neale in his book entitled *Narrative of the Residence in Siam*, in early Rattanakosin period before the reign of King Rama V (1868 – 1910 CE) there were nearly 70,000 raft houses on Chao Phraya river in Bangkok (Neale, 1840 - 1841). Some were luxurious and comfortable. He claims that the Siamese who lived in Bangkok left Ayutthaya for new capital city (Fine Arts Department, 1982). Somehow these houses were suitable for this country as it was cool all days due to the location on river. Therefore, raft house was the typical house of commoners since Ayutthaya period. It should be noted that until the recent time, along Sakaekrang river which connects to Noi river or the old course of Chao Phraya river, the raft houses can still be seen.

c) Boat house

Boat house normally was accommodation of merchants who brought products from other towns to exchange in Ayutthaya city island. According to Khaomala P (2009), the boat house in the late Ayutthaya period was called *Prathun* which was a log boat with a woven bamboo roof (see figure 5.50)(Khaomala, 2014). The whole family lived in a boat. Simon de La Loubère described that, in rivers, the traffic was heavily jammed. In fact, the information of boat houses in this period is rather limited than the other kinds of boat such the Royal barges. However, considering boat houses in later period, early Rattanakosin period (1782-1910 CE), living in boat houses might still be the same as those days at Ayutthaya. Boat houses continued sailing from the north where the merchants acquired the products such as rice, sand and wild or forest products, and traveled to Bangkok where they sold the products. Boat houses gathered around the floating market at the mouth of the city moat of Bangkok where it joins Chao Phraya river. In the early 20<sup>th</sup> century, Bangkok was expanded, therefore, some people moved out of the boat to live in houses on stilt along Chao Phraya river while other boat houses moved up north to the new area. Unfortunately, the traditional boat houses have disappeared since the latter half of 20<sup>th</sup> century.



Figure 5.50 Phratun, a logboat with a bamboo basketry roof.

Source:<https://www.saranukromthai.or.th/sub/book/book.php?book=39&chap=3&page=t39-3-infodetail03.html>

### 5.2.6 Food production: Rice cultivation

It is widely known that as the global centre for trade and commerce, especially since the reign of King Narai Maharaj, Ayutthaya produced several kinds of products to supply the international markets as well as played an outstanding role for exchanging the exotic goods from other parts including the hinterlands of the kingdom. Although this research focuses on the products relating to water management in the period, the trade of wild products from the outer towns and cities of Ayutthaya Kingdom, may indicate that the increasing number of short-cut canals and the construction of transverse canals helped facilitate the exchange of these goods. However, it is evident that rice cultivation is one of the best reflections how the Siamese in Ayutthaya adopted their knowledge in water management particularly in canalization and irrigation system to support and enhance rice production (Champapan, 2020b; Songsiri, 2016).

Due to the administrative system, Chatusadom or the Four Columns of the Kingdom's administrative entity, *Na* or Rice Paddy was named as one of the four columns known as the Bureau of Paddy Field or *Krom Na*. The Bureau oversaw the occupation of people including agriculture, mainly rice cultivation and ensured the sufficiency of food stock during war time. However, rice was not produced for export until the reign of King Narai Maharaj. The government investment on canalization was aimed for the transportation, communication and military affairs rather than irrigation and drainage for agriculture. Possibly, the amount of rice production was enough for the kingdom's population because of the abundant water supply from natural inundation and the cultivation method which was suitable for the natural condition of the area. However, it should be noted that, recently, several historians including Sujit Wongtes and Chris Baker argue that Ayutthaya relied on international trade and commerce due to the monopoly business and the role as a middleman, other than agriculture (Baker, 2011).

#### 5.2.6.1 Wet-rice or deep-water rice cultivation: taking advantage from climate zone, tropical monsoon

For the rice cultivation fields in late Ayutthaya period, from the author's point of view referring to the reign of King Narai Maharaj to the fall of Ayutthaya, Tanabe S claims that the traditional wet-rice cultivation, especially in Ayutthaya period when rice consumption was mainly for its population and the exportation was in the early time, took advantage on water supply from inundation season. On the other hand, the uncertain tropical rain pattern may cause the water shortage so canalization for irrigation system to stimulate the annual flooding should be needed.

Regarding Takaya S (1969) Chao Phraya delta comprises two main geomorphological characters. The old delta of Chao Phraya river, as known as the upper part of Chao Phraya delta, is the area between Ayutthaya and Chai Nat province covering the alluvial plains of Chao Phraya river, Suphan Buri river, Noi river and Lop Buri river. From historical documents, presumably, this area has been the rice cultivation until present day as it is recorded that rice was cultivated in other rural towns of Ayutthaya kingdom since the early period of Ayutthaya.

Another geomorphological character is the lower part of Chao Phraya delta around Ayutthaya to the Gulf of Thailand, which is a flat terrain elevating less than 5 metres above sea level. In terms of geomorphological perspective, this part is considered a young or new delta emerging just thousands of years ago. According to Tanabe S, during Ayutthaya period in the lower Delta area the cities and main towns were situated around the mouth of river branches or the area where the water traffic was dense. In addition, the linear settlements were also seen from the mouth of water channel to the inner area along the main canals in the major towns. Behind these settlements, most vast pieces of land were neglected and uncultivated. However, for Ayutthaya city island and some other major towns, rice paddies could be seen in the swamp areas behind the linear settlement (see figure 5.51). It claims that these paddies were naturally irrigated by the annual flood as the areas in this recent delta has sufficient

water for rice growing. Even though small water channels or ponds were rarely dug. For the cultivation techniques, rice grains were sown into the paddies, and thanks to the appropriate high temperature, fertile soil of alluvial plain and enough amount of water during the growing period, rice would grow well, and rice yield could be high.

It can be seen that the cultivation technique was unique since it differed from what had been practiced in the other states located in other types of geographical areas, for example, Lanna Kingdom in the north developed another unique agricultural technique of rice terrace and mountainous irrigation system. This traditional wisdom requires a deep understanding and consecutive observation on the natural phenomenon in order to develop the efficient agricultural techniques.

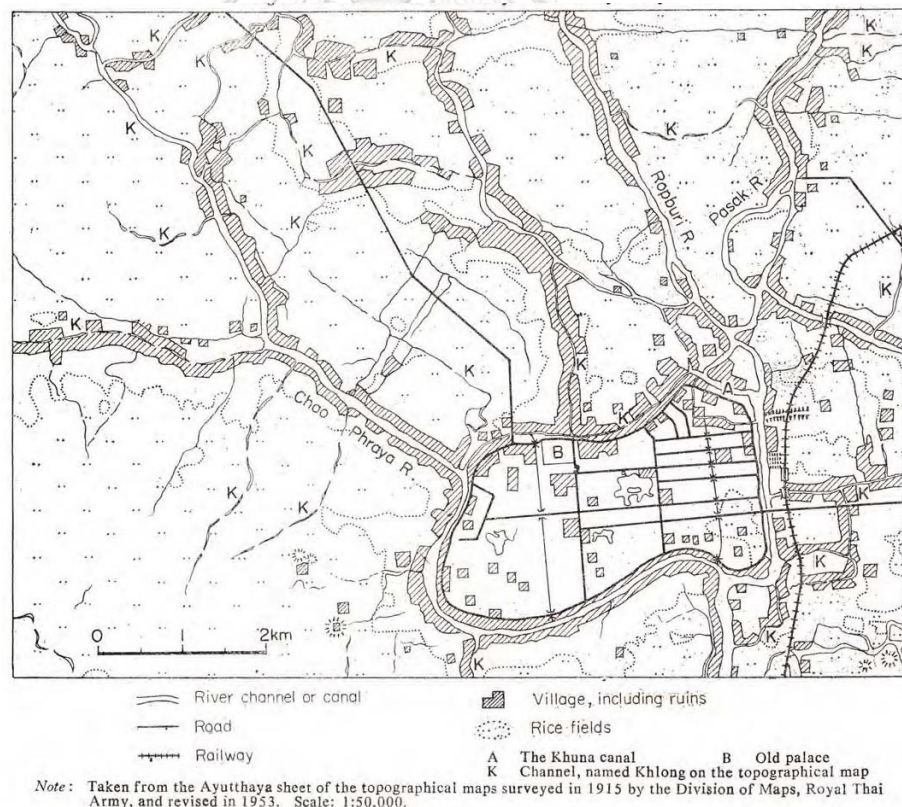


Figure 5.51 Linear rice paddies in the swamp areas.

Source: Tanabe S (1977)



#### 5.2.6.2 Rice grains: local varieties

Apart from the proper cultivation method, the appropriate selection of variety of rice is also another factor of successful harvest. According to Postharvest Technology Innovation Centre, from the historical studies, in Ayutthaya period when the rice paddies were heavily inundated that the invaders could not tolerate, rice was able to stretch up and continued growing well. The Centre also referred to two varieties of rice a) *Khao Khuen Nam* which can grow in the area flooded over 100 cm. and be able to internode elongate as well as upper nodal tiller, rooting and kneeing and b) *Khao Nam Luek* which can grow in the area flooded from 50 to 100 cm.

From archaeological evidence, the rice grains found at the archaeological site of Khok Phanom Di dated to circa 5,000 -2,000 years ago is the sticky rice species similar to other archaeological sites of contemporary period in Mae Hong Son, Loei , etc. Additionally, from a research on Thai Rice by Tayada Natabe, Tomoya Akihama and Osamu Kinoshita in the collaboration with Tottri University and Department of Forestry, Thailand, it is concluded that around 8<sup>th</sup> -10<sup>th</sup> centuries, the evidence of long-grain rice was found in the Southern Kingdom of Thailand as well as the city states of Dvaravati civilization in central Thailand, which may be influenced by Khmer civilization originated from India (Association., 2021). However, another source argues that the Indica long-grain rice was brought to the Irrawaddy river basin in present day Myanmar, via East Bengal, and arrived in central Thailand from the west. Nevertheless, wherever the long-grain rice came from, it is believed that the long-grain rice was consumed by the high-ranked people or elites of the society as it has been called *Khao Chao*. *Khao* means rice in Thai while *Chao* means a person who is royal-related. On the other hand, La Loubere explains that commoners of Ayutthaya consumed other kind of rice although it is unclear what kind of rice common people had but it is certainly not the long-grain rice, *Khao Chao*, as the normal Thai people has nowadays (Subwatthana & Purttinarakorn, 2019).

### **5.3 The Abandoned City (1767 CE – 1851 CE)**

This period covers the time from the defeat of Ayutthaya in 1767 CE to the end of the reign of King Rama III of Rattanakosin in 1851 CE. Since the city island was deserted, especially the area of the royal palace, palaces and temples while people came to resettle around the island afterwards. It was in the reign of King Rama IV, that Ayutthaya was revived, beginning with the restoration of the Front Palace or *Chankhasem Palace* located to the northeast of the city island. Consequently, the area around the palace started being urbanized and developed to become the market area as seen in the pictures taken during the reign of King Rama V when the King visited Ayutthaya as the node of commerce of the city.

#### **5.3.1 The last battle**

The highly advanced knowledge in water management can be seen even in war strategy. Ayutthaya took advantage from the natural phenomenon of inundation in the battles with other states or kingdoms for years. Since it was defeated by the Burmese in 1569 CE, the fortification system was improved and strengthened. The city moat on the eastern side was expanded along with the building of brick city wall and several forts situated in strategic locations around the city island. However, in 1767 CE, Ayutthaya kingdom was defeated for the second time in battle with the Burmese, although the defeat was certainly not because of the water management issues. Until today, many scholars, both Thai and foreign, still argue and propose the historiography of this last and remarkable event of Ayutthaya since it was the turning point that brought about the development of the present Thai history, and can be seen as an unclear but interesting foundation of the Thai society.

Focusing on the city island, after the Burmese invaded the city through the same place as the battle in 1569 CE when it conquered Ayutthaya, that is, the northeast city wall where Mahachai fort was standing. The city was sieged by the Burmese troop for 14 months. It has been argued that the city island was able to stand against the siege for such a long period because of the strategic location and designed protection system developed for hundreds of years. For 14 months, within the fortified city island, rice

was still cultivated so food shortage and scarcity should not be claimed one of the factors that the city island was eventually defeated. After the fall of Ayutthaya, the King and other members of Royal family, important noble officials, skilled persons i.e. artisans, craftsmen, performers, musicians, etc. were moved to Ava, the capital of Konbaung Dynasty situated near Mandalay, along with the treasures and precious objects.

At present, information from various sources is still arguable as some sources of claim that the city island was burnt to the ground by the Burmese troop. On the contrary, other sources e.g. the Burmese Chronicles states that the troop fired the foundation of the city wall at the northeast corner in order to enter into the city. Furthermore, from archaeological excavation at the foundation of Wat Phra Si Sanphet, the Buddha images which were believed to have been fired by the Burmese soldiers in order to slough off the gold as mentioned in several historical documents, has no evidence to indicate that they were really burnt when analysing stratigraphy (Krajaejun, 2019). However, the city was evidently deserted for a period of time.

### **5.3.2 Deserted city**

Approximately 8 months after Ayutthaya was defeated and abandoned, King Taksin declared independence and established the new administrative centre of the Kingdom at Thon Buri on the west bank of Chao Phraya river to the south of Ayutthaya, then he was coronated and ascended to the throne in the following year. Later, he spent several years to unite other city states which were parts of Ayutthaya kingdom into Thon Buri's domination as the reviving of Ayutthaya in the new location.

Accordingly, Ayutthaya has never been restored to be a capital city of the Siamese Kingdom again. Nevertheless, Thon Buri was the centre of the Kingdom only during King Taksin's reign (1767 CE -1782 CE). Then King Rama I, the founder of Chakri Dynasty (1782 CE – present), took over the throne and moved the administrative centre of Siamese Kingdom to the opposite side of Thon Buri, known as Krung Rattanakosin or Krung Thep (Wyatt, 2019).

From the Royal Chronicles, even though Ayutthaya has never been restored until the recent period, commoners probably returned to settle in the riverine area of the city

island mainly along the Chao Phraya river. According to the letters of a foreigner who came to Ayutthaya in 1769 and several years later, which is kept at the Archival Department of Missions Etrangères de Paris, he described that he saw many poor people around the city. They were mainly the Chinese and Siamese survivals who tried to find treasures buried underground (Chandee, 2021; Trevil, 1985). This proves that, after a short period of time, people returned to Ayutthaya. In addition, from the observation of the foreigners who came to Siam in the early period of Rattanakosin, along Chao Phraya river around Ayutthaya's city island, the elevated and raft houses were seen. Besides, it was mentioned that in the late King Taksin's period, there was a treason at Ayutthaya. This can imply that a group of people already resettled in Ayutthaya. Furthermore, regarding the Royal Chronicles, King Rama I came to Ayutthaya every year to offer the robes to the monks at the end of Buddhist Lent. Then Pallegoix patriarch who came to Ayutthaya in the reign of King Rama III also described that about 40,000 population were living around Ayutthaya city island.

Therefore, it is believable that people resettled along the rivers and canals in Ayutthaya city island and the surrounding areas, but not the areas of the royal palaces and many temples. The reason is that when King Rama IV was a monk and visited the city island, the Royal Palace, the Front Palace and most royal temples were still in the damaged and deteriorated condition (see figure 5.52).

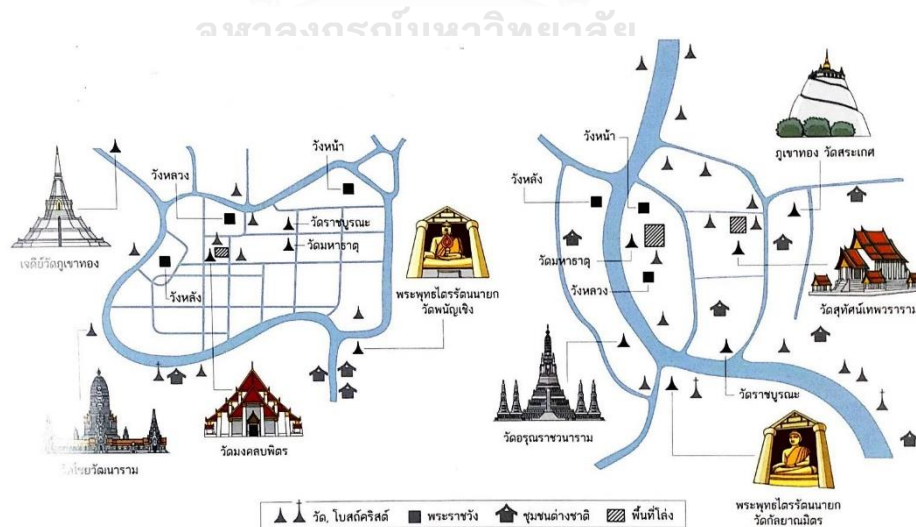


Figure 5.52 Bangkok, the reborn Ayutthaya.

Source: Shinawatra W et al (2009)

In consequence, the King started restoring some temples from that time onward. Thus, the continuity of Ayutthaya has never ceased. In the next chapter, activities and events relating to the water management of Ayutthaya are summarised and explored to fulfill the picture of its water management system at present.

### **Water management system of Ayutthaya: the resilient city**

Within 417 years of the existence of Ayutthaya as the capital of Ayutthaya or Siamese Kingdom, the knowledge on water management cumulated from the locals who lived in the area since former time and that which was received from outsiders brought the kingdom to the peak of its civilization as already discussed in this chapter. It can be seen from several aspects that the Siamese who lived in Ayutthaya Kingdom observed, collected, experimented, and developed the water management that was properly fit to its needs and with respect to its nature and environment. Sometimes the techniques to control water were transmitted from other cultures while other times deep water was harnessed to achieve in many purposes due to the in-depth understanding in water as well as its natural and cultural settings. Ayutthaya had developed better ways in response to dynamic and evolving change of water over its span of time. Therefore, it is clearly seen that Ayutthaya, especially the city island and its surroundings, was the city of resiliency where its population would always survive with a peaceful life.

Last but not least, the emergence and development of water management system of Ayutthaya city island during its 417 years can be concluded as below.

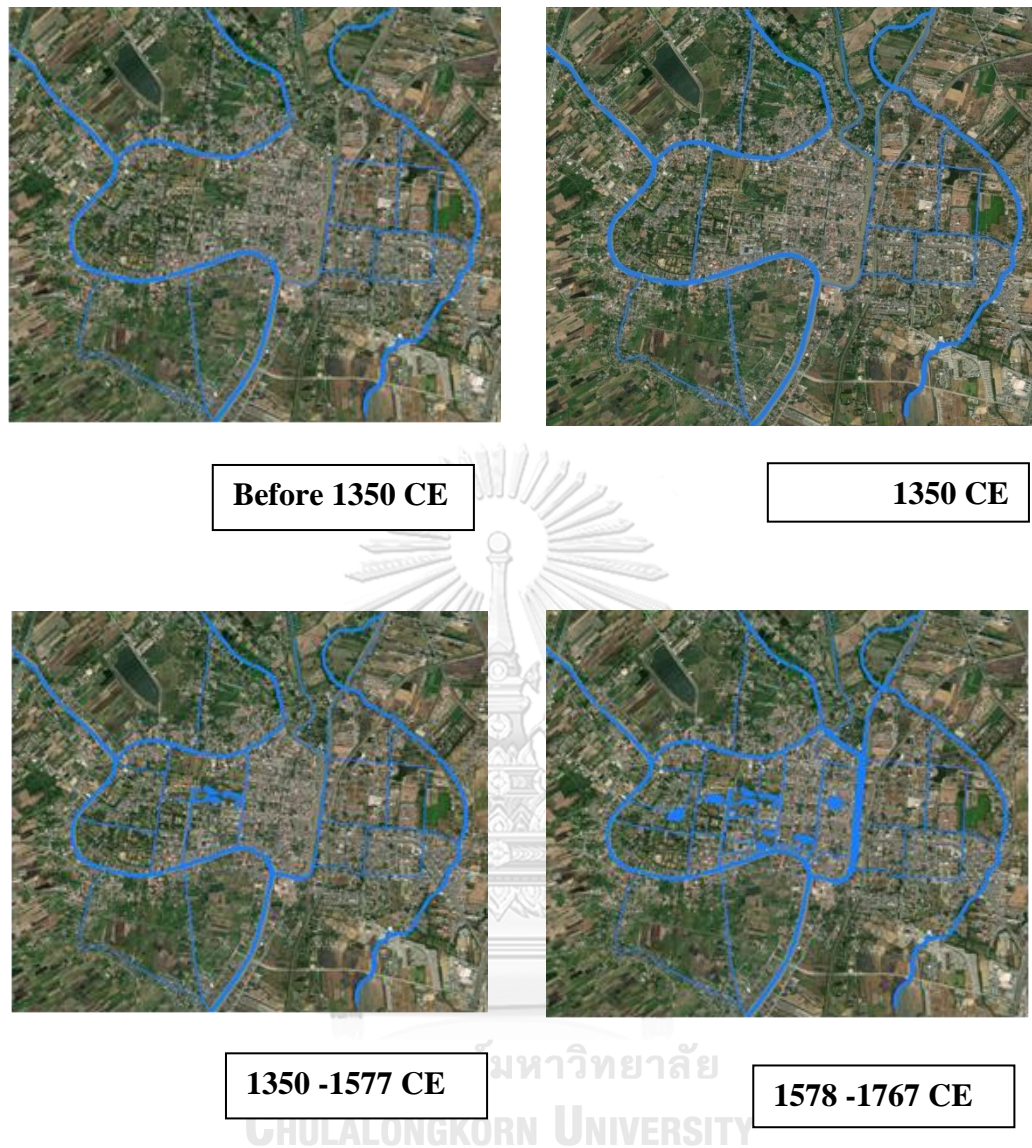


Figure 5.53 Development of water network within Ayutthaya City Island from 1350 – 1767 CE.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org) ©OpenStreetMap contributors

## Chapter 6

### **Ayutthaya at present: Changing Landscape and Challenges**

Regarding the landscape integration principles proposed in Chapter 3, it is necessary to take into consideration the changing of water management system since water management itself is not static but dynamic and evolving. This chapter aims to explore how water management system of Ayutthaya has changed from the end of the reign of King Rama III in 1851CE to the present day. It comprises three main parts: the first part discusses the overall changing conditions of Ayutthaya city island and its surrounding area, especially its status from the capital city of the kingdom to a province of a country; the second part, the major factors affecting the water management system of Ayutthaya are discussed; and the last part of this chapter examines the remaining water management components and the system.

#### **6.1 Revival from ruins**

After the fall of Ayutthaya to the early Rattanakosin period, as Ayutthaya was no longer the administrative centre of the kingdom, evidently the physical features of Ayutthaya city island and its vicinity gradually changed. On the contrary, from the mid 20<sup>th</sup> century, Ayutthaya has dramatically changed in several aspects comparing to the previous period. Since 1926 CE, the city island has been perceived as the ancient remains of the old capital of Siamese kingdom when the archaeological survey which produced a map showing existing condition of Ayutthaya city island was first conducted by Phraya Boran Ratchathanin (see figure 6.1). Regarding Baker C and Phongpaichit (2017), this awareness on the importance of Ayutthaya was emphasized and has become a meaningful tool to raise patriotism either for the Siamese or the Thais in later period. The reason is that, under the pressure during European colonization in Southeast Asia, King Rama V intended to show how deep was the Siamese kingdom rooted in this region. As a result, the so-called mainstream history of Thailand was composed by Prince Damrong Rajanubhab, which states that Ayutthaya was the second capital city of the Siamese which succeeded from Sukhothai. However, this does not have significant tangible effect on Ayutthaya particularly in the city island, instead, it initiates a strong motivation for preserving

the archaeological remains of the Royal Palace and temples of Ayutthaya for the following generations (see figure 6.2).

On the other hand, the change that might have critical impact on the urban structure of Ayutthaya city island including the canal network and traditional water management system was the economic development. Jarupongsakul T (anon.ad.) argues that the development of rice cultivation area at Thung Rangsit, Pathum Thani province which is the result of the Bowring Treaty between the Siamese kingdom and Britain that forced Siam to increase rice production had instigated a major physical change in Ayutthaya's water management system in the large scope of water network discussed in 6.2.1.3 (see figure 6.3) (Jarupongsakun, 1997). Furthermore, the initiation of industrial estate owing to the National Economic and Social Development Plan, 1st Issue, adopted in 1961 had evidently affected Ayutthaya (Office of National Economic and Social Development Council).



Figure 6.1 Aerial photo of Ayutthaya in 1946 taken by Peter Williams-Hunt

Source: Fine Arts Department





Figure 6.2 Old picture of Ayutthaya taken by Peter Williams-Hunt  
Source: Fine Arts Department



Figure 6.3 Canalisation at the South Pasak River Basin, the field of Rangsit,  
Pathum Thani province in 1900 CE.

Source: <https://aloudbangkok.wordpress.com>

### 6.1.1 Phra Nakhon Si Ayutthaya Province

From the previous chapter, it can be seen that even after the city island was deserted, Ayutthaya has never been forgotten from the mind of the Siamese. It has continued as a rice cultivation area to support the demand from the new capital city of the kingdom in Rattanakosin period when Ayutthaya became a town within a commutable distance from Bangkok due to the efficient transportation via the Chao Phraya river. According to the record of Sir John Bowring, the British representative who came to Siam for establishing the Treaty known as Bowring Treaty signed in 1855 CE during the reign of King Rama IV (1851-1868 CE), he stated that Ayutthaya was the second biggest city of Siam. Most parts of the city were connected to the rivers or canals while the number of populations was approximately 20,000-30,000, most of which were the Chinese with a small number of Laos and Burmese included. He also mentioned that the people were merchants, farmers and fishermen and mainly lived in the raft houses. Bowring emphasized that rice produced from Ayutthaya was of the highest quality and the rice paddies in Ayutthaya covered the largest area of Siam. From his record, it can be seen that the city island was also famous for its old temples where many people, which might have included the foreigners, visited on the way to the north and northeast.

In the reign of King Rama V, the governing system of the Kingdom of Siam was modernized by restructuring the system which was used since Ayutthaya period as part of the country's adaptation scheme during the western colonization in mainland Southeast Asia. Between 1895 CE and 1896 CE, Ayutthaya which was called *Krung Kao* (the Old Capital) at that time became a city of Monthon Krung Kao administrative region which included other seven cities. In 1933 CE according to the Act of Administrative Regulations of the Kingdom of Thailand 1932 CE, Monthon Krung Kao region was terminated and the provincial system has been adopted instead.

Nowadays Ayutthaya or officially Phra Nakhon Si Ayutthaya is one of 77 provinces of Thailand. The province covers an area of 2,500.656 square kilometres, which is divided into 16 districts. The city island is located within Amphoe Phra Nakhon Si Ayutthaya district. Ayutthaya province has been envisioned as one of the main industrial areas of the country, therefore, the province is now located with three

industrial estates and three industrial parks. It has been observed and noted that the construction of these industrial areas, their facilities, as well as transportation network to support their activities and businesses has considerable impact on the larger water management system around the city island and, probably has also affected the canal network within the city island.

### **6.1.2 National Heritage toward World Heritage: Technologically advanced and unique in the world**

For Ayutthaya city island or *Ko Mueang* as it is called nowadays, during the reign of King Rama IV, the Front Palace, also known as Chankasem Palace, was restored to be the King's residence when he visited Ayutthaya. It should be noted that most buildings in the palace were torn down in order to reuse the bricks for the construction of Bangkok city wall. A new pavilion and mansion were also built on the palace grounds. At the same time, Wat Senasanaram temple was founded as the palace temple, however, the restoration and construction projects were completed in the reign of King Rama V.

Phraya Boran Ratchathanin was appointed the governor of Krung Si Ayutthaya in 1897 CE. During his governing period, he had the antiques found in Ayutthaya and those at Chankasem Palace collected and exhibited in a museum founded by the King's order. His survey map (see figure 6.4) which was made during that time has become one of the most important sources of reference when studying physical features of Ayutthaya along with his interpretation of a historical document believed to have been written in the early years of Bangkok by a native of Ayutthaya, which is entitled "Description of Ayutthaya". It has been used to learn how the city island changed from its glorious period to the reign of King Rama V.

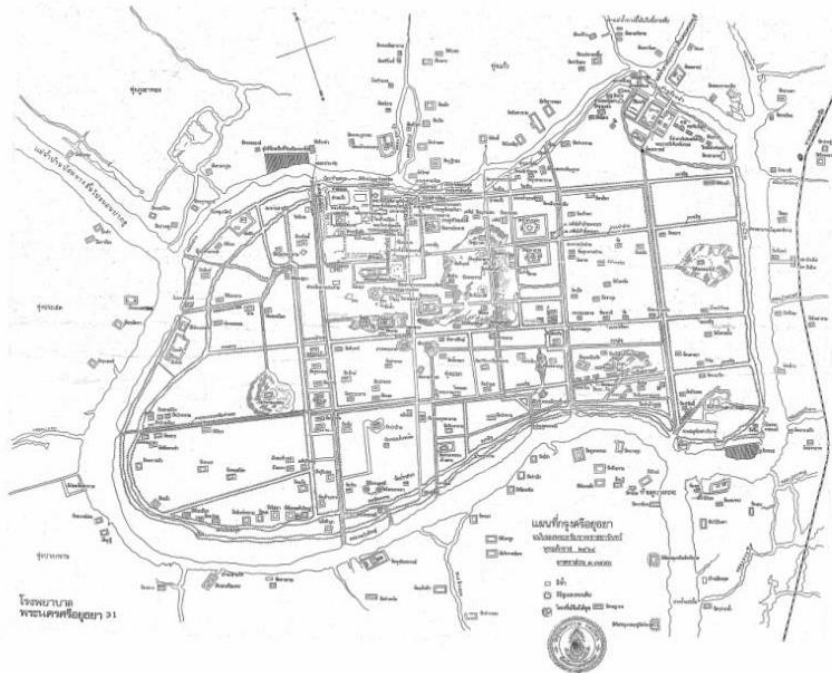


Figure 6.4 Archaeological survey map done by Phraya Boran Ratchathanin  
Source: Ton Chabab (2007)

It should be noted that, in 1872 CE, King Rama V declared the city island a public property which was not allowed for private land ownership. He also ordered to have archaeological survey conducted within the city island and restoration scheme for the remains of the Royal Palace complex. Later, after the democratization in 1932 CE, Ministry of Finance privatized some abandoned plots of land for commercialisation and governing purposes. Although two years earlier, the Fine Arts Department had 69 individual ancient monuments registered as National Monuments under the protection of the Act on Ancient Monuments, Antiques, Objects of Arts and National Museums. In 1976 CE, part of the area of the city island, around 2.90 square kilometers, has been declared a registered monument area and, later, was established as a Historical Park in 1982 CE. The protected area was extended to cover the whole city island, approximately 4.80 square kilometers, in 1997 CE after the Historical Park was inscribed on the World Heritage List in 1991 CE (see figure 6.5) (Faculty of Architecture Silpakorn University, 2010).

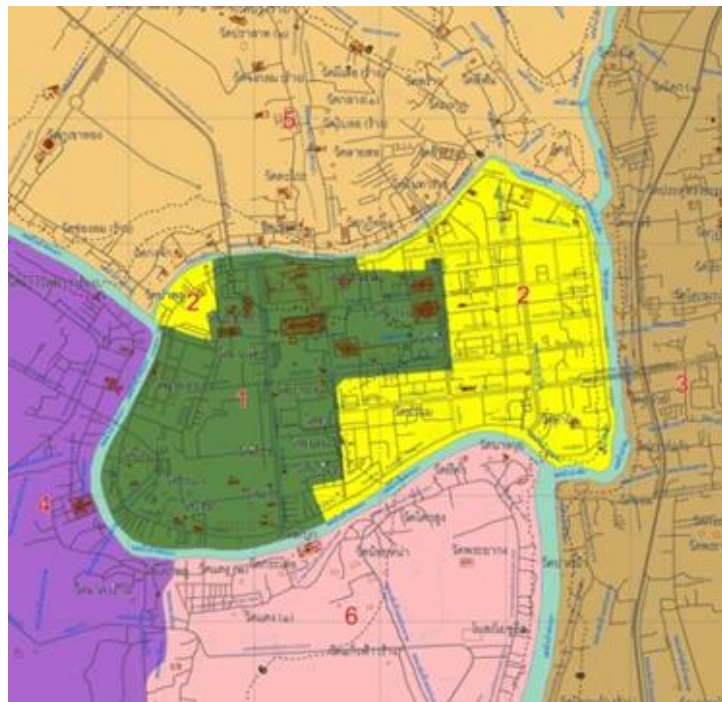


Figure 6.5 The boundary of the Historic City of Ayutthaya, World Heritage property.

Source: Fine Arts Department (2021)

Since 1976 CE, restoration of monuments within Ayutthaya Historical Park has been continuously carried out as the protected area is considered as an archaeological site while the rest of the city island has been urbanised and owned by governmental agencies, local authority and private people. In consequence, this part of the city island is the contemporary urban area that has been dynamically changed over time since the reign of King Rama IV. Therefore, the Fine Arts Department, the governmental agency in-charge of Ayutthaya Historical Park, has adopted the Master Plan for Conservation and Development of the Historic City of Ayutthaya to manage and conserve the City Island in 1996 CE. In fact, the Department already initiated the Second Phase Master Plan for the area outside the city island which can cover the footprint of Ayutthaya as well as the larger scale of water management of Ayutthaya in the glorious past. Unfortunately, the Second Phase Master Plan has never been implemented while the city island suffered the flood catastrophe in 2011 CE. As a result, another major restoration project within the Historical Park was implemented again after the disaster.

According to the Statement of Outstanding Universal Value of the Historic City of Ayutthaya, a World Heritage Property, that “.....*Ayutthaya was laid out according to a systematic and rigid city planning grid, consisting of roads, canals, and moats around all the principal structures. The scheme took maximum advantage of the city’s position in the midst of three rivers and had a hydraulic system for water management which was technologically extremely advanced and unique in the world.*” (UNESCO., n.d.-e), it is questionable what happened to the water management of Ayutthaya in 2011 CE. From its history as explored in this research, Ayutthaya has never seriously suffered from the flood. On the contrary, it even took advantages from the flood for several purposes. The present water management system of Ayutthaya, therefore, should be investigated to find out about the problem.

## **6.2 Changing landscape of Ayutthaya**

### **6.2.1 Transforming from water to land transportation**

According to the Historical Archives Archdiocese of Bangkok (2015), the construction of roads using western technology to serve the horse carriages of the European was first carried out in Bangkok during the reign of King Rama the IV (1851-1868 CE). Since then, other roads were gradually built along with the introduction of new kinds of vehicles including cars, trams and trains were to the country. In the reign of King Rama V (1868-1910 CE), the railway from Bangkok to Ayutthaya was constructed which was the first railway line in Siam. Consequently, the mode of transportation in the country was changed from water to land transportation because of the higher efficiency in terms of time and convenience.

Nevertheless, the transportation in Thailand was drastically changed when the National Social and Economic Plan have been adopted since 1961 as a national policy for the country’s development. The term of each issue of the plan is 5 years, which have been renewed consecutively until the present 12<sup>th</sup> Plan (2017- 2021) is being implemented. The earlier plans focus on the construction of the highways and roads connecting Bangkok to other regions around the country (see figure 6.6). These roads have affected water management system of Ayutthaya in two aspects, firstly, many of

the roads have obstructed floodways around Ayutthaya city island, therefore, the drainage system of the lower central plain of Thailand could not function as they did before; secondly, waterways are no longer the main transportation routes of people in the country, therefore, the canal system was neglected and the canals were left to shallow until, finally, many canals disappeared. At present, within Ayutthaya city island, only two north- south canals still function as drainage canals. While boats in three rivers around the City Island become tourist vehicles.

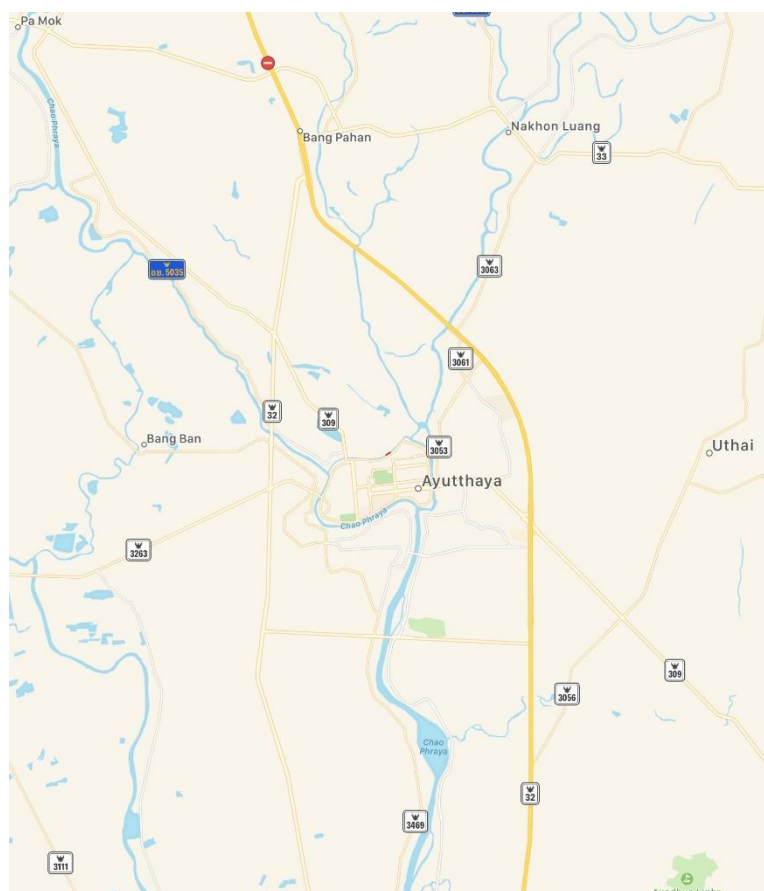


Figure 6.6 The road network around Ayutthaya city island and its vicinity.

Source: [www.openstreetmap.org](http://www.openstreetmap.org) © OpenStreetMap contributors

### 6.2.2 Commercialisation and industrialisation in the fields: Disappearing *Thung*

It appears that the fields around the city island did not change much until the reign of King Rama IV due to the Bowring Treaty made between the Siamese kingdom and Great Britain. Resulting from this treaty, the Siamese kingdom had dramatically

changed, probably in all aspects. In terms of the water management system, Siam had to increase its produce, especially rice for exportation. A vast field between Ayutthaya and Bangkok where the present Pathum Thani province is located was converted to be a rice cultivation. Therefore, a large scale of irrigation system was initiated. The system included canal network which diverted water from Pasak river and Chao Phraya river to this field, which is now known as Rangsit field. Anyway, changes at downstream of these rivers and canal network to the fields around Ayutthaya city island were not obvious comparing to upstream when three dams as mentioned above in this chapter were built in later period (Jarupongsakun & Kaida, 2000).

Since 1980s, due to the extreme economic growth of Thailand, many industrial areas were initiated and provided specific zones in the urban planning of the government. For Ayutthaya, six industrial estates and parks were constructed around Ayutthaya where the fields were originally located because they were identified as undeveloped areas which needed to be used. In general, the land of industrial areas is always filled to higher than their original ground level in order to protect the areas from flood. Moreover, by studying the aerial photographs (see figure 6.7), they are full of gigantic buildings and factories which have become the obstacles to the fields in detention of water from flooding and inundation. It is observed that these constructions have critically affected the drainage system in a large scale either at upstream or downstream areas. Therefore, the water pattern around Ayutthaya has completely changed visually as well as functionally.





Figure 6.7 Aerial photo of Ayutthaya at present

Source: [www.openstreetmap.org](http://www.openstreetmap.org) © OpenStreetMap contributors accessed

May 2021

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As already mentioned, in 2011 CE the central plain of Thailand was severely flooded. These industrial areas were badly damaged and suffered greatest economic loss in the country's history. Afterward, a gigantic water gate was built at Lop Buri river to control and divert water that may flow to the industrial areas while each industrial area also constructed large concrete dikes enclosing the whole area to ensure that they will not be flooded in the future. Consequently, it can be said that if the same amount of flooding water flows down to Ayutthaya again, the water may not flood over these areas but the city island and other lower or unprotected areas will still be affected. It should be noted that, if this scenario occurs, the situation will be worse as the amount

of water that flood the industrial areas will be pushed to other areas instead such as Ayutthaya city island.

In summary, the importance of the fields or *Thung* as the flooded areas has not been recognised. In consequence, these fields are not protected and taken into consideration seriously and comprehensively when the spatial planning has been done. Thus it can be seen that the water management system of Ayutthaya, especially its drainage system which was most advanced in its glorious period has deteriorated and partially disappeared so the system cannot function as it did in those days.

### **6.3 Tracing the missing teeth of water management system.**

Due to the previous parts of this research, it is explainable what the water management system in the glorious period of Ayutthaya was and how it functioned. Turning to the present state of the water management system, this section concentrates on the remaining elements of the system that still exist based on the author's filed survey. It is an informative exploration which is aimed to compare the present water management system and the past one. The result is expected to provide some sources of further studies or actions in order to regain the knowledge of water management system which has been recognized and commended as one of the most advanced and unique among other prominent water management systems in the world as well as, ultimately, to adopt or adapt the knowledge for present day circumstances.

#### **6.3.1 The remains of canals network**

##### **6.3.1.1 City moat and canal network in the City Island**

###### **a) City moat**

According to the map made by Phraya Boran Ratchathanin, the city moat comprising Chao Phraya river to the west and south, Lop Buri river to the north and Pasak river to the east, still exist and encircling the city island as they were in Ayutthaya period. However, the northern city moat, Lop Buri river, which was often used in the ancient times is obviously narrower. In consequence, it is not recognised as a river but a canal by its size, thus it has been locally called *Klong Mueang*, which literary means the city canal.

Another change is that a small water channel to the northeast of the city island parallels to Khu Khue Na was dug, possibly between 1917 CE and 1921 CE. This water channel is later known as Khlong Chong Lom. This canalisation was conducted by Phraya Boran Ratchathanin in order to solve the erosion of embankment in front of Chankasem Palace due to the whirlpool resulting from the confluence of the new course of Lop Buri river and Pasak river and the water force flowing from Khlong Hua Ro (Vandenberg 2010). This canal was expected to share the amount of water from Pasak river to Lop Buri river as well as to slow down the water speed and force of the river (see figure 6.8). However, it did not work satisfactorily as expected so another water channel, Khlong Sai was widened in order to change the water course of Pa Sak river to directly join the east city moat or Khu Khue Na (see figure 6.9). At present Pasak river has completely become the east city moat of Ayutthaya.



Figure 6.8 Khlong Chong Lom to reduce the erosion in front of Chankasem Palace.

Source: Khemnakh P (2019)

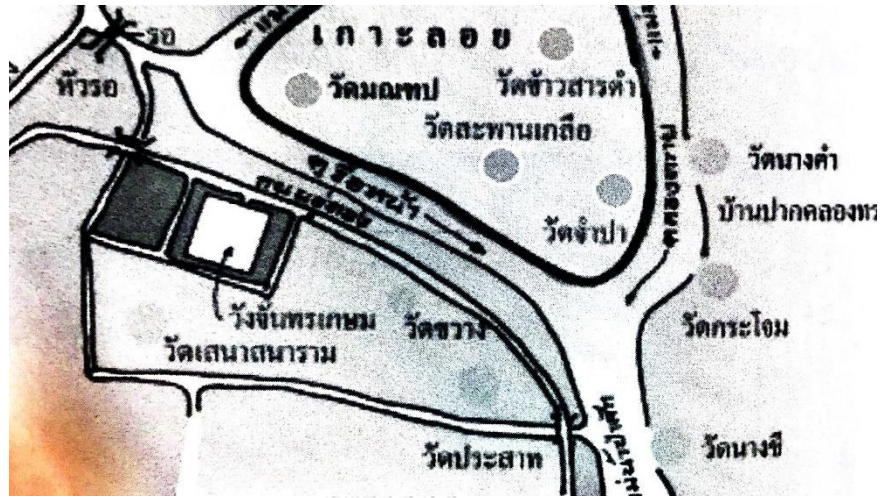


Figure 6.9 Map shows the location Khlong Sai

Source: Khemnakh P (2019)

b) North-south canals (see figure 6.10).

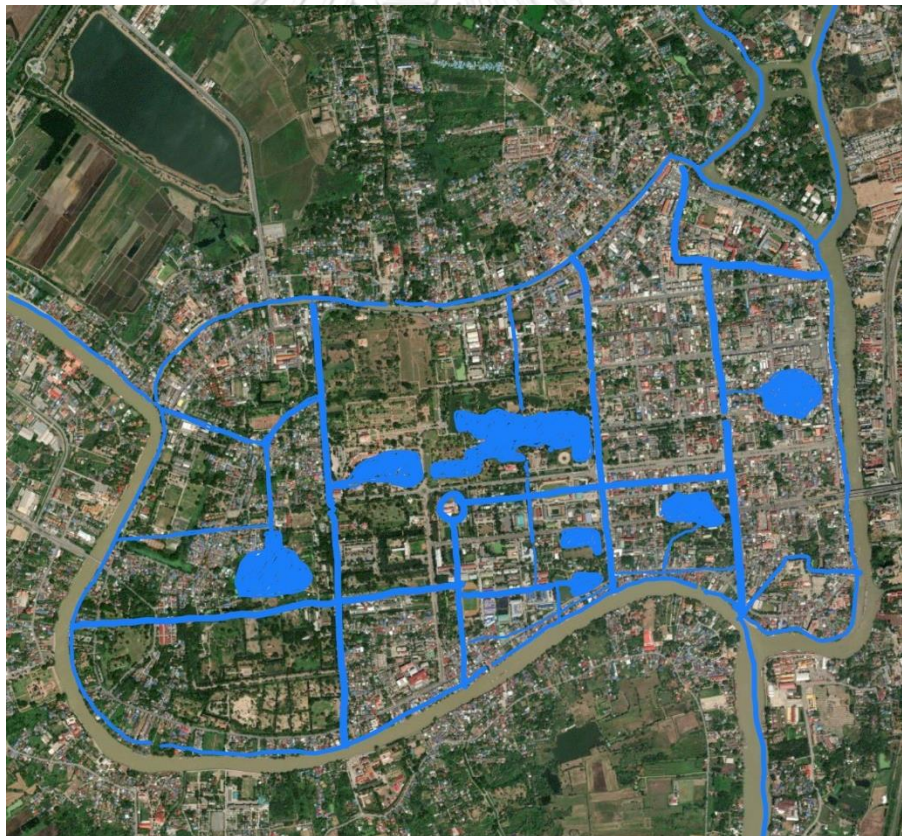


Figure 6.10 Map showing canals during the reign of King Rama VI.

Source: Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

©OpenStreetMap contributors

In the reign of King Rama V, the main north-south canals still existed as seen from the survey map of Phraya Boran Ratchathanin. These canals included Khlong Cha Krai Yai, Khlong Cha Krai Noi, Khlong Pratu Thep Mi, Khlong Pratu Khao Plueak and Khlong Nai Kai. Obviously, in the reign of King Rama V, several ponds which connected to these main canals can also be seen. From a recent map made by the Fine Arts Department, Khlong Cha Krai Yai, now called Khlong Tho, and Khlong Nai kai, now called Khlong Makhham Riang, are clearly seen while other canals have disappeared.

c) East-west canals

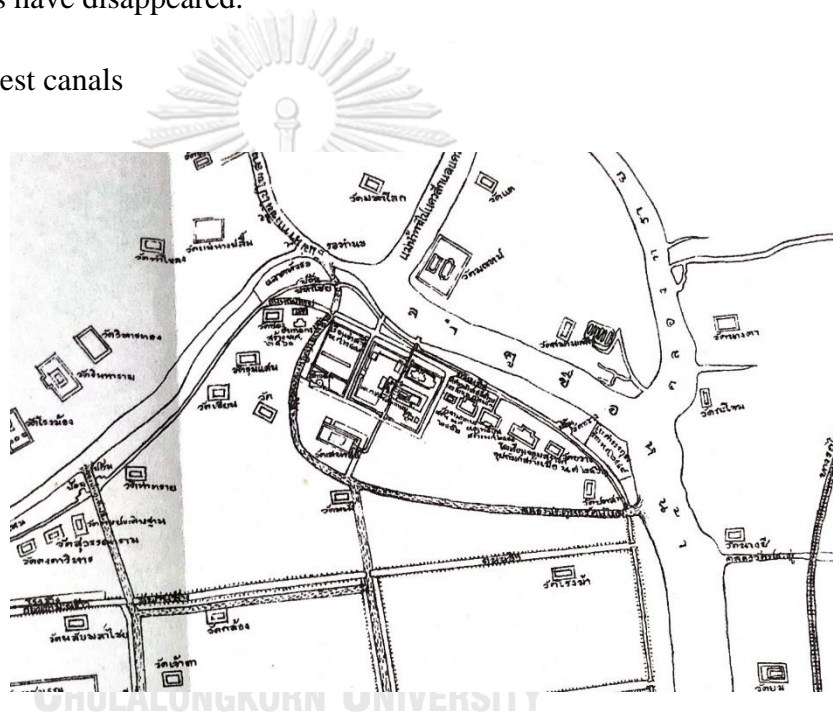


Figure 6.11 The Front Palace and its surrounded canals in the reign of King Rama VI

Source: Phraya Boran Ratchathanin's survey map.

It can be seen that a canal surrounded the Front Palace was found (see figure 6.11), whereas in the maps drawn by foreigners during Ayutthaya period this canal was not shown. The Front Palace was moated but there was a small canal from the palace which connected to a short canal lying in east-west direction (see figure 6.12). In Phraya Boran Ratchathanin's map, a mouth of the canal joins Lop Buri river around the *Ro* dam where

Mahachai fort was located, and flows to the back of the palace then turns to the east direction to join the new Pasak river or Khu Khue Na, the east city moat. This moat was probably dug when King Rama IV ordered to restore Chankasem palace. For other east-west canals, most of them were found in this period. However, at present, a few canals are seen but it is evident that they do not connect to the network (see figure 6.13).



Figure 6.12 The Front Palace and its surrounded canals in the picture drawn by Engelbert Kaempfer printed in 1727.

Source: Tansirivanich T (2006).



Figure 6.13 The Front Palace and its surrounded canals at present.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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### 6.3.1.2 Canals around the City Island

Canals around the City Island have not been mapped for a period of time even when Phraya boran Ratchathanin did the survey. Therefore, it may be concluded that these canals might not have been changed until the recent period when Ayutthaya was urbanised and modernised as the areas around the City Island have become the industrial estates (see figure 6.14). According to the Fine Arts Department's Master Plan for Conservation and Development: The Second Phase, the area on the eastern side of the city island, Ayothaya has been a dense residential area. Due to the change of water course of Pa Sak river, the canal network in the area was downsized. It is obvious that the small east-west canals are shallow while some main canals are still clearly seen or have disappeared. The recent conditions of these canals were reviewed when the Master Plan was carried out.

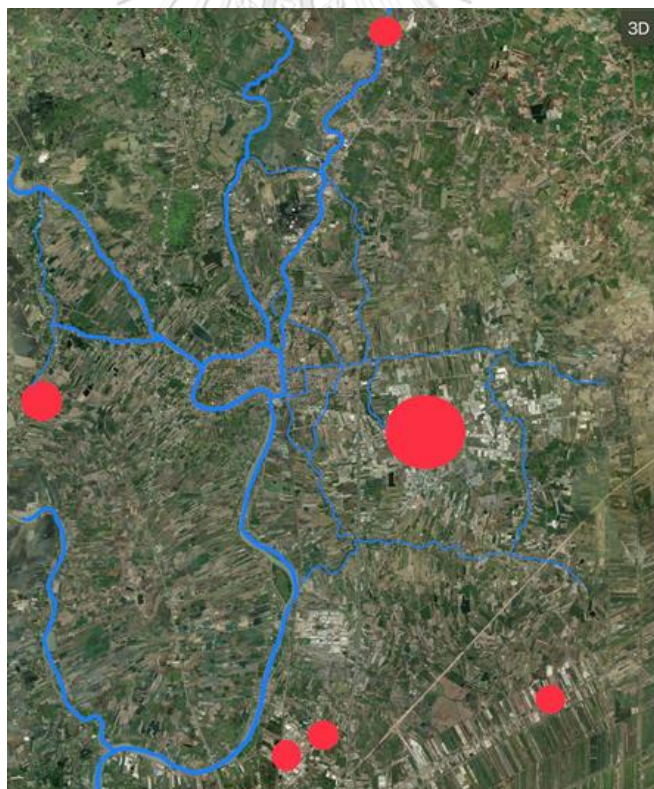


Figure 6.14 Industrial Estates around Ayutthaya city island.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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For instance, Khlong Hantra which distributed water from Pa Sak river has presumably been dredged up to be used as a route of transportation for the communities located along the canal. On the other hand, canal network in the southern part of Ayothaya is shallow and silted. Apart from Khlong Dusit and Khlong Pak Khao San, the rest have disappeared. Khlong Khao Mao still functions because it is still a water transportation facility to connect Ayutthaya with other districts. For the northwest of the city island, a short-cut canal of Chao Phraya river became widened and looked like the original course of the river while the canal network in this area, around the Phu Khao Thong (Golden Mountain) stupa, Khlong Maha Nak is silted but can still be traced. The main canals found to the south of the city island are still seen as there are a few communities and temples located there. However, from archaeological excavation of the remains along Khlong Patha Khu Cham, evidence of a canal was discovered. It proves that several small canals may have already disappeared.

#### 6.3.1.3 Canals in Chao Phraya delta.

The canals, short-cut canals and transverse canals dug during Ayutthaya period, have changed, tangibly and intangibly, over the period of time from being neglected as well as from intervention by people in later periods even though they still exist. This research figures out the outstanding issues in relation to these canals that should be identified.

- a) The innovation of new courses of Chao Phraya river (see figure 6.15).  
The short-cut canals including Bangkok short-cut canal, Khlong Lat Kret Yai and Khlong Lat Mueang Non have become part of Chao Phraya river due to their wider courses. On the contrary, the original river courses which were cut by these canals were downsized until they appear like canals or branches of Chao Phraya river instead. The transformation as these man-made parts of nowadays-Chao Phraya river which demonstrate the local wisdom of the Siamese on harnessing the nature of river to serve the national strategies in the past should be studied and recorded.







Figure 6.16 Khlong Lat Pho at present.

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

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Jarupongsakun T argues that, during Ayutthaya period, the area southward from Ayutthaya was not as densely populated as those along the rivers and canals northward. This area was strategically planned to be a natural buffer between Ayutthaya's administrative centre, the city island, and the sea (Jarupongsakun, 1990). A similar scenario can be seen from an old town in Bandar Seri Begawan, Brunei Darussalam, located along the Brunei River known as Kampong Ayer or Water Village. As the ancestors of the Bruneian arrived Bandar Seri Begawan from the sea, the first settlement was near mouth of the river, along the coastal area. In a course of time, in order to avoid the invasion from its enemies as well as ocean-related natural hazards, the settlement moved into the inner area of the river until finally settled at the present location. It can be seen that human instinct and experience learned from observing natural phenomenon, especially in the similar natural condition of delta area are coincided.

Thus, regarding the strategy of Ayutthaya, the saltwater was not its concern as the area along Chao Phraya river from Bangkok to the Gulf of Siam was not inhabited and cultivated.

However, when the capital of kingdom was moved down to Bangkok, this area has become urbanised and used for agriculture. Consequently, saltwater became a problem of the settlement in this area. As mentioned above, the attempt to resolve this seawater invasion was initially made in the reign of King Rama I, however, the problem-solving scheme could not last until today as the river changes over time. The area around this canal, which is near the Gulf of Siam, was rapidly developed in the reign of King Rama IX when, for example, a number of housing estates, industrial factories and infrastructures have been constructed. Furthermore, the canal network from Ayutthaya and early Rattanakosin period has been reduced and replaced by roads. As a result, the area also suffered from the failure of drainage system particularly in the rising tidal period. Therefore, in 2002 the project to solve this problem was started and completed in 2005. The canal was widened and deepened by the Royal Irrigation Department while a water gate was constructed at the mouth of the canal to control flood water and prevent the coming of salty water when tide rises (The Crown Properties Bureau, 2011)(see figure 6.17).



Figure 6.17 Khlong Lat Pho Irrigation Project.

Source: [https://www.khaosod.co.th/lifestyle/news\\_1905949](https://www.khaosod.co.th/lifestyle/news_1905949)

c) Water transportation

Considering the purposes of short-cut canals and transverse canals since Ayutthaya period, the transportation seemed to be the main and the most important objective especially when Ayutthaya focused on international trade which made the Kingdom become prosperous and wealthy. As communication activities need efficient transportation, the waterways functioned satisfactorily until land transportation was introduced and expanded in the country due to the adoption of the 1<sup>st</sup> National Economic and Social Development Plan starting in 1961 CE, which lasted 6 years and consecutive plans have been made and implemented until today. Water transportation, unfortunately, has been reduced its significance in the National Policy, then it has finally become the optional means of transportation and one of tourist attractions.

d) The water management system in modern time.

Since 1915 CE modern infrastructure projects which appear to have considerable impact on Chao Phraya river basin have been constructed. According to Jaruphongsakun T (1994), the irrigation system of the South Pasak river basin was initiated and completed in 1915 CE. The project includes the construction of King Rama VI Dam and canal network to irrigate water into rice cultivation areas in Ayutthaya province, Saraburi province and Rangsit field in Pathum Thani province (see figure 6.18), which have possibly reduced the amount of water from Pasak river to its previous canal network around Ayutthaya city island. Furthermore, in 1962 CE another major irrigation project covering an area from Chai Nat province to Ayutthaya province for rice cultivation was carried out. The construction included Chai Nat or Chao Phraya Dam as well as the irrigation canal network (see figure 6.19).

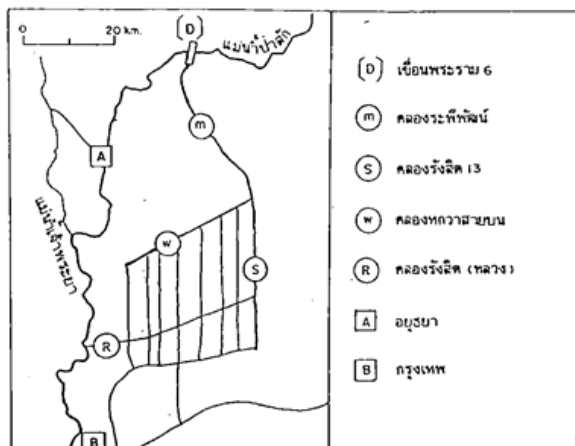


Figure 6.18 Rama VI Dam and its canal network.

Source: Jarupongsakul T (1997)



Figure 6.19 Chainat or Chao Phraya Dam

Source: [https://www.matichon.co.th/region/news\\_326060](https://www.matichon.co.th/region/news_326060)

Moreover, other two important dams of Thailand were constructed at the upstream of Chao Phraya river. In 1964 CE, Bhumibol Dam, a multi-purposed dam was constructed on the Ping river while Sirikit Dam, another multi-purposed embankment dam was built on Nan river and started to function in 1974 CE. It should be noted that both Ping river and Nan river are the tributaries of Chao Phraya river. Even though these infrastructures are significantly beneficial to the irrigation and power generation of the country, the impact on the downstream of Chao Phraya delta should also be considered. Due to these dams, the amount water of the rivers around Ayutthaya city island and their canal networks has relied on the water management of these dam. It is observed that, consequently, flood has been increasing on the lower plain of Chao Phraya delta including Ayutthaya. On the contrary, from a study of Hydrology Division, Office of Water Management and Hydrology, the Royal Irrigation Department, it is found that the annual average amount of water in Chao Phraya river in Ayutthaya decreases after the two major dams of the country, Bhumibol Dam and Sirikit Dam, were constructed (see figure 6.20).

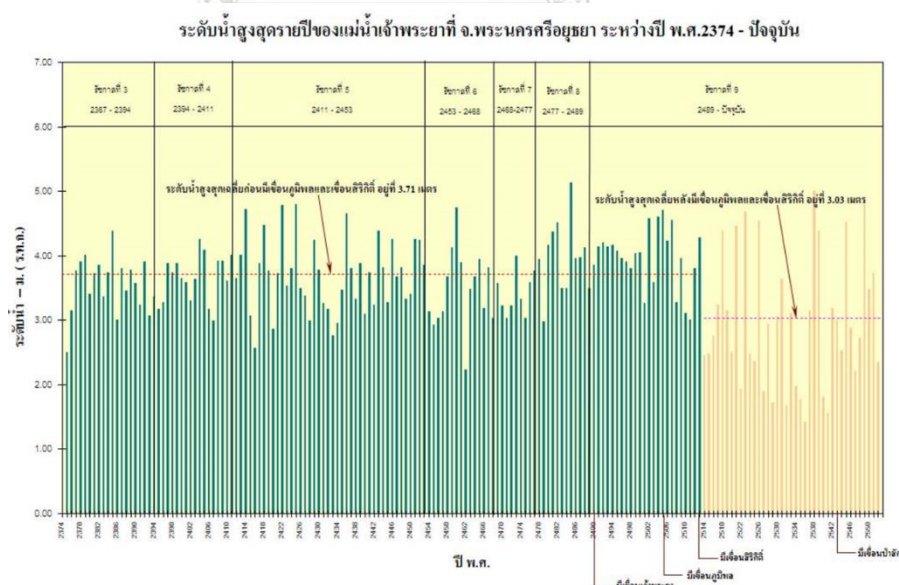


Figure 6.20 The water level of Chao Phraya River at Ayutthaya province from 1831 CE to 2007 CE

Source: <http://water.rid.go.th/hydrology/downloads2554/>

### 6.3.2 Water-related structures

Based on the field survey from 2011–2020 CE, this section attempts to identify the water – related physical elements discussed in Chapter 5 that still exist. The observation on the deterioration due to concerning factors are also provided in order to raise the issues for further proposed actions to regain the knowledge in water management from these elements. Nevertheless, it should be noted that only the elements above ground that can be seen and the underground evidence discovered by archaeological excavation can be included. It is believable, therefore, that there are still many remaining structures underground which require further study and investigation.

#### 6.3.2.1 Bridges

As mentioned in Chapter 5, many bridges were built in Ayutthaya period as seen in the maps drawn in various periods. From the survey map of Phraya Boran Ratchathanin, some bridges were still seen especially the ones across Khlong Pratu Khao Plueak such as Chang bridge, Pa Than bridge, Shi Kun bridge and Pratu Chin bridge. At present Khlong Pratu Khao Plueak is already filled and has disappeared owing to the urbanisation, only the remaining of these bridges still exist, for instance, the foundation of Shi Kun bridge is located along a road (see figure 6.21), remaining only some brick structure of which, the architectural character cannot be identified. Another remaining bridge, Pratu Chin, which is located in front of the place that was Chao Phraya Wichayen's residence, which is a school at present. This bridge was made of brick, believed to have been in Persian architectural style as seen from the remaining Persian arch. It should be noted, however, that this bridge was not included in the survey of Phraya Boran Ratchathanin.



Figure 6.21 Shi kun Bridge.

Source: Author's collection, 2020

Another bridge remains is Din So bridge (see figure 6.22) located across Khlong Cha Krai Noi. It can be seen that most part of the canal is silted while the rest has become waterlogged and cannot be recognized as a canal. The bridge structure and paving are made of brick with Persian arches which allowed boats to pass beneath. It is also observable that this bridge was not included in Phraya Boran Ratchathanin's map.



Figure 6.22 Din So Bridge.

Source: Author's collection, 2020



The third and last bridge remains is Thep Mi or Thet Mi bridge, located in the area of Phranakhon Si Ayutthaya Rajabhat University at present. This bridge was originally built across Khlong Thep Mi near the area where Sheik Amad's house was located. The architectural style of the bridge is similar to Din So bridge but larger with three-arch structure, the length is 10-12 metres long which suggests the width of the canal. From the archives of budget allocation in 1957, it is recorded that the Government of Field Marshal P. Phibunsongkhram approved the budget to restore this bridge, therefore, it is believable that after the restoration in 1957 this bridge was still intact. However, due to the present location, the bridge has been disturbed by the modern infrastructure construction, therefore, it is in a rather ruined state (see figure 6.23).



Figure 6.23 Thep Mi or Thet Mi Bridge.

Source: Author's collection, 2020

#### 6.3.2.2 Ponds

The remarkable water body clearly seen at present is a pond, Bueng Phra Ram or Nong Sanoh, in the Royal Palace, which has been conserved and maintained. Due to local annual flood, Bueng Phra Ram is reserved as “the Monkey Cheek” area or reservoir that functions like the retention pond for

drainage purpose. However, the water flow of this pond and canal network in the City Island is not well-connected, therefore, the system is already non-functional. There are also small ponds around the city island.

#### 6.3.2.3 Water tanks

The building which is believed to be a water tank for domestic use in the Royal Palace is located to the south of Wihan Phra Mongkhon Bophit where a parking lot of Ayutthaya Historical Park is located. The area is now a market for tourists. The physical condition of this ancient structure is deteriorated, although it has been maintained but is still not as well-conserved as religious structures, which may be because its significance is unclear and unrecognised. However, as part of water management system for domestic uses in the Royal Palace, this remains should be paid more attention in terms of the maintenance, interpretation and presentation (see figure 6.24).



Figure 6.24 The remaining water tank.

Source: Author's collection

#### 6.3.2.4 Unearthed water-related evidence from recent excavations.

These archaeological excavations were conducted during the past few years while their reports are still in progress. This research could be able to observe and interview the archaeologist who was in-charge of the excavations. As a result, this matter could only shortlist the locations and share the on-site visible information.

##### a) Water-related structure (see figure 6.25)

From the archaeological excavation at the site of the Royal Palace of Ayutthaya, an archaeological evidence believed to be water-related structure was revealed. Based on observation, it is a brick sunken structure with shallow depth, less than one metre in estimation. The terracotta pipe was seen at the wall of the structure. It could be an inlet or outlet to this structure which has been claimed a royal bath. However, further in-depth study or research should be conducted to determine its original function and working technique.



Figure 6.25 Archaeological remain of water-related structure.

Source: Author's collection, 2019

- b) Sluice gate at a connecting location of a canal in the Royal Palace and Khlong Cha Krai Yai or Khlong Tho.

In 2017 CE, an archaeological excavation was carried out at Khlong Cha Krai Yai, one of two existing north-south canals. Evidence of a sluice was found at Khlong Cha Krai Yai and an unknown canal was also discovered (see figure 6.26). From archaeological point of view, the evidence could be the spaces to insert timber panel, therefore, it is believable that the remains is a sluice or water gate to control water level of the buried canal which could be a canal in the Royal Palace since it is similar to the water gate described in Phraya Boran Ratchathanin's explanation on the historical document "the Description of Ayutthaya".



Figure 6.26 Archaeological excavation site that found the evidence of sluice.

Source: Author's collection, 2019

- c) Pom Pratu Khao Plueak (see figure 6.27)

Pom Pratu Khao Plueak or Pratu Khao Plueak fort was located to the northeast of Ayutthaya city island. It was related to the encirclement of Ayutthaya's city moat since it was built when the city wall on the

northeastern part was expanded and the city moat at the side was widened in order to strengthen the defense system of Ayutthaya city island during the reign of King Maha Thammaracha as discussed in Chapter V. However, at present the fort has already disappeared. Its existence is known from historical documents, therefore, archaeological excavation was carried out to find out its physical evidence and to further research and study.

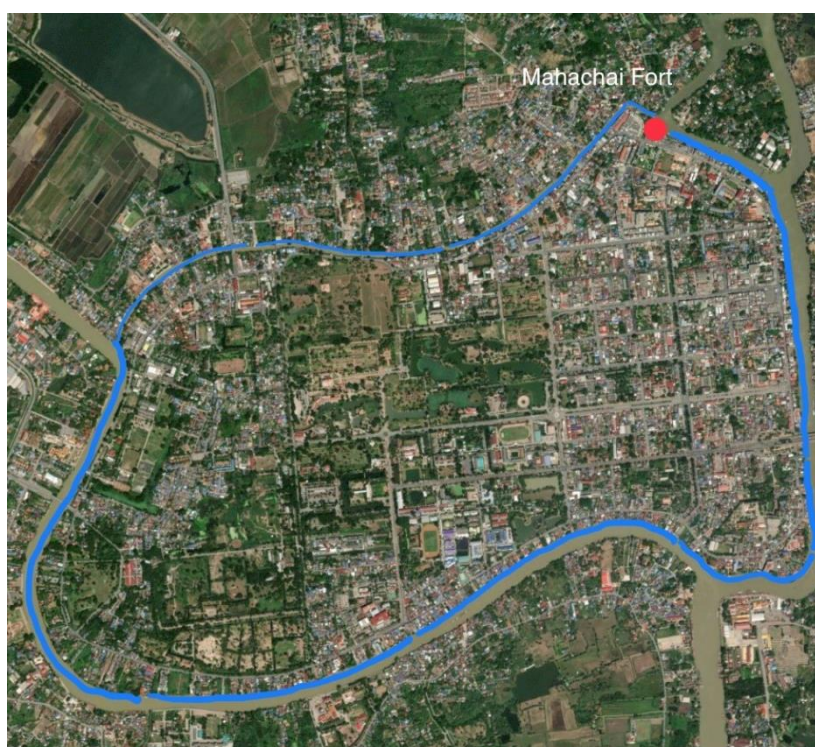


Figure 6.27 Map showing location of Maha Chai fort

Source: Baseline map from [www.openstreetmap.org](http://www.openstreetmap.org)

©OpenStreetMap contributors

d) Archaeological ruins of a pier at Wat Tawet (see figure 6.28)

Wat Tawet is located along Patha Khu Cham canal in the area believed to have been the temporary settlement of King U Thong when he was building the palace in Ayutthaya city island before its establishment.

Herringbone brick paving, like a ramp sloping down to a canal and brick

embankment were found at nearly three meters deep from the ground level. From the canal network pattern of this area, it can be assumed that the structure was a pier of the temple situated on the bank of a canal which is now filled.



Figure 6.28 The herringbone brick paving ramp found at Wat Tawet

Source: อยุธยา-Ayutthaya Station, 2019. Available at <https://www.facebook.com/Ayutthayastation/photos/pcb.1378762075606895/1378760745607028>

### 6.3.3 Continuing Living Traditions

#### 6.3.3.1 Intangible aspects: believes, customs and literature.

- a) Oath of Allegiance, one of the oldest Thai literature.

Since Ayutthaya period, water has been used to demonstrate the power of the King. The Ongkan Chaeng Nam (Curse on the Water) still exists as a literature, and the *Phiti Thue Nam Phra Phiphat Sattaya* ceremony (Oath of Allegiance Sworn by Taking the Holy Water) is still performed until today. It should be noted that *Phiphat* deriving from Sanskrit word means the commitment whereas *Sattaya* also coming from Sanskrit language refers to ratification. As already explained in Chapter 5, *Phiti Thue Nam Phra Phiphat Sattaya*

ceremony (Oath of Allegiance Sworn by Taking the Holy Water) is a ritual that people commit to ratify their honesty to the King forever through drinking the holy water containing a curse for the betrayers. Similar to the ancient times, this Royal ceremony has been continued during Rattanakosin period in special occasions, particularly the coronation because the ceremony is the reflection of the King's power as the incarnation of the Hindu God, Narai (Vishnu) . The continuity of the ceremony to modern time is apparently based on the spiritual values. After the democratization in 1932 CE it was terminated for some time but has been revived in 1969 CE and has continued until the present day.

b) Sacred Ponds

Accordingly, the *Phiti Thue Nam Phra Phiphat Sattaya* ceremony (Oath of Allegiance by the Water) ceremony performed during the coronation ceremony requires water from sacred ponds, which have been protected as the water sources of holy water. It has been discussed in the previous chapter that the water resources used in the ceremony, particularly in the coronation, show how extensive the power of the kingdom is, therefore, each reign, from Ayutthaya to Rattanakosin period, the number of sacred ponds has differed based on the situation of the kingdom at that specific time. However, some water sources are highly recognised, respected and protected such as the sacred ponds located Suphan Buri province including Sa Kaew, Sa Kha, Sa Yamana and Sa Ket because these ancient permeating water sources have been known even before the establishment of Ayutthaya. As a result, they are now under statutory protection.

6.3.3.2 Arts and Architecture

a) Temples: The remains and reflection

Since Ayutthaya city island has been restored in the reign of King Rama IV, some temples are still in use while others have left as ancient remains. It should be noted that most temples located within the

present-day Ayutthaya Historical Park are archaeological remains, except the Wihan (vihara) of Wat Mongkhonbophit (see figure 6.29) which was fully reconstructed.



Figure 6.29 Mongkhonbophit Vihara before and after reconstruction

Source: <http://www.mongkolbp.com/mp4.htm>

However, the style of the reconstructed building has been argued whether it is the style of the original architectural design although the image of the Vihara is already well-known among both religious visitors and tourists. On the other hand, most reconstructed temples are located outside the historical park, probably funded by support and contributions from the surrounding Buddhist communities. No Na Paknam (1967) who wrote a memoir for his survey in Ayutthaya city



island and its surrounding along the canal networks, he stated that, along the canals and rivers, many temples built in Ayutthaya period were still be seen when he spent 5 months during the years 1966 CE – 1967 CE around the area.

As mentioned, because of the short-cut canals constructed during Ayutthaya period, most original water courses of Chao Phraya river have become narrower and appeared like canals. In consequence, several old temples from those days are found along these canals especially Bangkok Noi – Bangkok Yai canals and their network. Also, the temples along Chao Phraya river, particularly in Bangkok where the short-cut canal was dug, can be clearly seen (Chuvichien, 2018). It should be noted that these temples have been developed in the later period until today but can be traced back historically by the components from the past such as Wat Pho and Wat Thewarat Kunchon.

Besides, many temples built in the early Rattanakosin period also reflect similar beliefs in Buddhism through the art, architectural style and planning. One example is Wat Arun Ratchawararam Woramahawihan or Wat Arun, also known as the Temple of Dawn (see figure 6.30) located opposite to the Grand Palace of Bangkok. It is believed that this temple was built by the concept of Buddhist cosmology, similar to Wat Chai Watthanaram in several aspects including its location, site planning and architectural character. It is remarkable, however, that the temple has been developed over the course of more than 200 years time while Wat Chai Watthanaram now exists as remains. The reflection of Wat Chai Watthanaram can still be clearly seen and discussed at present.



Source  
<https://www.naewna.com/lady/322877>

Source  
<https://www.watarun1.com/th/news-detail/312>

Figure 6.30 Wat Arun Ratchawararam Woramahawihan (left) and Wat Chai Watthanaram (right)

b) Houses: Continuing living adaptation

From the historical record of Frederick Author Neale who came to Siam in the early Rattanakosin period (Fine Arts Department, 1982), he states that a large number of raft houses, probably including the boat houses, were seen along the Chao Phraya river and main canals of Bangkok (see figure 6.31) (Neale, 1840 - 1841). Some houses might have been moved from Ayutthaya to Bangkok, the new capital city. These houses are a form of nomadic settlements based the residents' occupations. As previously mentioned in this research, during Ayutthaya period, people who lived in these houses were mainly merchants who brought several kinds of goods from the hinterland to the capital city. Since the living style in the early Rattanakosin period was similar to Ayutthaya period, the raft houses were also popular. The gathering areas of these houses were also found around Ayutthaya city island in this period. Probably on the way from the hinterland to the

north and northeast to Bangkok, some raft or boat houses stopped over at the main cities. The reason is that even Ayutthaya was no longer the capital city of Siamese kingdom after it failed, the city still played as the second most important city of the kingdom. Later, when Bangkok was stable and flourished, some raft and boat houses were transformed to be houses on stilts built on the embankment of the river in order to settle down more permanently. It is not clear whether this transformation was similar to the case of the raft communities around Ayutthaya city island due to lack of study on this issue. Although the raft and boat houses located around the city island are no longer seen, the more recent communities of houses on stilts along the canals especially the north city moat can still be found.

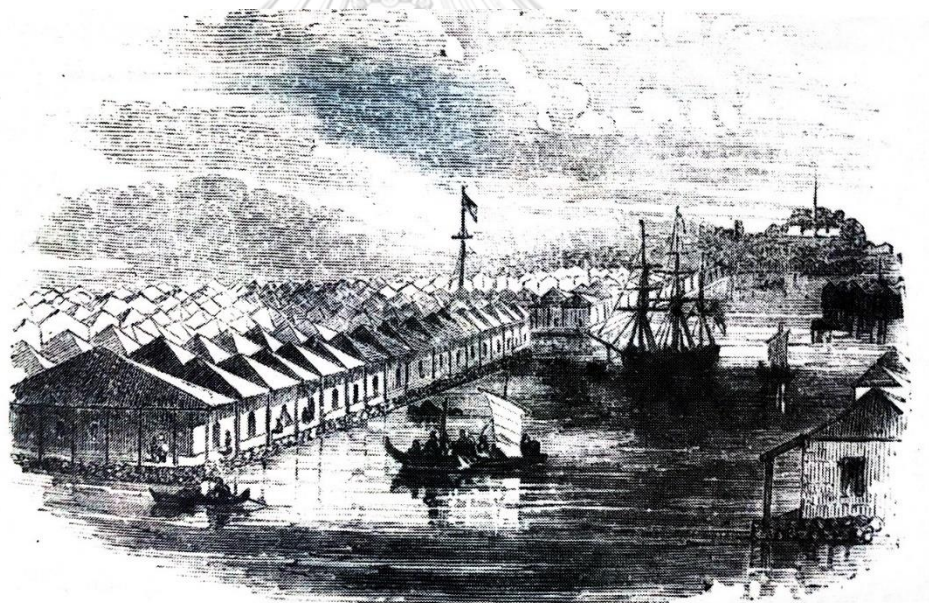


Figure 6.31 Drawing of raft houses in the book,  
“Narrative of a Residence in Siam”

Source: Fine Art Department (1982)

Another kind of houses, the elevated house which is now called classical Thai house, can be seen around the central plain of Thailand. In fact, owing to the same natural settings and cultural transfer between Ayutthaya and Bangkok, the classical Thai house has continued to be a

typical architecture for the nobles and the wealthy people in Rattanakosin period before the western influence came. On the other hand, for commoners, their houses were made of bamboos structure with palm leaves roofing material as seen from the pictures taken by the foreigners who visited Siam in Rattanakosin period. From the journal of Henry Mouhot who visited Indochina countries from 1858 – 1861 CE, it can be seen that people still lived along and on the rivers and canals in bamboo houses when he was passing through Ayutthaya (see figure 6.32) (Mouhot, 1826-1861).



Figure 6.32 Drawing of houses at Ayutthaya in the book “Voyage dans les Royaumes de Siam, de Cambodge, de Laos et autres parties centrales de l’Indo-chine, par feu Henri Mouhot, naturaliste français 1858 -1861”

Source: Silpa Watthanatham (2015)

Within Ayutthaya city island, physical evidence of the elevated houses built in Ayutthaya period does not exist. The reason is based on the two possibilities, firstly, the elevated houses were made of timber, a perishable material which required high maintenance, thus the houses might be damaged during the war or neglected after the fall of Ayutthaya; secondly, since this kind of houses is prefabricated and

movable as discussed previously, those which were not damaged after 1767 CE or some wood panels which were in a good condition, were moved to be reassembled or reused in the new capital city the same as other building materials i.e., bricks. Nevertheless, even though the elevated houses built in Ayutthaya period may disappear, houses of the same style constructed in later period still exist and are built until today because the building knowledge is kept and transferred to the later generations. It is noted that according to some scholars a few number of elevated houses or buildings built during the time Ayutthaya was a capital city of the kingdom are found in other provinces of present-day Thailand. These buildings including the hall of worship of Wat Yai Suwannaram at Phetchaburi province, were donated to temples as a tradition of merit-making of people in the high class of Ayutthaya (Saksi, 2020).

### **Traditional knowledge: a key of resiliency toward sustainability of Ayutthaya**

In overview, the City Island of Ayutthaya and its surrounding areas, referring to the areas identified in the Master Plan for the Development and Conservation of the Historic City of Ayutthaya: Second Phase (see figure 33), has been rarely changed until the reign of King Rama IV. After the Treaty of Friendship and Commerce between the British Empire and the Kingdom of Siam aka Bowring Treaty was signed, the surrounding areas which were rice fields since the past period had changed due to the impact from other areas which were turned to be rice fields and needed to share water with other existing fields. However, the overall eco-cultural system was still continued in the same way. On the other hand, some remaining temples and palaces in the city island were restored and reconstructed but the work did not significantly affect water management physical components. From historical documents, it argues that it is difficult to evaluate whether the system was still working during the time from the fall of Ayutthaya to the reign of King Rama IV, however, it can be said that damages from natural disasters relating to water were not recorded. For the lower plain of Chao Phraya delta, canal networks built in Ayutthaya

period were not altered to the extent which affect Ayutthaya's water management system. On the contrary, several canalisations were carried out to strengthen the kingdom's effectiveness and efficiency in various purposes such as transportation, both internally and among the kingdom and its dependencies, commerce, and military services.

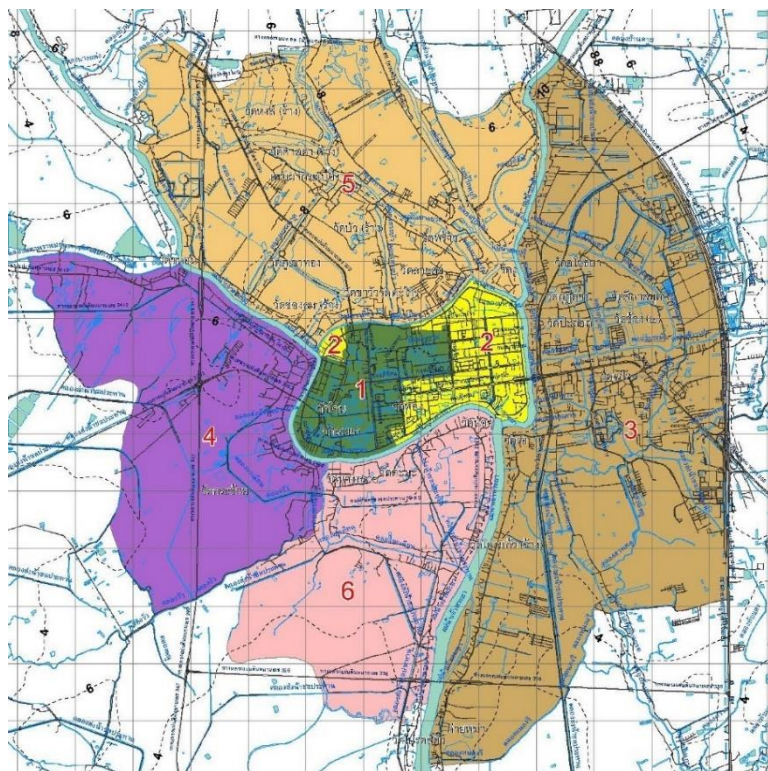


Figure 6.33 Map of Ayutthaya city island of Ayutthaya and its greater areas according to the Master for Conservation and Development of the Historic City of Ayutthaya Phase II.

Source: Fine Arts Department, 2010

From the reign of King Rama V to 1960s, the country was dramatically modernised in all aspects including the change of the country's name from Siam to Thailand.

However, in terms of the water management of Ayutthaya, the system has gradually changed but was not negatively affected until 1960s when Thailand adopted the 1<sup>st</sup> National Economic and Social Development Plan (1961 CE – 1966 CE), although Thailand has not shifted its strategic policy in order to be a developed country. Since then, Thailand has been led by the policies proposed through the National Economic

and Social Development Plan, each of which regularly lasts 5 years. The impact from the implementation of the National Economic and Social Development Plan to the water management system to Chao Phraya delta was enormous as already discussed above.

In brief, the water management system at the city island and its surrounding areas, as well as the lower plain of Chao Phraya delta does not function as it formerly did because the water management components including natural and cultural elements were partially changed. The reason is mainly that stakeholders concerning to Ayutthaya and its water management system such as economic and industrial development sector, urban planning agencies, irrigation organization, etc. worked separately. As a result, unexpected natural disaster in 2011 CE, the central plain of Thailand covering several river basins i.e., Chao Phraya basin, etc., was severely flooded. Even the circumstances during Ayutthaya period were not exactly the same as in the present time, it has never mentioned about the impacts of inundation or flood to people or cities in those days. From this research it can be perceived and understood what the knowledge in water management of people in those days was and how it was implemented to make people lives resilient to any situation occurring in the same area which suffered from disasters in the present time, therefore, it can be concluded that, as a city located in flood plain area, making the city resilient to water is a key knowledge of people who lived in Ayutthaya in the past that may also make Ayutthaya sustainable from the present to the future.

## Epilogue

### Conclusion and next chapter

#### 1. Filling the gaps.

The methodology and principles from newly developed Landscape Integrated Approach is an expected result of this research. Even though landscape approach has been discussed about its concept by various fields while practical application to specific issue seems to be unclear. It provides a systematic structural method to identify research questions and issues from multi-disciplinary perspectives. As landscape is evolving process by its nature, the methodology goes beyond time limitation which also fits to the ever-changing water management. Through the case study: Ayutthaya, the methodology can demonstrate how this research helps reducing gaps in the study of water management in ancient towns identified in Chapter 2. Nevertheless, it may not be able to prove how deeper study of water management of Ayutthaya can be contributed by this approach. Nevertheless, its clearer picture should be evident.

#### 2. The application of Landscape Integration Approach to the study of water management system in Ayutthaya.

##### 2.1 Desk-based research.

Using multidisciplinary knowledge and methods to find out about the water management of Ayutthaya is challenging. This research mainly is a desk-based work ranging from literature reviewing to developing methodology. While field work could not help much in terms of data gathering since the research focuses on ancient towns that has lost their physical evidence and have limited documents on the water-related issues. During the past few years, several site observations were done in combining the cumulative experience of the researcher working in the case study area since 2012. However, the visible evidences are obviously rare due to urbanisation and land occupancy. Furthermore, the existing studies and research on water management in ancient towns especially in Thailand have been conducted from a specific field of academic. To explore each research question set at the beginning of this research, the information from various sources and



fields were brought out and put back together like playing a jigsaw. Then the water management system of Ayutthaya can be narrated from the emergence of its land to present day.

## 2.2 New narrative of Ayutthaya historiography.

As seen in Chapter 4, 5 and 6, the result of the application of newly developed approach brings a new way to tell the history of Ayutthaya through its water management development. Since the history of Ayutthaya has been studied on its polity, governance, religions and recently society within a specific timeframe which is probably a proper research method. However, the proposed principles of Landscape Integration Approach suggest that the framework in terms of period and context needs to be extensive in order to understand the management cycle which continues in response to other issues of Ayutthaya's history.

## 2.3 Expected and unexpected results.

It is expected that the result of this research should prove the necessity of multi-disciplinary study in water management, therefore, the research questions were designed to cover the information from many professionals. The structure of Ayutthaya water management system is comprehensive, therefore, within time limitation, this research cannot explore much in-depth details while the main difficulty is the understanding in specialisations, technical terms, and jargons of each discipline. On the other hand, since the scope of this research was planned to focus on water management of Ayutthaya city island during Ayutthaya period (1350 – 1767 CE), the unexpected issued was found when the Landscape Integration Approach was being developed, it became clearer that the water management system of Ayutthaya cannot be explained according to the proposed scope. Since the rivers and canals of at least three river basins and their branches are connected while the periods were also written based on governing regime and unexplainable for the development of water management. Consequently, the spatial framework was expanded to cover Chao Phraya delta which is the

whole lower central plain of Thailand as well as the timeframe is changed to be unlimited.

#### 2.4 Consequent enigma from clarifying research questions.

Regarding the case study of this research, it is clearly seen that some points of water management system of Ayutthaya can be scientifically proved, however, they need further actions, for example archaeological excavation along the canals which already disappeared, soil boring test to prove geomorphological layers of Ayutthaya City Island. On the contrary, other aspects may be mysterious forever since it is still unclear whether the urban planning of Ayutthaya city island was intentionally designed when it was initially established and by who. In fact, any events that already happened might not be possibly known even when they were recorded. The reason is that history is always written by the winners, therefore, it was narrated from some person's perspective. In the case of Ayutthaya, the narrative of water management system of Ayutthaya tries to refer to reliable evidence from various angles of professionals in different fields, hopefully it is convincible.

#### 2.5 Water management system of Ayutthaya

From Chapter 4 and 5, it is clearly seen that water management system of Ayutthaya, especially during its glorious period comprises various components. It was not merely structural and physical but included the way of life, beliefs, and attitudes of people living with water. Thus, the flood risk mitigation measures to be implemented for the protection of Ayutthaya should concern not only building structural barriers. Comprehensive measures including the revival of broader drainage system and adapting ways of life would be considered. In addition, urban planning and industrial as well as commercial policies should also consider the traditional system which made Ayutthaya resilient in the past and will help create sustainable future for Ayutthaya.

### 3. Application to other ancient towns

In order to apply the Landscape Integrated Approach to a study of water management in ancient towns, three suggestions should be taken into consideration.

3.1 Reconceptualising the landscape perception as proposed in Chapter 3. Since landscape is living and changing while containing the evidence and narrative of the past. Using landscape as a concept, the timeframe should be unlimited. In addition, it is remarkable that human is a linkage to integrate natural environment and cultural components so anthropologic dimension is inclusive in landscape concept.

3.2 Adopting principles of landscape integration approach when developing methodology matrix for any case studies. The Table 3.1 and 3.2 exemplify the relation of multi-disciplines, issues to be explored and research questions.

3.3 Implementing water management development cycle to ancient towns sharing similarity to Ayutthaya. It is possible to use the research questions and issues in Table 3.3 as a typical matrix to find out water management system of the towns. However, it should be noted that the matrix is flexible and adaptable while the main research questions may not be much different.

### 4. Further recommendations

#### 4.1 Extensive archaeological studies.

From the data gathering and analysis, archaeological studies including non-invasive survey, excavation, landscape archaeology should be conducted. Since Ayutthaya city island and its surrounding area have been urbanised and become very densely inhabited. The non-invasive survey technique such as Electronic Resistivity, Electromagnetic Ground conductivity, Ground Penetration Radar, GPR and etc. at the vanished areas is recommended while archaeological excavation should also be carried out in specific areas including the northeastern area where the city wall was relocated and the city moat was enlarged. In addition, pollen analysis may help to better understand the development of Ayutthaya barrier island because there is still

a long temporal gap from the time this land emerged to the time this area was first settled down.

#### 4.2 Experimental studies.

Based on multidisciplinary approach, the experiment of some water management techniques should be modelled, for example, the issue of water pumping techniques should be tested by building the proposed water wheels with reproduced terracotta water pipes to the remaining water tank. The real modelling may help clarify which kind of water wheel is the most possible to be used in the past.

Another experiment that is worthwhile to try is the water sluice which helps control water level in the canals. As the technique proposed by Phraya Boran Ratchathanin is simple and might have been used until the recent time in the rural area. Accordingly, it should give a clarification of water control technique of Ayutthaya city island.

On the other hand, according to the advanced computer technology, the virtual reconstruction of water management components will be greatly beneficial for further actions. For instance, the canal network within Ayutthaya City Island after it was encircled should be reconstructed digitally. The assumed dimensions of those canals including ground level of canals and riverbed should be included. The reconstructed canal network will provide the supportive information whether it helps for current and future needs such as surface drainage system of Ayutthaya City Island.

#### 4.3 Further research on historical documents in foreign languages.

It is obvious that historical documents written about Ayutthaya or relating to Ayutthaya in European language, mainly Dutch, French and English were already translated into Thai and studied, which help providing a great amount of information about Ayutthaya from the time these Europeans came to the kingdom. However, the information about earlier period may be recorded by the Chinese and Indians who came to mainland Southeast Asia much earlier. At present, there have been a few Chinese documents

translated while Pali and Sanskrit used by the Indian are mostly religious texts. This issue may connect to Dvaravati period which emerged before Ayutthaya in this land since the studies and research of Dvaravati whatever is towns, culture or civilisation are even more limited than Ayutthaya. This is also the reason that the emergence of Ayutthaya seems to be mysterious as the period connects to Dvaravati.

#### 4.4 Trials with other case studies for sustainable development.

Finally, the Landscape Integration Approach should be applied to other settlements, towns and cities as well as other heritage typologies such as agricultural landscape. Since this research aims to develop the methodology that should be applicable to those sharing the same limitations as Ayutthaya. This approach will be able to be further developed and advanced. Ultimately, it should be reflected in spatial planning and sustainable development in the future.

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## APPENDIX

### Online Questionnaire for Multidisciplinary Study (Landscape Approach) on Water Management in Ancient Towns

#### Introduction

This questionnaire is part of my ongoing PhD research entitling “Landscape Approach in a Study of Water Management System in the Ancient Towns: A Case Study of Ayutthaya”. My name is Ms. Hatthaya Siriphatthanakun, graduate student on Ph.D. (Architectural Conservation), Faculty of Architecture, Chulalongkorn University, Thailand. It is distributed to those (targeted samplings) who work on water management in ancient/old towns and areas and/or civilisations. The questionnaire aims to review the discipline(s) needed in the study of water management in the ancient/old towns where its remains and existing information on it are scarce. There are four (4) sections. The completion of this questionnaire will take around 15 minutes or less.

Please be assured that your information will be confidential and used only for the purposes of the said research. When presented as information, responses and results of this questionnaire will not be rendered partially but in their entirety.

***Thank you for your contribution.***

#### Section A: Personal/Professional Background

1. How old are you?
  - a. Younger than 20
  - b. 20 - 30
  - c. 30 - 40
  - d. 40 – 50
  - e. Older than 50
2. Where do you live?
  - a. Australia
  - b. East Asia
  - c. South Asia
  - d. Southeast Asia
  - e. Middle east and Maghrib
  - f. The rest of Africa



- g. Europe
  - h. North America
  - i. Latin America
  - j. Other. Please identify
3. What is your education level?
- a. Undergraduate
  - b. Post graduate
  - c. Doctorate
  - d. Post doctorate
  - e. Other. Please identify
4. Which faculty/department(s) did you study in? (more than one answer is acceptable)
- a. Anthropology
  - b. Archaeology
  - c. Architecture
  - d. Engineering
  - e. History
  - f. Liberal arts
  - g. Geology
  - h. Science
  - i. Other(s). Please identify
5. What would you identify yourself as?
- a. Anthropologist
  - b. Archaeologist
  - c. Architect
  - d. Civil engineer
  - e. Environmental engineer
  - f. Historian
  - g. Hydrologist
  - h. Geologist
  - i. Geomorphologist
  - j. Landscape architect
  - k. Water resource manager
  - l. Other(s). Please identify
6. Have you ever attended any extra curriculum programmes relating to water management?
- a. Yes. Please identify
  - b. No.

**Section B: Working Experience**

7. What kind of organization are you working for?
  - a. Governmental agency/organisation
  - b. University
  - c. Academic and educational institutions
  - d. Non-governmental organisation
  - e. Non-profit organisation
  - f. Intergovernmental organization
  - g. Entrepreneur/Social enterprise
  - h. Others. Please specify.....
8. How long have you worked in your present organisation?
  - a. 1-5 years
  - b. 5-10 years
  - c. 10-15 years
  - d. More than 15 years
9. How long have you worked in this field?
  - a. 1-5 years
  - b. 5-10 years
  - c. 10-15 years
  - d. More than 15 years
10. Is your organization involved in water-related issue(s)?
  - a. Yes.
  - b. No. Go to question 13.
11. Do you think your profession is related to water management?
  - a. Yes.
  - b. No.
12. How are you involved in water management?
  - a. Academic aspects i.e. teaching, research, etc.
  - b. Practical activities i.e. water resource conservation, management, construction, etc.
  - c. Public outreach activities i.e. public participation programme, etc.
  - d. Other. Please identify
13. Do you think your professional activities are related to ancient/old town(s)?
  - a. Yes.
  - b. No. Go to question 19.
14. How are you involved in ancient/old town(s)?
  - a. Academic aspects i.e. teaching, research, etc.
  - b. Practical activities i.e. urban planning, conservation, urban or architectural design, etc.

- c. Public outreach activities i.e. public participation programme, etc.
  - d. Other. Please identify
15. What disciplines should be applied in understanding water management in the ancient towns?
- a. History/Architectural history/History of engineering
  - b. Archaeology/Land archaeology
  - c. Anthropology
  - d. Geology
  - e. Geography
  - f. Ecology
  - g. Hydrology
  - h. Others. Please identify

**Section C: Understanding in Water Management in the ancient/old town(s).** Please choose from absolutely agree=5 to disagree=1

16. At present, most studies of water management in the ancient/old towns are still unclear and questionable as they are not comprehensive.
17. Various fields of knowledge are required in the study of water management in the ancient/old towns?
18. Research is more credible if more disciplines are involved in the study of water management in the ancient/old towns.
19. Study of water management in the ancient/old towns must include knowledge in the natural science and humanity.
20. The intangible aspects of water management in the ancient/old towns are necessary for the understanding of how water management has been developed in any civilisations.
21. The results of this research on water management in the ancient/old towns will be useful for water management at present and in the future.

**Section D: Your project**

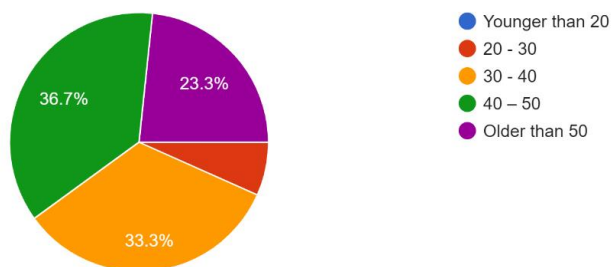
22. Please provide title/name of your study/research/project relating to water management in the ancient/old towns that describes your experience in this field. (only one is needed)

## SUMMARY of RESPONSES

### Section A: Personal/Professional Background

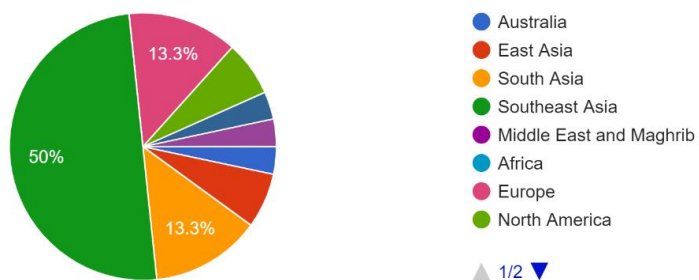
1. How old are you?

30 responses



2. Where do you live?

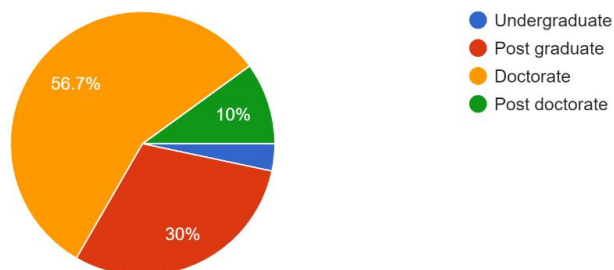
30 responses



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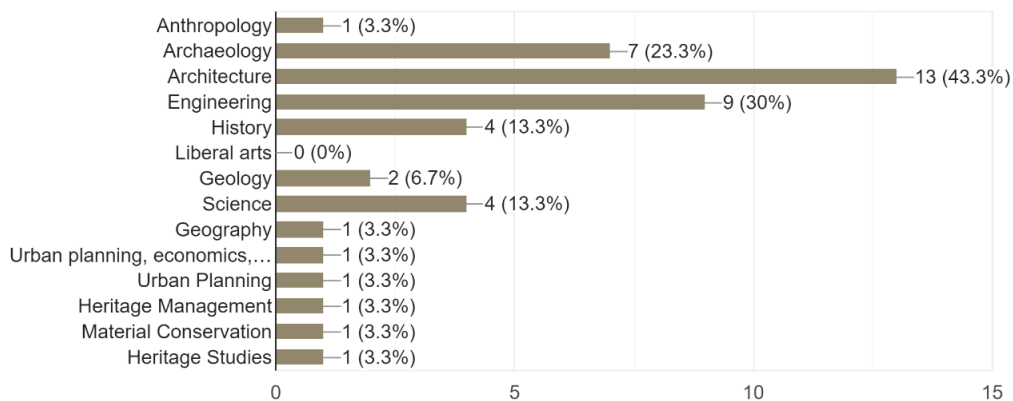
3. What is your education level?

30 responses



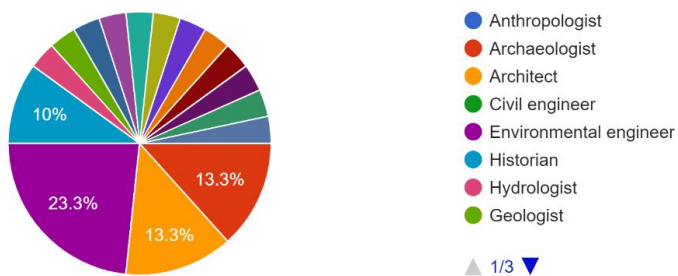
4. Which faculty/department(s) did you study in? (more than one answer is acceptable)

30 responses



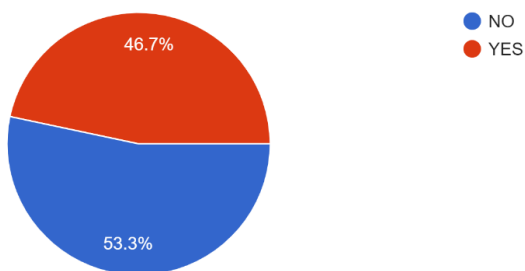
5. What professional (s) do you identify yourself?

30 responses



6. Do you ever attend any extra curriculum programmes relating to water management?

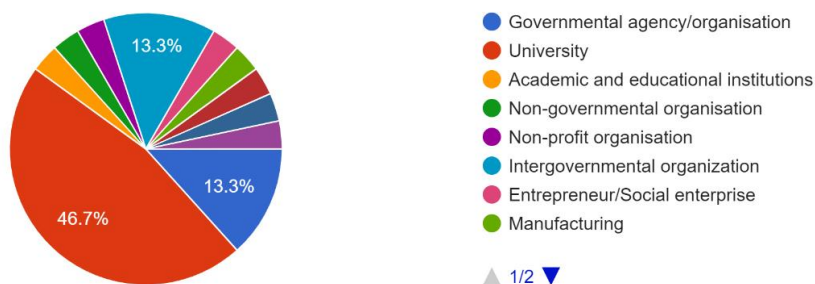
30 responses



## Section B: Working Experience

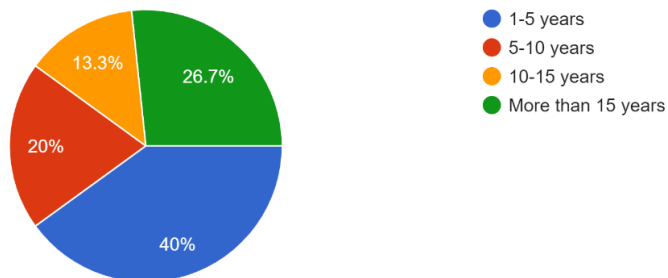
7. What kind of organization are you working for?

30 responses



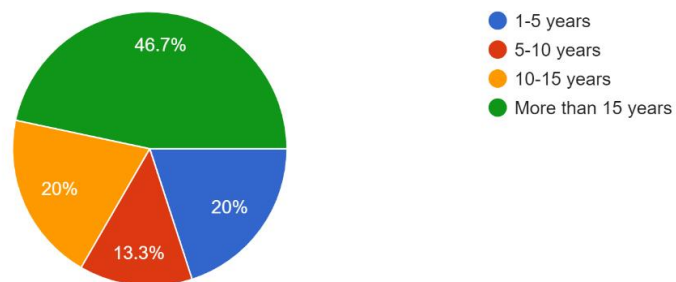
8. How long have you worked in your present organisation?

30 responses



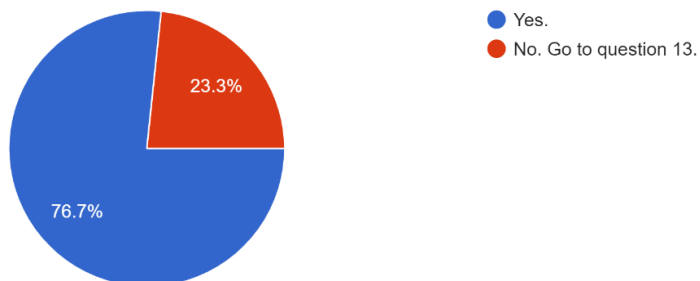
9. How long have you worked in this field?

30 responses



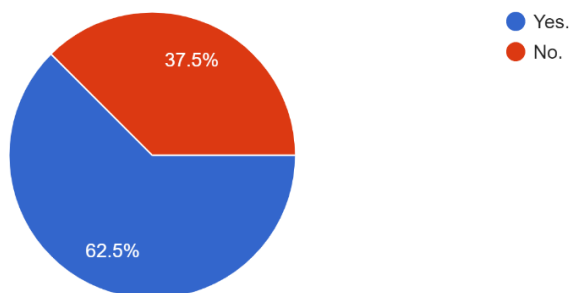
10. Is your organization involved in water-related issue(s)?

30 responses



11. Do you think your position at the organisation is related to water management?

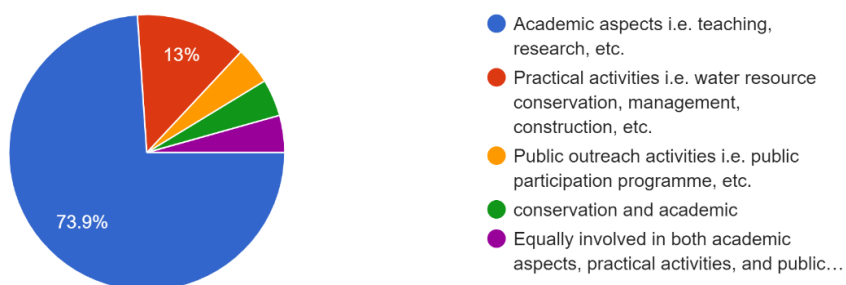
24 responses



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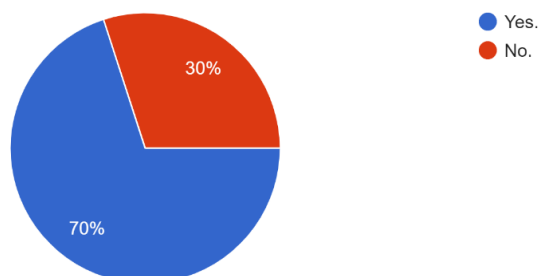
12. How are you involved in water management?

23 responses



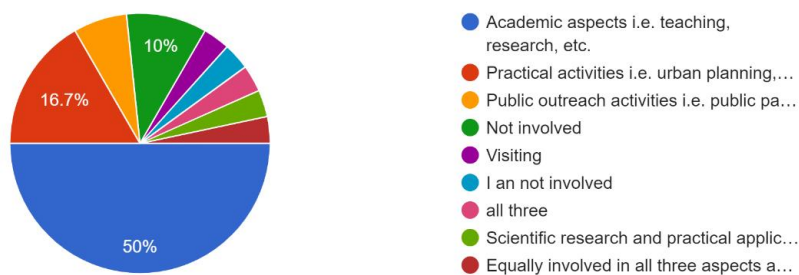
13. Do you think your professional activities are related to ancient/old town(s)?

30 responses



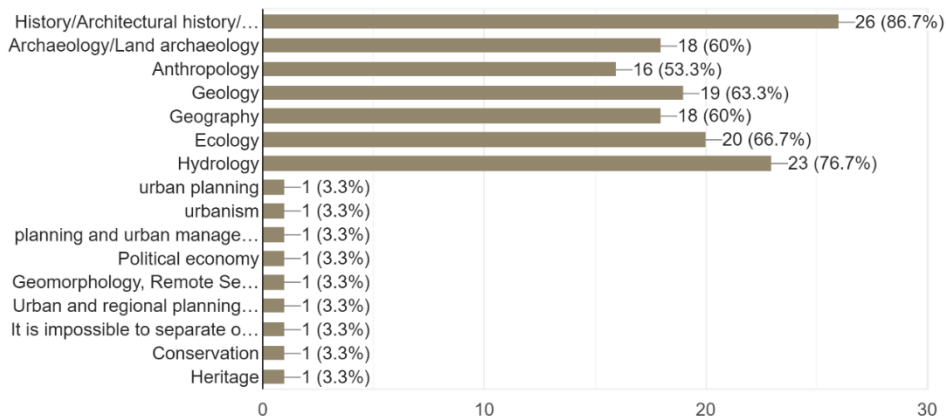
14. How are you involved in ancient/old town(s)?

30 responses



15. What disciplines should be applied in understanding water management in the ancient towns?  
(more than one answer is acceptable)

30 responses





### Section C: Understanding in Water Management in the ancient/old town(s).

16. At present, most studies of water management in the ancient/old towns are still unclear and questionable as they are not comprehensive.

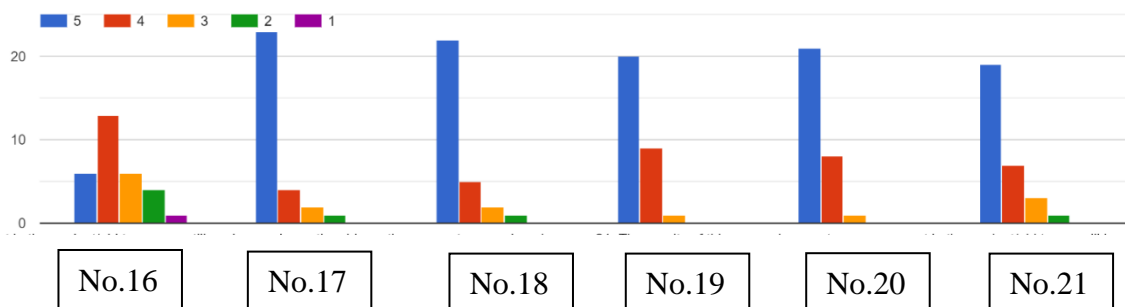
17. Various fields of knowledge are required in the study of water management in the ancient/old towns?

18. Research is more credible if more disciplines are involved in the study of water management in the ancient/old towns?

19. Study of water management in the ancient/old towns must include knowledge in the natural science and humanity.

20. The intangible aspects of water management in the ancient/old towns are necessary for the understanding of how water management has been developed in any civilisations.

21. The results of this research on water management in the ancient/old towns will be useful for water management at present and in the future.



## Section D: Your project

22. Please provide title/name of your study/research/project relating to water management in the ancient/old towns that describes your experience in this field. (only one is needed)

- Chaopraya river and related canal (irrigation ) system
- Mike11
- Soil Aquifer Treatment in Shiga Prefecture, Japan
- Heritage of Chao Phraya
- A new interpretation of the boundary of Dvaravati Shoreline on the Lower Central Plain, Thailand
- Resilient Urban Water Resources Management Strategy of Bangkok
- Integrating Climate Adaptation into Asset Management Planning: Assessing the Adaptation Potential and Opportunities of an Urban Area in Bangkok
- Corten, J.P., Geurts, E., Meurs, P., Vermeulen, R., Heritage as an Asset for Inner-City Development. An Urban Manager's Guide Book. (Rotterdam 2014)
- An Urban Political Ecology of the 2011 Bangkok Floods
- Landscape management plan in the ancient site of Mrauk-U, Rakhine, Myanmar
- Flood risk management at Ayutthaya, historic landscape study at Sukhothai, cultural landscape management at Pyu Ancient Cities, agricultural planning at Bagan
- 2016. Water management in the Urban Cultural Heritage of Myanmar with U San Win and Pyiet Phyo Kyaw. TRaNS: Trans-Regional and National Studies of Southeast Asia. Vol 4/2: 283-305.
- Water management systems in World Heritage Site of Hampi in India
- We are currently studying and Documenting the Ghats ( historic establishments made to access the river) and look at their historic and current day scenario of the same
- Studied the temples on the ghats in Wai (Post graduate semester)
- Development plan for Braj
- See icomos water and heritage on YouTube
- Develop E-learning Curriculum for school-children on Water Management, using World Heritage resources
- Revitalization of Water Heritage
- Rehabilitation of ancient hydrology and water management system at Angkor
- Nothing specific on this theme but entire Sri Lankan ancient civilisation is based on water management systems/ irrigation which was the main area of work related to heritage over 40 years.

- I co-chaired a session on 'Waterscapes' at the 2019 International Conference 'Water as Heritage', Chiayi, Taiwan; 27-30 May 2019.

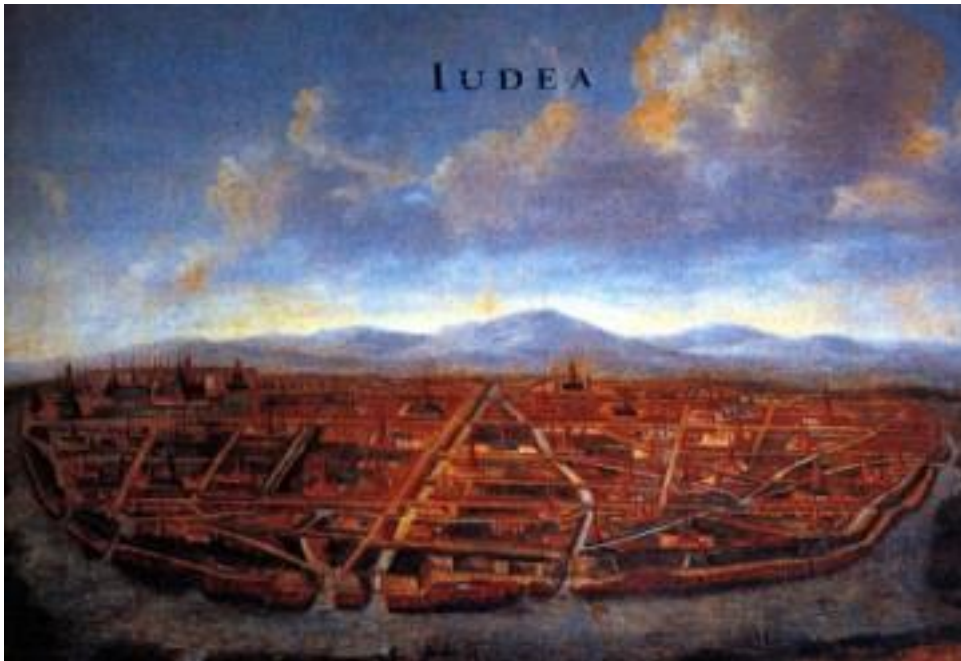
23. Other comment/input or suggestion (if any).

- see ICOMOS's ISC on Water and Heritage
- programmes need to help the local community in order to be sustainable
- I am working on the area of how to revive these old water structures.
- Please let me know if i can be of any help in your studies.
- All the best for your research.
- Lohit Jain
- Mobile number: +91 9646743373
- One important aspect of the study of water management -- with relevance to both historic changes in the system, and in relation to future conservation strategies -- that has not been highlighted is that of the impact of climate change on the hydrological regimes of ancient cities/civilizations. The historic cities of S E and SEA are all of sufficient historic time depth to have to experienced multiple and variable fluctuations in water resource availability, seasonality, and the impact of climate changes on hydrological regimes. To the extent that the water management strategies and of a city was able to cope (or not) with these changes had considerable impact on the resilience of the urban form, innovation in and maintenance of hydrological infrastructure, labour (re-)organization, the economics of agricultural production, as well as the demographic dispersal of the population. Ritual activities intended to control the politics associated with managing these changes are also a consideration, as the ritual control of water was an important aspect of kingship in Cambodia, Siam, Burma, Ceylon, and across India.
- Happy to introduce people who have worked on ancient irrigation systems
- There are a number of publications (edited volumes) put out by the group that is now the ICOMOS ISC on Water and Heritage. I can send references if you are not already familiar with these.
- In Chinese
- In this study, I hope to study the relationship between water management in ancient cities and people's lifestyle, such as whether there is a centralized water intake point and whether it is an important space for people to communicate.

## ANNEX

## Collection of old maps and drawings about Ayutthaya

Johannes Vingboons (c.1616 - 1670)



*Iudea*



*Afbeldinge der Stadt Iudiad Hooft des Choonincrick Siam*

**Jan Janszoon Struys (c.1629 - c.1694)**



*De Stadt Judia - the first printed map*



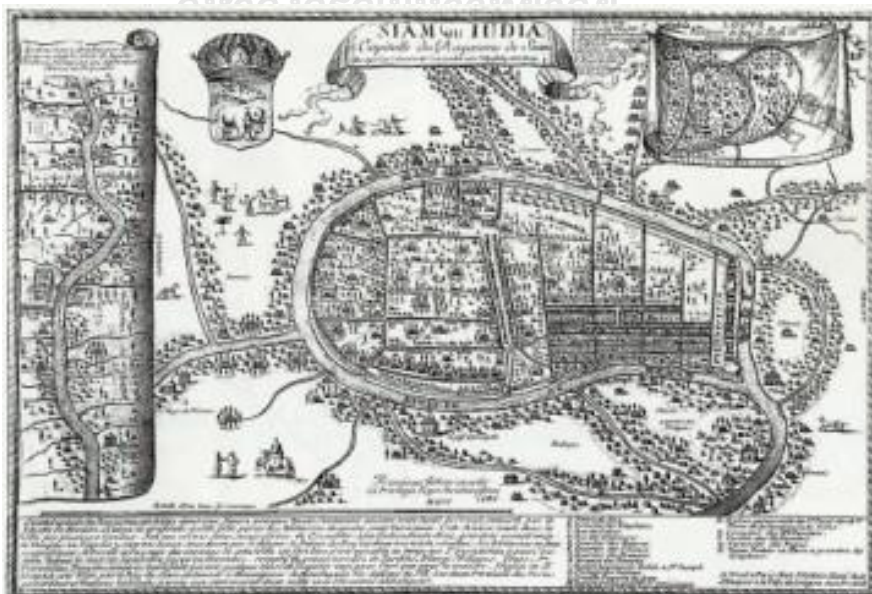
*La Ville de Judia - Les voyages de Jean Struys - published in 1681 by Chés la  
Veuve de Jacob van Meurs (À Amstredam engraving of 18 cm by 28 cm)*

**Alain Manesson Mallet (1630 - 1706)**



*India ou Sian*

**Jean de Courtaulin de Maguelonne**



*Siam ou Iudea*

**Nicolas Gervaise (1662 - 1729)**



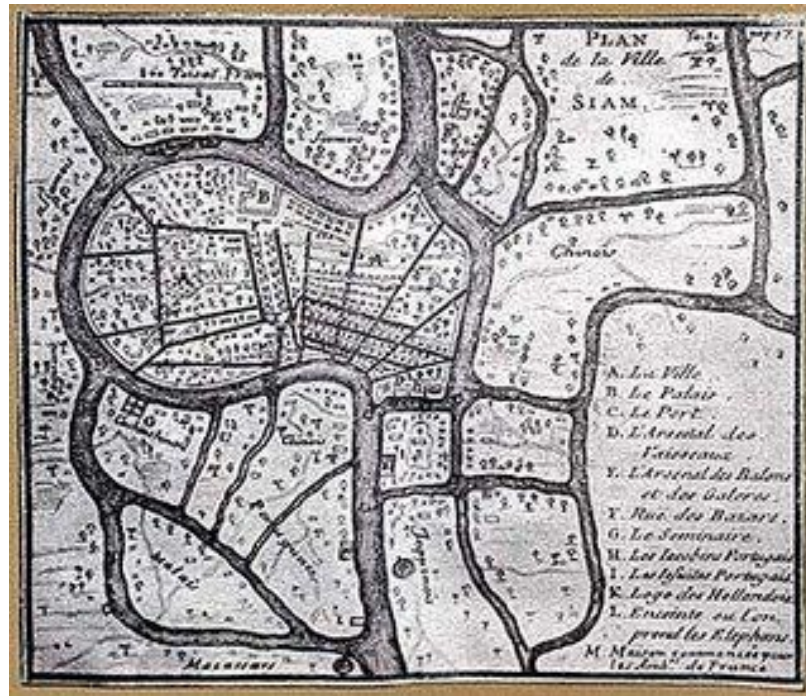
*La Ville de Judia*

**Isaac de Graaff**



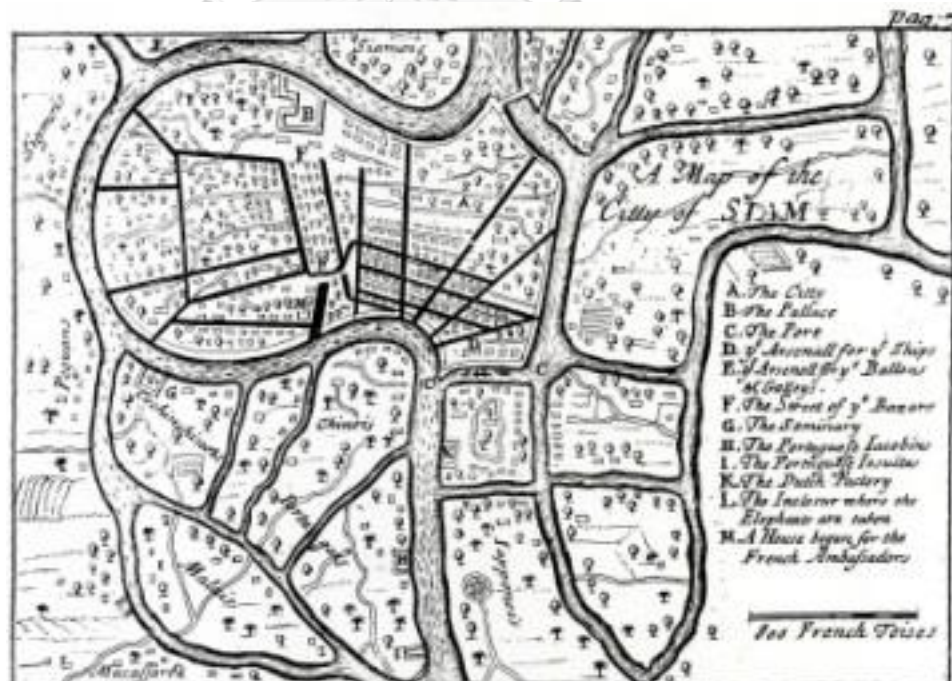
*De Stadt Judia*

Simon de La Loubère (1642-1729)



*Plan de la Ville de Siam*

Vincenzo Maria Coronelli (1650 - 1718)



*A Map of the City of Siam*



**Maguelonne's 1986 map "Siam ou Iudea"**



*Siam O Judia*

**François Valentijn (1666 - 1727)**



*Judia, De Hoofd-Stad van Siam*



**De Groote Siamse Rievier Me-Nam ofte Moeder der Wateren inharen loop  
met de in vallende Spruyten Verbeeld**

**Engelbert Kaempfer (1651 - 1716)**



*Mappa Meinam Fluvij*



*Unnamed*

Another copperplate printing of 19,5 cm by 28,5 cm called “de Stadt Judia” was made by an unknown engraver and published by Johannes Marshoorn ca

จุฬาลงกรณ์มหาวิทยาลัย



**Jacques Nicolas Bellin (1703-1772)**



*Plan de la Ville de Siam, Capitale du Royaume de ce Nom;  
 Levé par un Ingénieur François en 1687*



*Judia / Capitale de Siam. / Hoofd-stad van Siam*



*Plan de la Ville de Siam, Capitale du Royaume de ce Nom; Levé par un Ingénieur François en 1687*



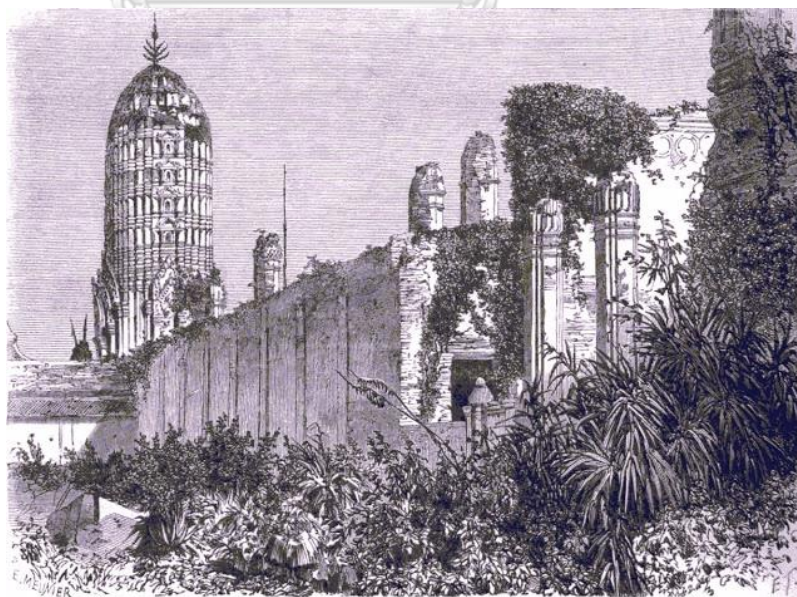
*Ville de Siam ou Juthia*

**John Andrews - c. 1776**

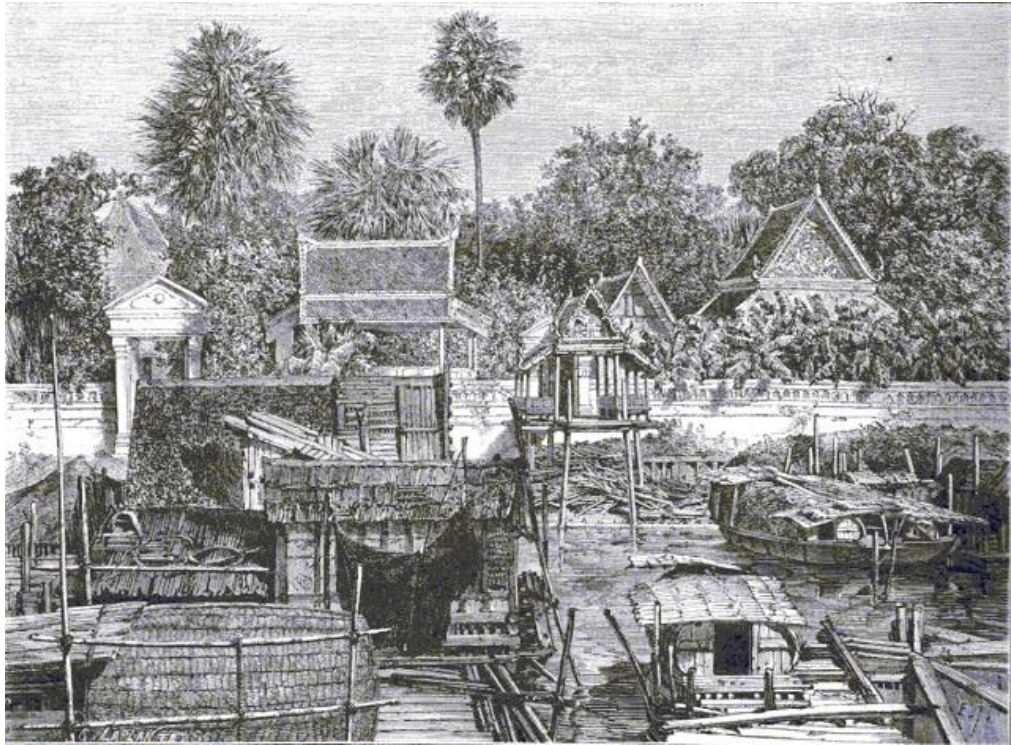


*A Plan of the City of Siam or Juthia*

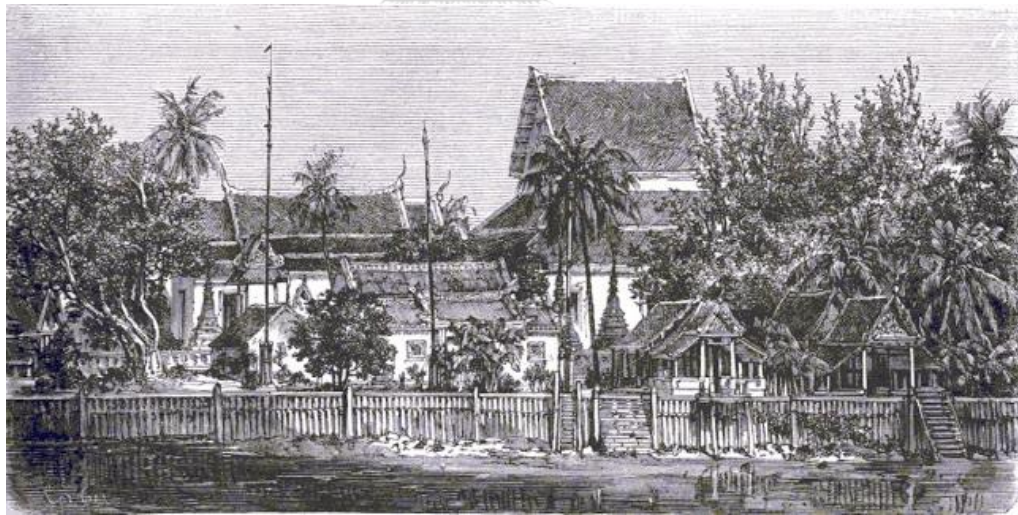
Paintings from the book “Voyage dan les Royaumes de Siam, de Cambodge, de Laos...” by Henri Mouhot



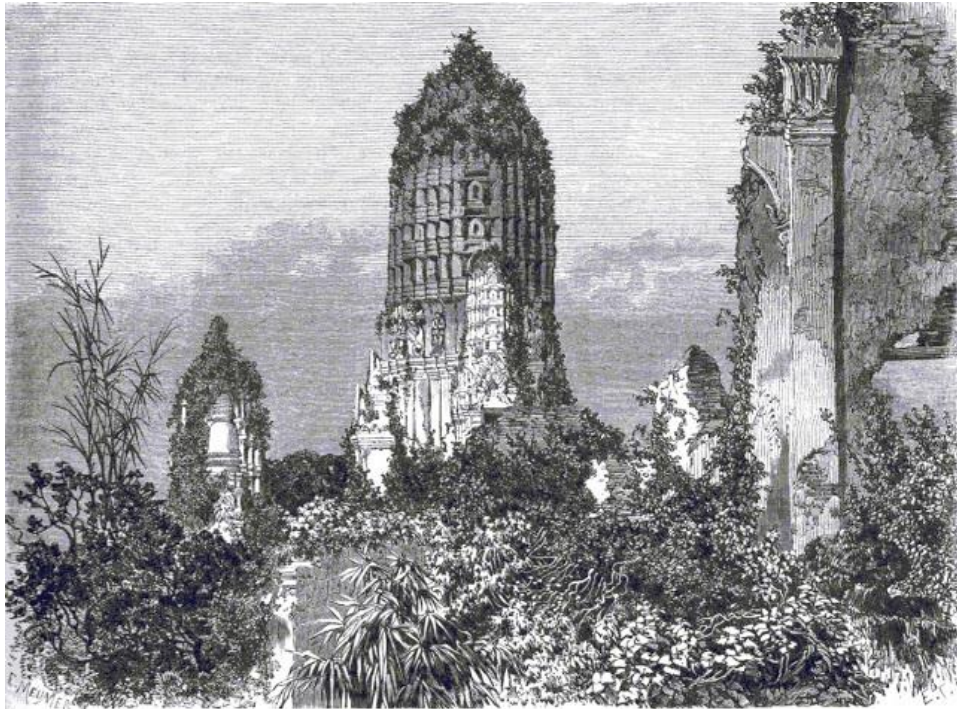
*Wat Phutthai Sawan*



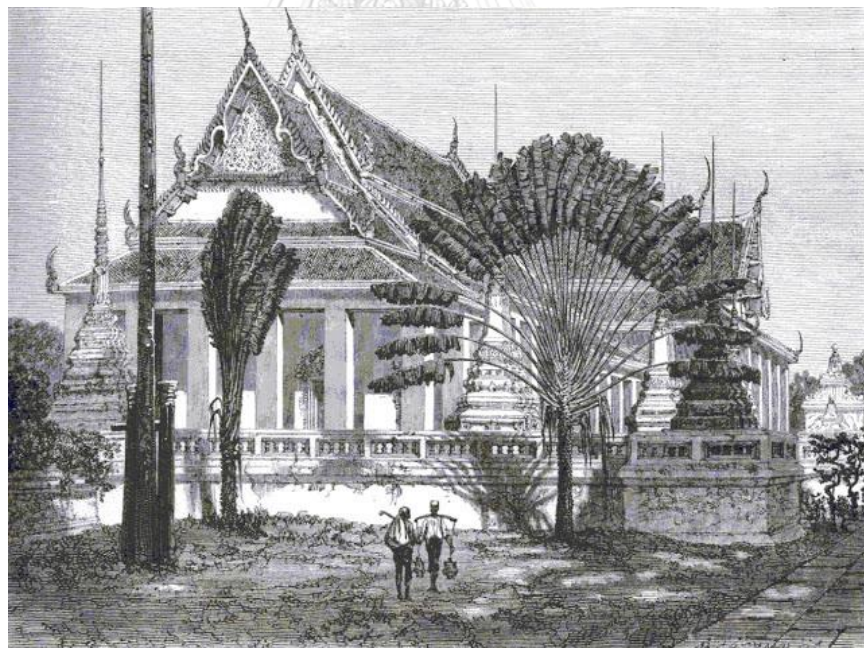
*Khlong in Ayutthaya*



*Wat Phanan Choeng*

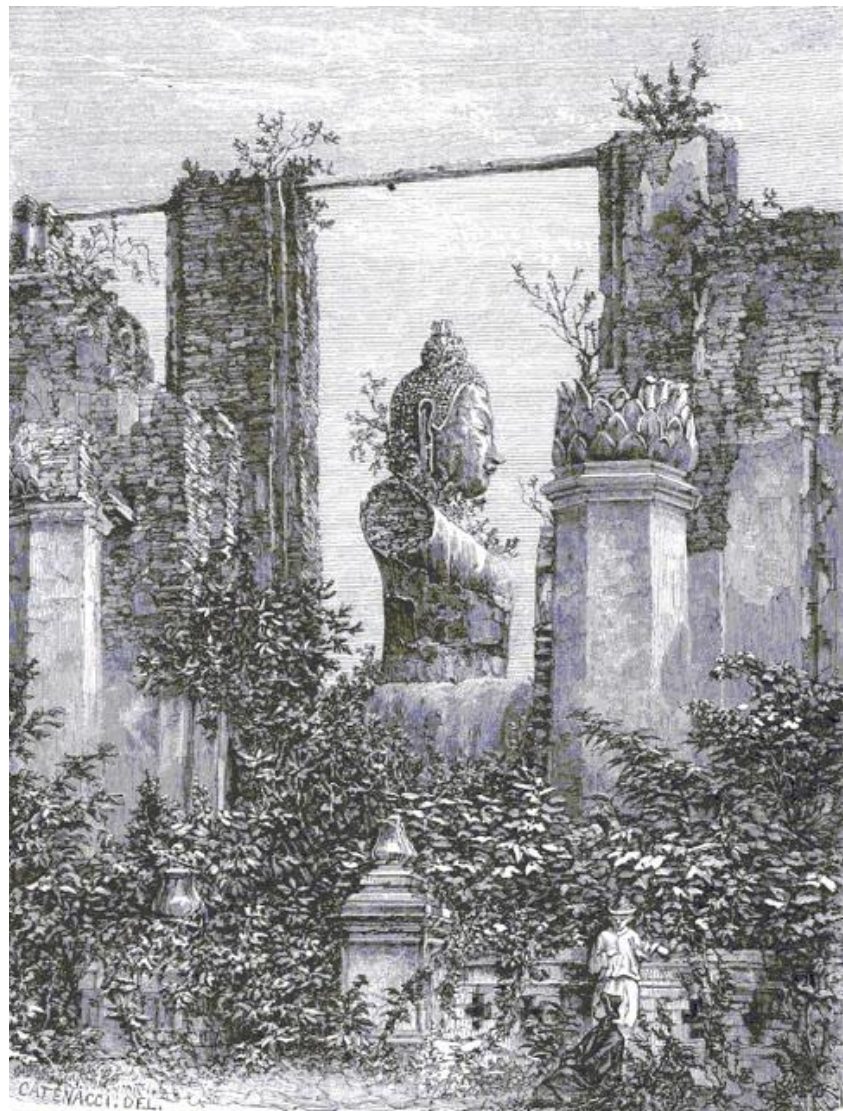


*Ruins in Ayutthaya*



*Pagode in Ayutthaya*





CHULALONGKORN UNIVERSITY  
*Phra Borom Bophit*



Wat

*Phra Si Sanphet*

## VITA

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