A RESEARCH ON THE HYDRAULIC SYSTEM FOR MANDALAY, THE LAST ROYAL CITY OF BURMESE KINGDOM

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Abstract
Many of the historical capital cities of the Burmese Kingdom were known to have a moat around the square shaped walled city where the Palace was located. In regard to Mandalay, the last Royal City of Burmese kingdom before the British colonization, a moat, ponds, tanks and canals were built as the basic infrastructure of the city, but little is known about them today.
In this study, historical documents relating to the building of Mandalay were investigated in a bibliographical study, and historical maps of the city as well as for a wider regional area of Mandalay were analyzed. As a result, the elements constituting the hydraulic system of Mandalay were integrated on a map. The hydraulic system thus enumerated was analyzed over a time frame from the twelfth, eighteenth, nineteenth centuries and finally at present, when these hydraulic systems were built, modified and discarded. This paper successfully revealed the formation and transition of the hydraulic system of Mandalay and its surrounding area and discussed the characteristics of the hydraulic system. These findings would lead to more comprehensive understanding on how the Burmese Royal Cities were built and operated.

Keywords: *Mandalay, Burma, capital, hydraulic system, canal*

1. INTRODUCTION

1.1. Background

Before the British colonial rule started in the late nineteenth century, Burma (present-day Myanmar) was governed by Burmese kingdom with the capital city built one after another as the administrative center of the kingdom. Many of the Royal Cities of the Burmese Kingdom are known to have a moat around the square shaped walled city as shown in Fig. 1 and 2, The moat is an important element of the capital cities, as it provides defense as well as serves as the water source for the Palace. The moat had to be filled up all the time.

This means that some kind of hydraulic system was to be made so as to supply water to the city as well as to keep the water in the moat. In regard to Mandalay, the last Royal City of Burmese kingdom before the British colonization, a moat, ponds and tanks, and canals were built as basic infrastructure of the city, but little is known about them today.

In this study, historical documents contemporary to the building of Mandalay as well as historical maps of Mandalay as well as its wider regional area were analyzed. For this purpose, a present day topographical map of the area is used to integrate the hydraulic facilities as a network. This research will provide a basis for scrutinizing the hydraulic aspect of Mandalay, as well as other historical royal cities of Burmese kingdom. This paper summarizes findings about the formation and transition of the hydraulic aspect of Mandalay and Amarapura.

Part of this research is to be published as part of the report for the JSPS Core-to-Core Program: Establishment of the Network for Safeguarding and Development of Cultural Heritage in the Mekong Basin Countries (Yamada 2019).

1.2. Previous Studies

Maung Mung Tin (1966) has an overview of hydraulic facilities related to Mandalay. In his paper, Mang Maug Tin introduced a map of Mandalay which was printed on a *parabaik* paper with five (5) colors, as shown in Fig. 3. He explained that this map was stored at Shwenandaw Kyoung Monastery in Mandalay since as early as 1886, and later it became possession of Mandalay University, and rediscovered in 1956. Maung Maung Tin considered that this map was made some time in 1855 before the shifting the capital city from Amarapura to Mandalay. This map contains a number of hydraulic elements, such as rivers, canals and tanks (reservoirs). Maung Maung Tin transcribed the original map on to a scaled map as shown in Fig. 3.

Also, Seale (1928) provided detail geographical information of the hydraulic facilities iin Mandalay District. In regard to the Royal Palace of Mandalay, Duroiselle (1931) provided essential guidance as to the location and function of

the moat and others and its relation to the source of water.

1.3. Purpose of this Research

The purpose of this research is to prpvode an outline of the hydraulic facilities related to Mandalay in a network configuration, and show how this network evolved form the twelfth, eighteenth, nineteenth centuries and at present.

1.4. Method of the Research

The method of this Study is to integrate the information about hydraulic elements, such as rivers/lakes, tanks, canals, moat and ponds, and clarify the relationships as a network on a geographical setting. For this integration, the latest 1:50,000 topographical maps published by the Survey Department of the Government of the Union of Myanmar will be used.

2. OVERVIEW OF HYDRAULIC ASPECTS of MANDALAY

In this chapter a bibliographical survey as to the location and functions of hydraulic elements in Mandalay is given.

2.1 The Mandalay Area

The area in which the hydraulic network for Mandalay was built was roughly a rectangular area bounded on the west by the Irrawaddy river, on the south by the Mytinge River, on the east by mountain ranges of the Shan Highlands, and on the north by the Chaung Ma Gyi River. This area corresponds to what was called the Golden Chain Reserved Area (*shwe-gyo-that-ne* in Burmese) and was approved by the King on 27 January 1857 (ROB IX, xvii.). The area is 21 km east –west and 51 km north-south (Ohno, 92), with a total area of approximately 1,100 km^2, as shown in Fig. 5. In this paper, this area will be referred to as the Mandalay Area.

2.2 Hydraulic System

A hydraulic system in this paper is defined as a system made of natural features and artificial facilities for intaking, transferring, storing, supplying and discharging water. Fig. 6 shows a schematic representation of a hydraulic system.

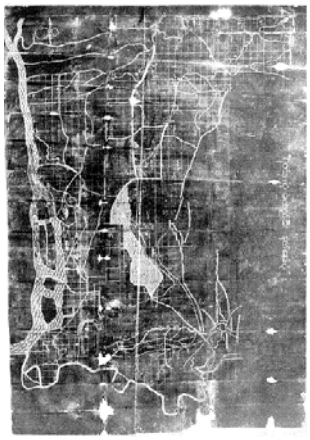
A tank refers to a man-made pond for the supply of water. A canal refers to a man-made ditch mainly for the transportation of water. A moat is a ditch which surrounds a palace or a castle. The Mandalay palace has a moat around the walled city which was (and still is) filled with water. A weir is a low dam built across a river to raise the level of water upstream or regulate its flow. A bund, or an embankment or causeway, was used where necessary in a tank or canal.

Source: Map by Google, Image by DigitalGlobe

Fig. 1. Royal City of Mandalay and its Moat

Source: Map by Google, Image by DigitalGlobe

Fig. 2 Royal City of Amarapura and its Moat

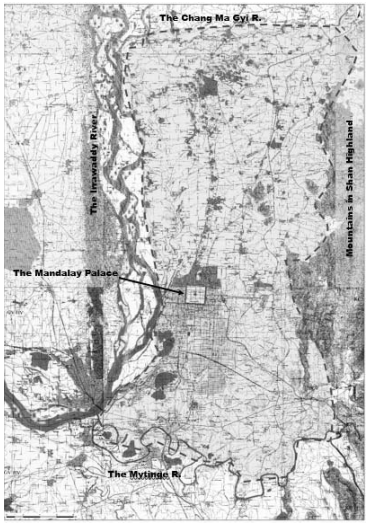


Source: Maung Maung Tin, 35

Fig. 3. Mindon Min's Development Plan of Mandalay

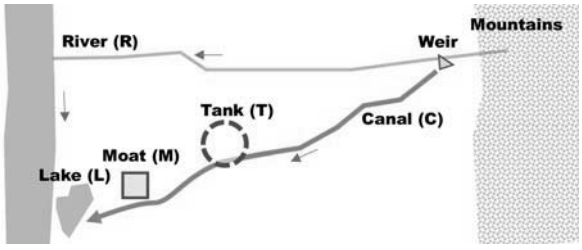
Source: Maung Maung Tin, 36

Fig. 4 Mandalay Area as Transcribed by Maung Maung Tin



Source: Original map by Survey Department, modified by the Author

Fig. 5. The Mandalay Area shown in 1:50,000 Topographic Maps



Source: Author

Fig. 6. Hydraulic System in Schematic Diagram

2.3 Hydraulic Systems in the Area

This section reveals an outline of the hydraulic systems in the Area, based on descriptions in historical documents. Table 1 summarizes the elements in the hydraulic system.

2.3.1. Rivers

(1) The Irrawaddy River

The Irrawaddy river runs about 3 km west of Mandalay. The course of the river changed from time to time.

(2) The Chaung Ma Gyi River

To the north of Mandalay by about 25 km is another tribu-

tary of the Irrawaddy called the Chaung Ma Gyi river running to the west. To the west of Mandalay are Shan Mountains. The Mytinge River

On the south of Mandalay is a winding tributary of the Irrawaddy called the Mytinge River flowing westward to join the Irrawaddy near Inwa (Ava), another Royal City.

(3) The Nadaunggya River

The Nadaunggya River is a small tributary of the Mityinge River in the southern part of the Mandalay Area. It flushes down from the Shan Highlands near the town of Se Daw, and after 8 km or so, it connects to the Mytinge.

2.3.2. Lakes

(1) Taungthaman Lake

Lake Taungthaman near Amarapura is a lagoon fed from the Irrawaddy. Today, Lake Taungthaman is a large perennial lake, but when Amarapura was built nearby, it was more of a low-lying area with seasonal impounding of water, so it is shown as a small lake in the map of 1914.

Table 1 Hydraulic Elements of Mandalay Area

Category	Abbreviation	Name	Feature
Rivers & Lakes	R1	Irrawaddy River	A major river in Burma
	R2	Chaung Ma Gyi R.	A northern tributary of R1 in the north
	R3	Mytinge R.	A southern tributary of R1 in the south
	R4	Nadaunggya R.	A tributary of R3
	L1	Lake Taungthaman	To the south of Amarapura, which became bigger in 20th C.
	L2	Lake Zaung Kalaw Kan (or Lake Taung Kale Kan)	To the east of Amarapur, not existent after the shift of Capital to Mandalay あ
	L3	Lake Kan Daw Gyi	To the east of Amarapura, not existent till the end 19th C.
Tanks	T1	Nanda Tank	Dug by Alaungsithu in 12th C., fed from the Shwelaung Canal, repaired and integrated with T4 by Bodawpaya, in 1788, and repaired again by Mindon in 19th C.
	T2	Maungmagan T.	Dug by Alaungsithu in 12th C., repaired by Bodawpaya in 18th C.
	T3	Taunggan T.	Dug by Alaungsithu in 12th C., reexcavated and repaired by Min Don in 19th C.
	T4	Aungbinle T.	Dug by Minshinsaw in 12th C., repaired by Bodawpaya in 18th C., integrated with T1 in 19th C.
	T5	Tamokso T.	Dug by Minshinsaw in 12th C., repaired by Bodawpaya in 18th C., by Mindon in 19th C.
Canals	C1	Shwetachaung Canal	Built by Bodawpaya in the late 18th C, and repaired by Shwebo in 1837.
	C2	Shwelaung C.	Built by Bodawpaya in the late 18th C, and repaired by Shwebo in 1837.
	C3	Myaungmadaw C.	Built by Bodawpaya in 18th C. together with T1.
	C4	Dinga C.	Dug by Mindon in 19th C. not functional
	C5	Nadi C.	Dug by Mindon in 1857.
	C6	Mandalay C.	Dug by the English in early 20th C.
Moat	M1	Moat of Amarapura	The moat around the royal city Amarapura, built by Bodawpaya in 18th C.
	M2	Moat of Mandalay	The moat around the royal city Mandalay MIndon in 19th C

Source: Author

(2) Zaung Kalaw Kan (or Taung Kale Kan) Lake

Lake Zaung Kalaw Kan (or Taung Kale Kan) was located to the east of Amarapura. After Amarapura was abandoned, this lake disappeared.

(3) Kan Daw Gyi Lake

Lake Kan Daw Gyi on the northwest of Amarapura was a former river course of the Irrawaddy trapped inland.

2.3.3. Tanks

(1) Nanda Tank[1]

The Nanda Tank (Reservoir) is said to have been dug originally by King Alaungsithu (1112-1167 A.D.). Later in 1788, King Bodawpaya repaired the bund of this tank from the Mandalay Hill to a village of Kalamadaung to the northeast of the hill. The tank was fed from the Shwelaung Canal. As will be discussed later in this sub-section, Nanda and Aungbinle Tanks were combined together by King Bodawpaya. Later in 1841, King Shwebo repaired this bund (Searle, 65).

(2) Maugmagan Tank[2]

The Maungmagan Tank was located north of the Mandalay Hill near the Irrawaddy river. King Alaungsithu was ascribed the construction of this tank. The Maungmagan tank survived until the time of King Bodawpaya, as he was believed to have repaired the embankments of this tank in his reign (Harvey, 275).

(3) Taunggan Tank[3]

The Taunggan tank was reputed to have been originally constructed by King Alaungsithu, (1112-1167) to store and redistribute the flood water of the Kyetmaok Chaung. King Mindon had it re-excavated and repaired by state prisoners settled in the local villages (Maung Maung Tin, 33).

(4) Aungbinle Tank[4]

The Aungbinle Tank, which was the main reservoir for Mandalay, was said to have been constructed by King Minshinsaw in 1151 A.D. and it was repaired by King Bodawpaya in 1788 (Searle, 119). King Bodawpay combined the Aungbinle and Nanda Tanks, and it was called Aungbinle Lake[5], which measured about three miles (5 km) across. After the foundation of Mandalay its chief use was to feed the moat of Mandalay which was the main source of water supply for the town and the only source for the palace and its surroundings (Searle, 119). Later, King Shwebo repaired the bund of this tank in 1841, and then again, King Mindon repaired it in 1856. (Searl, 65-66).

(5) Tamokso Tank[6]

The Tamokso tank was built by King Minshinsaw in 1151 A. D. to store flood water from the Nadaunggya Chaung by means of the Myaungmadaw Canal. It was repaired by King Bodawpaya in 1783, and again by King Mindon in 1862. The bund of the Tamokso Tank carried an unmetalled cart road towards the Myitnge River.

2.3.4. Canals

(1) Shwetachaung Canal[7]

The Shwetachaung Canal (Fig. 7) was constructed by King Bodawpaya in the late eighteenth century, and repaired under the orders of King Shwebo in 1837 (Searle, 120 – 121). It was 26 miles (42 km) in length, with the head on the Chaung Ma Gyi at Kalamet, six miles (10 km) northeast of Madaya vil-

lage and an outlet into the Irrawaddy river just below Mandalay Town. The purpose of this canal was to improve the irrigation of the Lebyin lands (Maung Maung Tin, 33), but at the same time, as it runs just northwest of Amarapura, the former Capital City built by Bodawpaya, the canal was also intended to supply water to Amarapura and replenish its moat.

This canal was said to be prone for frequent breaches due to the drainage of water from the east, and submergence by the high water of the Irrawaddy from the west, both in the rainy season (Searl, 121).

(2) Shwelaung Canal[8]

The Shwelaung Canal (Fig. 8), which runs in the eastern part of Mandlay City, was dug also by Bodawpaya when he repaired the Nanda Tank in the late eighteenth century. Originally, this canal was intended to supply water to Amarapura. It was repaired under the orders of King Shwebo in 1837 A.D. (Searle, 119). The purpose of this canal was to improve the irrigation of the Kaing lands but the water of the canal was also used to fill the Nanada-Aungbinle Tanks, located just west of its reach (Maung Maung Tin, 33).

When it was built, this canal took off from the Chaung Ma Gyi near Zehaung village, just above the present head-works of the Mandalay Canal, and ran for about 28 miles (45 km), first in a deep cutting along the foot of the hills and then in a south-westerly direction to Amarapura where it had an outlet into the Irrawaddy. After the construction of Mandalay, the canal was connected to the Nanada-Aungbinle Tanks which was used also to fill the moats and ponds and supply drinking water to Mandalay. It was said to be difficult to maintain the headworks due to the flooding of the Chaung Ma Gyi river. Eventually in 1878, the headworks failed, and thousands of acres of land were put out of cultivation (Searle, 120).

(3) Myaungmadaw Canal[9]

The Myaungmadaw Canal is said to have been constructed by King Bodapaya when he repaired the Nanda Tank in 1788. It took off from the Nadaunggya Chaung, a tributary of the Mitinge river, at Sedaw village, and connected to Tomakso Tank. Later, this canal also helped the Shwelaung to feed the Nanda-Aungbinle tanks (Searle, 121).

(4) Dinga Canal[10]

As the Shwelaung canal was liable for serious breaches caused by floods, King Mindon's engineers, after the construction of Mandalay, planned an additional line of supply to be drawn from the Chaung Ma Gyi river many miles below the Shwelaung Canal intake (Maung Maung Tin, 33). Thus the Dinga canal was dug between the Shweta Chaung and Shwelaung canals as an additional supply route for Mandalay. Unfortunately, the level of the Dinga canal was higher than that of the Shwetachaung and this canal has never been of any use for irrigation and discarded soon after its completion.

(5) Nadi Canal[11]

In 1862 King Mindon dug the Nadi Canal (Fig. 9) on the east of Mandalay City from north to south, and had gardens made along its banks (Searle, 66).

(6) Mandalay Canal

The Mandalay Canal is a major irrigation canal today, which obtains its water from the Chaung Ma Gyi river with head works at Sedaw village, sixteen miles (26 km) northeast of Madaya village. The Mandalay canal was first opened for irrigation in 1902-03 after the annexation of Burma. As the course of the Mandalay Canal crisscrosses with that of the Shwelaung Canal, the Mandalay canal probably took over the same service areas of irrigation of the Shwelaung canal.

Source: Author

Fig. 7. Shwetachaung Canal Today

Source: Author

Fig. 8. Shwelaung Canal Today iEast of Mandalay Palace

Source: Author

Fig. 9. Nadi Canal Today

Source: Author

Fig. 10. Mandalay Moat Today

Source: Author

Fig. 11. Remaining Part of Amarapura Moat Today

Source: Author

Fig. 12. The bund of the Aungbinle Tank Today

2.3.5. Moats

(1) Mandala

The moat of Mandalay walled city (Fig. 10) was constructed almost at the same time as the Palace, and was completed in 1859 (Duroiselle, 14). The moat was 225 feet (69 m) broad and of an average depth of 11 feet (3.4m) (Duroiselle, 24).

(2) Amarapura

The moat of Amarapura (Fig. 11), according to Yule, was nearly eighty feet (24 m) in width extending along the east and west sides, the greater portion of the north, and about half in the south. This ditch was from sixteen to eighteen feet (5 to 6m) deep (Yule, 132).

2.3.6. Other Elements

(1) Weir

The usual type of weir was made of stone in cribs and raised the water level a few inches to six feet (1.8 m) or more in height (Searl, 21). All the canals had a weir in upstream reaches of a tributary river of the Irrawaddy to intake water.

(2) Bund

Some of the tanks are known to have bunds around them (Fig. 12). The Aungbinle Tank, when it was repaired by Bodawpaya in 1788, the dimensions of the bund were height 37.5 feet (11.4 m), breadth at bottom 105 feet (32.0 m), breadth at top 21 feet (6.4 m), and the length of the bund as just over five miles (8 km) (Searle, 119).

The dimensions of the bund of the Nanda Tank, when it was raised for four miles (6 km) from Mandalay Hill to the Kalamadaung, were: height 30 feet (9.1 m), width at bottom 162.5 feet (49.5 m) and the width at top 21 feet (6.4 m) (Searle, 119). Bunds were often used as cart road. The bund of the Aungbinle Tank still remains today and is used as Mandalay – Lashio Road. Some of the canal had bunds, too. The Shwetachaung and Dinga Canals were said to have bunds, which were used as elevated roads at the top.

3. INTEGRATION OF HYDRAULIC FACILITEIS ON A NETWORK

This chapter presents the results of an effort to integrate the hydraulic facilities, as discussed in the previous chapter, and put them on a network based on the relationships of each of the elements.

3.1 Base Maps for Integration

In order to integrate the hydraulic information gathered in this research on a comprehensive format, the base map was made from the Maung Maung Tin's transcribed map as shown in Fig. 4. Also, 1:50,000 topographic maps prepared by Survey Department, Ministry of Forestry, the Republic of the Union of Myanmar in 2003 were used as a base map for the present day configuration and were also broadly referenced for identification of locations.

As seen in Chapter 2, the hydraulic facilities were made in different times. Thus it is useful to show the hydraulic facilities in several phases when they were built and utilized.

3.2 Transformation of Hydraulic Network

3.2.1 The Twelfth Century

The twelfth century in Burma was the time when the center of the Kingdom was in Bagan. It was King Alaungsithu (r. 1112 – 1167) who built the Nanda and Maungmagan tanks in this area. Alaungsithu also constructed Taunggan tank in his reign. The Aungbinle and Tamokso tanks were built by his son, Prince Minshinzaw sometime later than the former two (Harvey, 319). He also built a system of irrigation channels (Harvey, 49), though details are not known. By the end of the twelfth century, all the five tanks were already in existence and contributed to the production of crops in this area. Fig. 13 shows the network of hydraulic facilities in this time.

3.2.2 The Eighteenth Century

During the 16th and 17th Centuries which followed the fall of the Pagan Dynasty the area around the present day Mandalay was stagnant, and almost depopulated. A drastic change came when King Bodawpaya (r. 1782-1819) moved the capital to Amarapapura in 1783. The tanks were repaired and canals were dug to supplement the hill water to fill the tanks. More villages were settled on the plains and outlying parts were opened up (Searle, 50).

In the late eighteenth century, King Bodawpaya dug Shwetachaung, Shwelaung and Myaungmadaw Canals, and repaired Nanda, Maungmagan Aungbinle and Tamokso Tanks. He combined Nanda Tank with Aungbinle Tank to make a bigger tank sometimes called Aungbinle Lake. Fig. 14. shows the network of hydraulic facilities in this time.

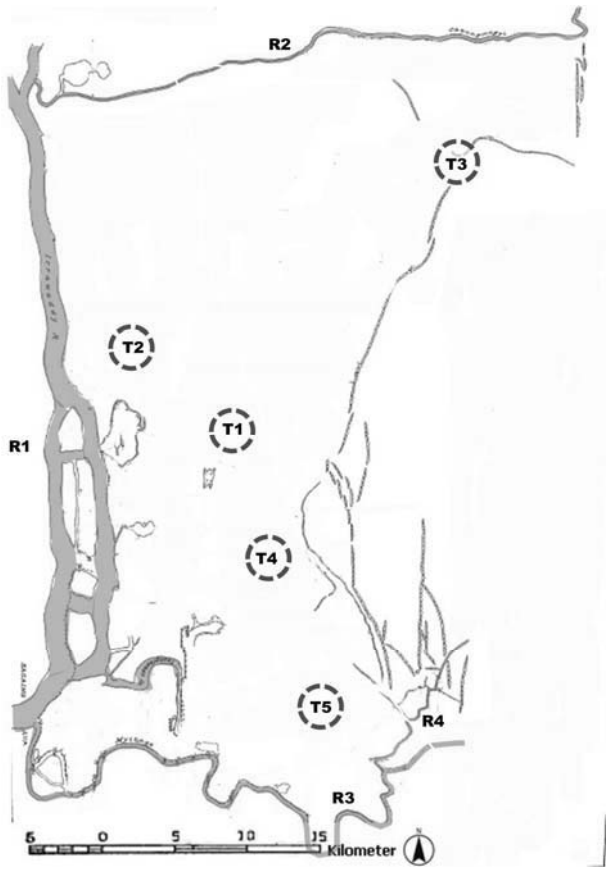
3.2.3 The Nineteenth Century

The irrigation works were kept in fairly good order until the end of King Mindon's reign. Mindon transferred the capital from Amarapura to Mandalay in 1857. Mindon dug the Dinga Canal, which did not flow very well, and the Nadi Canal east of Mandalay, and repaired Nanda and Aungbinle Tanks, and combined the two together to make the Aungbinle Lake. The shape of the Aungbile Lake is shown in Fig. 3.

Thus Mandalay was to be supplied water from the Shwetachaung Canal from the west, and from Aungbinle Lake from the east, which was supplied by the Shwelaung and Myaungmadaw Canals. The hydraulic system in this period was as shown in Fig.15.

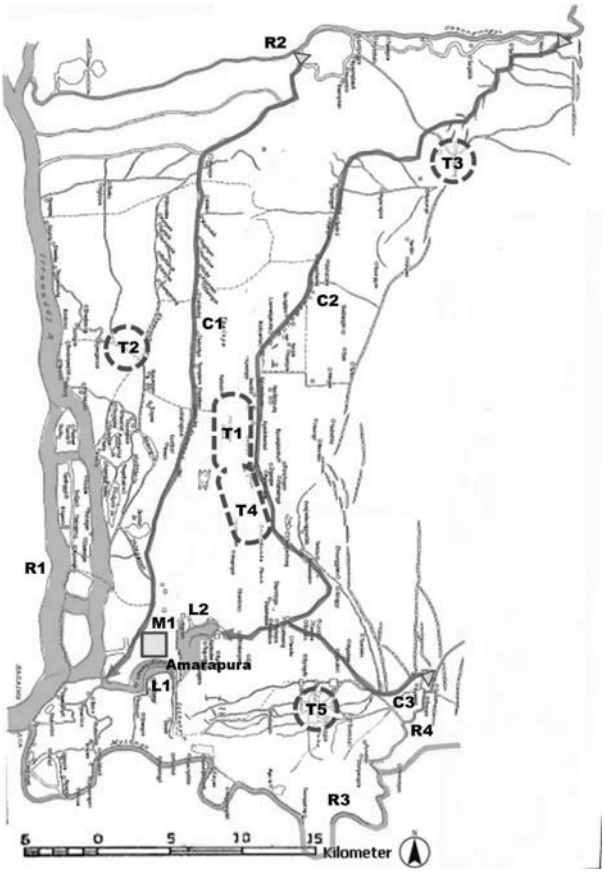
3.2.4 The Present

At present, most of the canals survived, maybe except only for the ill-fated Ding Canal. All the five tanks no longer exist. With regard to lakes, Taungthaman Lake has become a large lake and Kan Daw Gyi Lake emerged in the twentieth century to the northwest of where Amarapura was. The Mandalay Canal was built in the early part of the twentieth century which passed further east of the Shwelaung Canal runs. The hydraulic system in the 20th century is shown in Fig. 16.



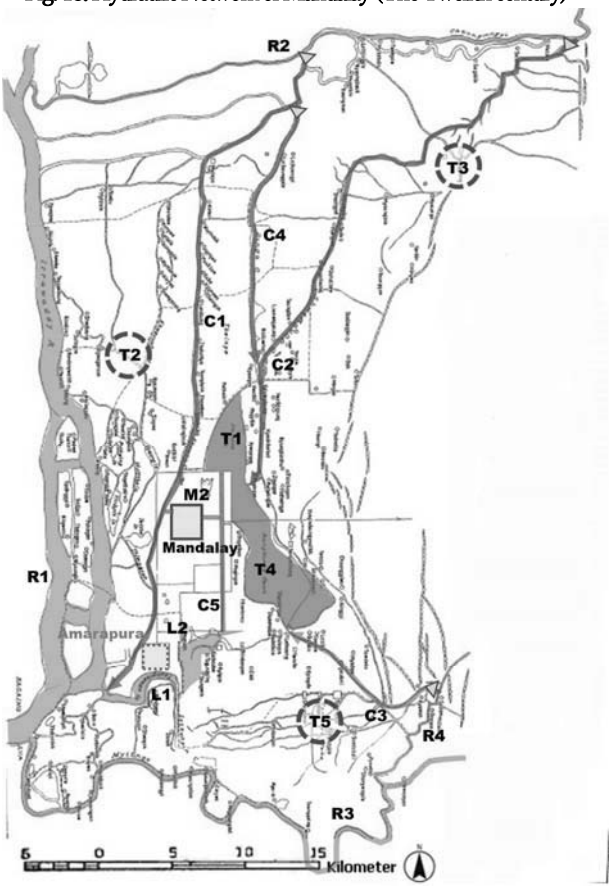
Source: Author; Base map by Maung Maung Tin.

Fig. 13. Hydraulic Network of Mandalay (The Twelfth century)



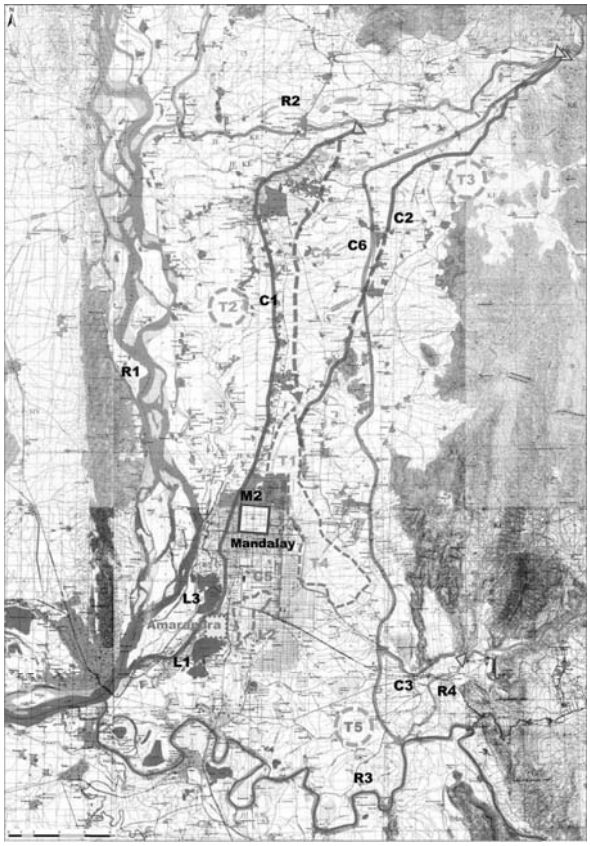
Source: Author; Base map by Maung Maung Tin.

Fig. 14 Hydraulic Network of Mandalay (The Eighteenth century)



Source: Author; Base map by Maung Maung Tin.

Fig. 15. Hydraulic Network of Mandalay (The Nineteenth century)



Source: Author; Base map by Survey Department.

Fig. 16. Hydraulic Network of Mandalay (At Present)

4. DISCUSSION ON THE CHARACTERISTICS OF HYDRAULIC SYSTEM

An outline of the hydraulic system of the Mandalay Area and their transformation over a long period of time has been revealed above. In this chapter characteristics of the hydraulic system of the Mandalay Area will be discussed.

4.1 Gravitational Flow

The hydraulic system of the Mandalay Area was found to date back at least to the twelves century, when electricity nor steam engine was not yet available, and historical document did not mention any pumping or harnessing. Thus flow of water in the hydraulic system was basically gravitational.

For the gravitational flow of water to occur, an intake point of a canal was taken at an elevated place near the foot of the mountains in the east. The canals followed the natural slope of the terrain, that is the east to west and the north to south, so that water would flow naturally by gravity towards the area where water was necessary.

There were four (4) to five (5) tanks in the area by the end of the nineteenth century, but none of them survive today. Checking on the locations where that tanks used to be there, it can be seen that the tanks were set mostly on low-lying areas. Some of the tanks, including the Nanda and Aungbile Tanks, were known to have been built with a bund around them. As mentioned earlier, the bund for the Aungbinle Tank was about 11.4 meters high, and that of the Nanda Tank was 9.1 m high.[12] High bunds were built to increase the volume of water stored in the tanks, and possibly increase the head of the stored water for the ease of supply to the moat by gravity.

4.2 Multiple Purposes of Hydraulic System

The hydraulic system, consisting of man-made facilities such as a weir, canal and a tank, and the natural elements such as the river and lake, was first built in the twelfth century for the purpose of irrigation. That was to say, by providing stable water to the terrain, the production of crops was to increase.

Later, a new royal city named Amarapura was built in the late eighteenth century, and later Mandalay was built in the mid-nineteenth century, the purpose of the hydraulic system shifted to the supplying of water to the Palace as well as to the city. Surplus water after the supply to the Palace and the city was used for irrigation also.

Thus the hydraulic system of the eighteenth and nineteenth centuries had multiple purposes of water supply to the Palace and the city, as well as irrigation.

Some of the canals were also used for transportation purpose. Gazetteer mentioned that the Shwetachaung Canal was "navigable in the rains for country boats as far up as Sagabin; a few miles west of Sedaw (Searl, 2)." As Sedaw is located a few kilometers from the intake point of the Shwetachaung Canal, so the canal was considered to be navigable in most of its reach during the rainy season.

4.3 Dual Supply for Moat

In view of the performance of the hydraulic system, it was considered to be of utmost importance that the moat around the Palace be filled with water all the time. The moat was intended for defense at the time of enemy's attack, but there were other considerations. The moat was a main source of water supply for the town and the only source for the palace and its surroundings.

For Amarapura, the supply of water to the moat was done by the Shwetachaung Canal (C1) which runs just northwest of it, but that was not the only one. As the Shwetachaugn Canal had only one bank and caught all drainage water from the east, as there was no means of regulating the water that came in at the head, the canal frequently breached (Searl, 121). In case the Shwetachaung Canal defects, another source was necessary. Thus the Shwelaung (C2) and Myaungmadaw (C3) Canals were built to convey water for Amarapura via Lake Taungthaman to the south of it. This was depicted in a map compiled in 1855 (before the shift of the capital city from Amarapura to Mandalay) as shown in Fig. 17. It showed clearly that Amarapura received water from the dual sources; namely the one from the northwest and the other from the south.

Fig. 17. A 1855 map showing Amarapura, supplied by Shwetachaung Canal from the west and via a Lake Taungthaman from the south[13]

For Mandalay, the supply of water to the moat was also done from two sources. Lake Aungbinle, which was the combination of Nanda (T1) and Aungbinle (T4) Tanks, was a very large water tank supplying water to Mandalay. The water to the lake was replenished by the Shwelaung (C2) Canal from the northeast and the Myaungmadaw (C3) Canal from the southeast. In addition to this, the Shwetachaung Canal (C1) could also supply water to the moat of Mandalay from the west. A map compiled in 1914 for Mandalay and its environs showed the duality of supply sources clearly, as shown in Fig. 18.

Fig. 18. A 1914 map showing Mandalay, supplied by Shwetachaung Canal from west and via a canal from the east[14]

5. CONCLUSIONS

No city could survive without stable supply of water. Transition of the capital city in the Burmese Kingdom thus had to consider whether a new cite of the capital would be able to obtain water supply. In the case of Mandalay, major elements of the hydraulic system for its predecessor capital, Amarapura, had been ready in the proximity of the new capital, so that the only thing that had to be done was to repair and rehabilitate the hydraulic system.

In this study, historical documents relating to the building of Mandalay and Amarapura, the last two royal cities of the Burmese kingdom, were investigated in a bibliographical study, and historical maps of a wider regional area of Mandalay were analyzed. As a result, the elements constituting the hydraulic systems of Mandalay were integrated on a map. These hydraulic systems were analyzed over a long time frame from the twelfth, eighteenth, nineteenth centuries.

As a result, the network was found to have been formed, transformed and some part of it discarded over the time, but the basic characteristics of the hydraulic system remained unchanged – i.e. 1) gravitational flow without pumping/harnessing, 2) multiple purposes for water supply, irrigation and others; and 3) dual supply sources for Palace for the security of supply.

These findings about formation and transition of the hydraulic system of Mandalay and Amarapura explains how the Burmese Royal Cities were planned and implemented from the hydraulic aspect. Further to this, a more extensive field survey and quantitative analysis will be necessary to clarify the performance of the hydraulic system thus built more in depth.

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Endonotes

[1] The location of the Nanda Tank follows Fig. 4 by Maung Maung Tin (MMT).
[2] The location of the Maugmagan Tank is shown here based on the description that it was located two miles (3km) north-west from Nyaungwun Village (Searle, 53).
[3] The location of the Taunggan Tank follows from the description that it was located eighteen miles (29 km) north-east of Mandalay (Searle, 122) where a village with the same name still exists in 1:50,000 topographic map.
[4] The location of the Aungbinle Tank follows Fig. 4 by MMT.
[5] The location and the shape of Aungbinle Lake was shown in Mindon's plan shown in Fig. 1, and Fig. 2 by MMT. The bund are still existent, so the shape is confirmable in 1:50,000 topo map, too.
[6] The location of the Tamasko Tank follows Fig. 4 by MMT/
[7] The route of the Shwetachaung Canal follows the one indicated in the map shown in Fig. 4 by MMT.
[8] The route of the Shwelaung Canal follows Fig. 4 by MMT.
[9] The route of the Myaungmadaw Canal follows the indication on the 1:50,000 topo map.
[10] The route of the Dinga Canal follows Fig. 4 by MMT.
[11] The route of the Nadi Canal follows Fig. 4 by MMT and the indication on the 1:50,000 topo map.
[12] The difference in the height of the bunds for the Nanda and Aungbile Tanks was presumably comes from the difference in the ground levels. The elevation of the top of the bunds for the two Tanks may be more or less the same, as the two tanks were combined together to make one contiguous lake.
[13] This figure shows a part of the map by Alan (1860).
[14] This figure shows a part of the map by Baedddeker (1914).

ビルマ王国最後の王都･マンダレーの水利システムに関する研究

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Abstract

ビルマ王国においては、多くの歴史的王都が王宮と濠を有していることが知られている。濠の外側には王国の臣民が居住する都市が広がる。そのため、都市および王宮に対して恒常的に水を供給するための水利施設が必要であった。イギリスによる植民地化以前のビルマ王国最後の王都であるマンダレーでは、濠、池および貯水池、運河などが王都の基本インフラとして建造されていたが、現在それらについて多くは知られていない。

本研究では、文献調査によりマンダレー創建当時の資料および当時の地図から、マンダレーを支える水利施設を地図上に同定した。次にこの水利施設の変遷を、12 世紀、18 世紀、19 世紀および現在の 4 時点から時系列で捕らえた。本研究では、マンダレーおよび広域圏の水利施設の建設、変遷が整理され、さらにその特性について議論を行った。これはビルマ王国の王都がどのように建造され、運用されたかを水利の面から知るための基礎となる。

Keywords: *Mandalay, Burma, capital, hydraulic system, canal*

(Received April 8, 209)