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THE 20th CENTURY DOMESTIC WATER SUPPLY IN ALOR SETAR, KEDAH

Alor Setar was the earliest location in Kedah which received the implementation of the domestic water supply plan by the British beginning in 1909. This initiative was due to administrative, economic, health, population and other relevant factors. Thus, the British built several water plants and the projects turned into a water supply module in other locations in the Kedah state. This paper would like to see the role of the British in developing the water supply system in Alor Setar from 1909 to 1957. This research began in 1909 due to the introduction to British advisers in the state of Kedah and ended in 1957 as the year was the final phase of the British domination in Kedah before the independence of the Federation of Malaya on August 31, 1957. This research employed materials and data from the National Archives of Kedah / Perlis, National Archives of Malaysia, University of Malaya Main Library, the Kedah Public Library, Tun Sri Lanang Library of Universiti Kebangsaan Malaysia and Kedah Water Company (SADA). The results of the study found that British advisers in Kedah successfully abandoned the water supply module in Alor Setar and succeeded in raising the standard of living of the residents at the stated locations.

Keywords: *Alor Setar Kedah, British, Water Supply, Domestic, Development*

Introduction

Water supply is the elixir of life and without a good source of water supply, life will be affected, and many other problems will surface after that. Water is very valuable to humans and a good water supply system will always be the main concern in choosing residential areas. Today's modern water supply has made the lives of the residents more convenient and healthier. In addition, water is used for various purposes such as for food, drink, economy and communication needs.¹ On Section 18, Water Supply, Enactment No. 130, water supply for domestic use can be defined as "home use supply, excluding water supply for buffaloes, cattle stored for sale, rent or production of milk or for car wash stored for sale or rent without excluding labor, manufacture or business or transmitter, swimming pool or to incinerate the land or for the purpose of the jewelry or for the purpose of the rope, "²

The research on the development of water supply in The Malay Peninsula has been underestimated by previous researchers. This situation is very surprising because the development of water supply is one of the most interesting research topics to be studied and analyzed. This is because issues related to water supply such as the problem of lack of water supply and high, water supply debt seems to have not been resolved until now. In fact, the recurring issue of water supply has a clear connection with the development of water supply in the past. However, several researchers such as Mohd Firdaus Abdullah, Arba'iyah Mohd Noor, Moo Hoi Ping, Joseph Fernando, Ruhana Padzil, A Rahman Tang, Ahmad Kamal Ariffin Mohd Rus and others have carried out research on water supply in several states in Malaya and Singapore.³ In fact, Leonard Y. Andaya on 'Water in the Study of Southeast Asia' also provided a clear picture of the types of raw water sources that can be used in water supply in southeast Asia.⁴ While existing research is still incomplete and focuses on the interests of certain authorities alone, it provides guidance and encouragement to other researchers to carry out research on water supply in Malaya in the future.

On the other hand, if we look at research on the development of water supply from abroad, it is more advanced and commenced earlier than in our country. Some researchers such as Walter M. Stern, Frank Geels, L. Mays (Editor) and others have produced research related to water supply development in some countries such as Britain, Netherlands, the United State and Egypt.⁵ It was found that the researchers were comprehensive and their studies have been a module for research on water supplies by other researchers. This proves that foreign scholars have looked at the importance of research on the development of domestic water supply for a long time and they are capable of providing relevant research results until now.

The northern Malay states or better known as the Unfederated Malay States received the introduction of modern water supplies in the early 20th century much later compared to the Federated Malay States (FMS) and the Straits Settlement (SS).⁶ This was due to the fact that in 1909, after Siam surrendered northern Malay states such as Kedah, Perlis, Kelantan and Terengganu to the British, only then there was an introduction of modern water supply in the stated states. However, the development of water supply in the Unfederated Malay States was more independent and mature than the development of water supply in the FMS and SS. This was because the delay in introducing water supply had caused people to make their own efforts to find a source of water to use in life. Kedah and Perlis were seen to have an attractive water supply development when they started with residents depending on natural water supply from natural rivers.

After that, the development of ideas and technology had encouraged people to try to build artificial streams, canals, wells and watercourses. The British arrival came together with an introduction to a good water supply system

based on the water engineering application system which was introduced in Britain.⁷ Indeed, the development of water supply was only available in the state of Kedah : the delay had highlighted the local residents' creativity and competitive edge in making life better through attempts in preparing their own sources of water supply. Kedah, also known as the largest rice producing state in Malaya, has faced many water supply problems that have taken place over the years.⁸ The research on the development of water supply in Kedah has been previously produced by Mohd Firdaus Bin Abdullah and Arba'iyah Mohd Noor. An important issue pertaining water supply has been addressed, and as a result Kedah has a good variety of raw water sources. This research gives useful information to this dedication.⁹ Alor Setar is the capital city of Kedah and was founded in 1735. As the state capital, the issue of population demands is increasing due to the development of the city.¹⁰ Indeed, the British had focused very heavily on the development of water supply in Alor Setar compared to other locations in Kedah and it was the earliest location in Kedah to receive the implementation of the domestic water supply plan by the British. Hence, this research seeks to see the role of the British in developing modern water supply in Alor Setar from 1909 to 1957. The discussion will start with the background of the water supply system before the arrival of the British, the current situation of water supply in Alor Setar, water supply management, water supply production, distribution of water supply and the effect of water supply planning in Alor Setar.

Water Supply System Background in Kedah Before 1909

The early settlements of Kedah began in 630 A.D, which was built near Sungai Qilah or Sungai Babur. Sungai Babur is now known as Sungai Merbok which flows through Sungai Petani, Kedah. Sungai Merbok provides a good water resource in order to meet 'the residents' needs. It is the responsibility of the government to provide and create an efficient and well-organized water supply system for people.¹¹ Although the approaches of the past and present are different, these efforts are the responsibility of the authorities : they have to provide a comfortable and satisfying life for the residents. This mutual relationship is a reward due to the support and loyalty from people to the government.

Apart from relying on natural sources for water supply, the source of water supply in Kedah is obtained from rivers and artificial canals extracted through energy deployment undertaken by the government since the 19th century to provide water supply.¹² The deployment of workers to dredge rivers and canals was a common procedure by the government in enhancing the development of water supply. The artificial rivers and canals utilized manpower and traditional equipment such as hoes and "Kedan" ,a digger made of wood.¹³ Based on the Al-Tarikh Al Salasilah Kedah manuscript,

the earliest evidence which showed the instructions for the construction of artificial rivers and canals could be traced to the reign of the Maharaja Kerma who had instructed the people to build a river from Batang Pasir, which passed through Kota Arung-Arungan until it reached the sea.¹⁴ Therefore, it has been shown that there was an effort made by the government to seek an alternative in obtaining water supply. The government carried out its responsibilities in the best possible way to provide a good water supply system to the consumers. Based on these situations, the idea of creating artificial river was adapted to the eco-system and it facilitated the procurement of water supply for domestic usage. Maharaja Kerma attempted to improve the social life of the people through the construction of the artificial river. The efforts to build this river were done to protect the interests of the government and the consumers. With these efforts, it was proven that the people of Kedah had had the expertise and advantages in constructing artificial rivers. The techniques and expertise used in constructing these artificial streams were assisted by governmental ideas and the geographic landscape of the site. Therefore, indirectly, the villagers were experienced in constructing an artificial river and were perceived to be forced labor in the construction of artificial rivers.

Water was obtained from the rivers in preparing food and drink. The community stored the water in caskets and tanks available at their houses. The residential area built along rivers had access to this water supply. Besides providing domestic water supply to the residents, the river was also a source for food resources. Sultan Ata'Allah Muhammad Shah I government who ruled Kedah from 1423 until 1473 ordered a river to be built to irrigate the rice fields from Sungai Jerluh to Alor Janggus, thus resulting an artificial river to be built to irrigate rice plants. Six years later, another river was built from Gunung Keriang to Sungai Cegar.¹⁵ Although the purpose of this artificial river is solely for agricultural activity, specifically for rice, it is also helpful for the people living nearby to those rivers in order to obtain water for domestic use. This is because the artificial rivers are the extension of the natural river and they flow and form the artificial streams. Moreover, they provide convenience to residents living near this artificial river in completing their daily needs.¹⁶

The opening of the Alor Setar town by Sultan Muhammad Jiwa Zainal Azilin Muazzam Shah II who ruled Kedah from 1710 until 1778 brought changes in the domestic water supply. Several rivers and canals were built around this location.¹⁷ The transition involved the migration of the residents from one location to another based on the government's town planning. Canals were dredged to meet the need of the residents based on the instruction of the Sultan. However, it was perceived that the purpose of the directive issued by His Majesty based on the instructions in the canal was unclear. Based on the landscape and map of Alor Setar, it can be concluded that this instruction was intended to meet the daily needs, which referred to domestic water supply and economic activity especially for paddy fields.

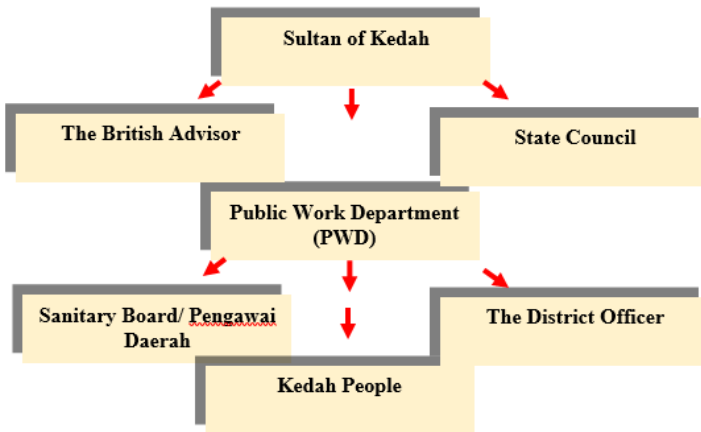
According to His Majesty, the people of Kedah built several canals; the first canal was located at Alor Semandun and it was connected to Sungai Besar in Pompong. The second canal was via a location named Kancut and then it was connected to the Sungai Besar at Tambang Badak. The last canal led to a place called Gebang through Geduk and it was connected to a big river in Pangkalan Kundur.¹⁸ The foundation of the canal was similar to the construction of the artificial rivers, which was to irrigate rice cultivation. However, artificial streams and canals were different in terms of their depth and length. The construction of the canal was one of the government's ideas aimed at facilitating paddy irrigation and was based on the concept of 'local genius' in the state of Kedah.¹⁹ Through the construction of this canal, the residents had enough water supplies. Besides, residents in the country were taught to seek water resources through the deployment of the government practiced in their lives. Although in the form of coercion and deployment, the move brought a change in their lives and affected the population pattern of the location until now. Indeed, water supply is very important for the survival of universal life.

The construction of Sungai Korok in Alor Setar²⁰ and The Wan Mat Saman Canal was from Alor Setar to Gurun. It was initiated by the first Chief Minister of Kedah, Wan Mat Saman Bin Wan Ismail in 1885. It had greatly benefitted the residents living around the canal as well as those living in the town of Alor Setar²¹ In addition to relying heavily on river for water sources, residents at the site had the advantage of taking water from this canal.¹ It was noted that the development of domestic water supply was in line with the development of the agricultural-based economic pattern of the state at that time. Both complement the development and were the representation that water is an important component in everyday life.

Water Supply Management in State of Kedah, 1909-1957

The arrival of British advisers in the state of Kedah which officially began in 1909 had certainly brought about changes in the water supply in Kedah. The British introduced the idea of water supply in the state of Kedah and for the management of water supply in the state entirely, the British was not alone in managing it. This is because the modernization of the water supply in Kedah was also assisted by the Sultan of Kedah, the state council, sanitary board, and eventually the people of Kedah itself. This indicated that all the community hierarchies in the state of Kedah played an important role in the management of water supply in the state including its capital, Alor Setar.

Figure 1: Water Supply Management in The State of Kedah, 1909-1957



Source: The figure above is adapted from the reference: CO 716/1, Noor Ain Mat Noor, Ahmad Kamal Ariffin Mohd Rus, “Kedah Pasca Perjanjian 1923: Kedudukan Orang Melayu Dalam Pentadbiran Kerajaan,” *Jurnal Sejarah*, No. 19, 2011 & Mohd Shariff Abu Samah, *Modenisasai Pentadbiran Negeri Kedah 1895-1957*, Kedah:Penerbit Universiti Utara Malaysia (UUM Press), 2012.

The figure above summarizes, the management of water supply in the state of Kedah from 1909 to 1957. Water management in the state of Kedah was under the authority of the Sultan of Kedah itself. This was because, all aspects of the administration and plans for water supply in the state of Kedah needed to get the consent of the Sultan of Kedah first. The Sultan of Kedah was assisted by a British adviser in the area of water supply management. The British was experienced in managing the water supply sector through its experience in developing water supply systems in Britain and other colonies.²³ This shows that the British had played an important role in the development of the water supply sector in Kedah. However, it appears that the British water supply sector developed by the British in Malaya did not fully resemble the model of water supply developed by the British in Britain. Undeniably, distinctive geographical factor affected the development of water supply in Kedah.

In the same position was the State Council who had the highest executive power headed by the Sultan of Kedah himself. The State Council established in 1905, was made up of Malay elites who assisted the Sultan in the administration of the state of Kedah. In fact, Kedah state assembly had chaired several key positions in government service, and this showed that these groups also had the power to make decisions in administrative matters including those related to Kedah water supply management. Even with the implementation of the 1923 Kedah-British treaty, the State Council was seen as more powerful

in making decisions than British advisors in Kedah.²⁴ However, in terms of water supply management, it could be seen that the Malay elites did not hold positions in the PWD in Kedah due to the lack of expertise and experience in water supply, unlike the British.

Next in this discussion is the state PWD of Kedah. Indeed, the PWD is a government department that is responsible for providing public infrastructure facilities such as roads, buildings, bridges, airports, water supply and ports. In 1916, the state water division of Kedah was established by D. M. Mc Diarmid, who was then the Kedah state engineer.²⁵ The PWD would ensure improvements and updates in water supply management to ensure smooth operation of the water supply without any problems and interruptions. However, the PWD Kedah seemed to be under State Council absolute control. This situation could be observed by the events of the State Engineer asking State Council to approve sick leave to F.C. D La Brooy, Public Works Department Assistant for 31 days and this matter was approved by State Council in its meeting on October 20, 1924. This situation showed that the PWD had no absolute authority even though the PWD was led by an engineer appointed by a British advisor in the state of Kedah.²⁶

The Sanitary Board also played a role in controlling the water supply sector implemented in the main state of Kedah. In addition, they also provide information to the state government on current water supply issues in the event of shortages, leaks, water shortages, diseases and others. This situation can be determined by the establishment of the Alor Setar Sanitary Board which aimed to provide current information on water supply to the state government. In fact, the sanitary board also acted as the governing body for the payment of water supply service charges by residents.²⁷ In the same position, district officials were also responsible for the management of the state's water supply. This situation could be related to the Kedah General Order, 1925 Chapter XVI, Section 210 which plays an important role in water supply.²⁸ The people of Kedah were in the last position as stated in Kedah's water supply management. The people's reaction to the water supply plan implemented by the PWD was important in order to test the effectiveness of the water supply plan implemented at that time. In fact, the villagers were effective agents of information delivery so that the information obtained can be used as a guide to strengthen the water supply system from time to time. In addition, residents are part of a measure of the success of the state government in developing the water supply in Kedah. This is because if the people of Alor Setar are healthy and free from waterborne diseases, this indicates that the water supply plan implemented will achieve its goals.

The Current Conditions of Water Supply in Alor Setar

The arrival of British advisors in Kedah revealed that the state of Kedah was

facing a severe and unsustainable water supply crisis. Based on the record of British advisers in 1906 indicates that the people of Alor Setar relied heavily on the source of water supply from wells and rivers near their houses. The water supply used by the residents was very dirty, smelly, muddy and contained many other pollutants. However, the villagers seemed to have no choice but to use the water supply mentioned.²⁹ This condition had affected the health of the population and their daily life. Some outbreaks of waterborne diseases such as Cholera and Dysentery spread among the population leading to high mortality rates.³⁰ Based on the listed outbreaks, the Cholera outbreak was reported as a major outbreak affecting the health of Alor Setar population. This situation was highlighted through several incidents of the outbreak of the disease from 1907 to 1914.³¹ In 1907 there were 330 cases of Cholera resulting in 247 deaths in Alor Setar and Kedah. This was due to prolonged drought from August to September until the rainy season provided rain at a specified location. From February to July 1911, 1211 Cholera cases were recorded resulting in 966 deaths. The state medical and health department of Kedah stated that in 1911, 1500 Cholera deaths were recorded in the state. Alor Setar was found to be the leading cause of Cholera outbreaks compared to other parts of Kedah. As of November 1913, 2196 cholera cases had been recorded and these resulted in 1502 deaths. The Medical and Health Kedah said the Cholera outbreak was based in Alor Setar and is the area was the main location for the spread of Cholera outbreaks throughout the state of Kedah. This clearly shows that Alor Setar was indeed an unhealthy city and the British vowed to solve this problem. From the stated period, the Cholera outbreak had claimed the lives of 5500 people. The number mentioned was so large that the outbreak contributes to 15% of the deaths in Kedah during the stated period.³²

Clearly, the Cholera outbreak was due to the use of unclean water for the purpose of eating and drinking among the residents. In fact, the lack of good health care awareness among the population had also contributed to the outbreak. The state surgeon had reported that the Cholera outbreak in Alor Setar originated from this location and not from the others. Dr. Stanton of the Kuala Lumpur medical institute conducted experiments on the water source of the Wan Mat Saman canal. Through the samples obtained, it was found that although the source of water supply was distilled, *Vibrio Cholera* bacteria was found to have rapidly increased. Through this situation he concluded that water sources in Alor Setar alone caused Cholera. He even hypothesized that the natural reservoir in Kedah had Cholera virus for a long time. To overcome and prevent the outbreak from spreading, the implementation of modern water supply systems was the best solution.³³

If the town of Alor Setar was still plagued by the outbreak of the disease, it would disrupt the health of the population and undermine the government's administration at that time. Even economic activities such as rice production in Alor Setar would also be disrupted. This was because the

population played an active role in the economic sector at that time. If their health was disrupted, the residents were unable to work, thus crippling the economic activities. The British image would also be tarnished should it fail to resolve the situation described by the implementation of the water supply plan in Alor Setar. The Kedah state administration would also face various problems as the government center was in Alor Setar city.

With good water supply, the state government could control the health of the people, the productivity of their jobs would increase, and the economy would flourish over time. Even the water supply resource that was developed was taken as a business. The resulting water supply will increase the state's income and lead to future development. The British was aware of the importance of good water supply in Alor Setar, and through their experience in managing the water supply sector in SS, FMS and in Britain, the British themselves did plan several water supplies schemes in Alor Setar that began in 1906.

The Plan and Implementation of Water Supply Plans in Alor Setar, Kedah, 1909-1957

Through the favorable source of water in Alor Setar, several locations became PWD choices in developing the state's water supply system and the role and function of Bukit Wang Water Plant and Bukit Pinang Water Plant.³⁴ Starting in 1913, the PWD saw Bukit Wang as a suitable water supply plant in the state of Kedah.³⁵ Bukit Wang or currently known as the Bukit Wang Forest Reserve is a popular recreation area located in Kubang Pasu and located 20 Kilometers (KM) from the Alor Setar town. Bukit Wang has a good water source that refers to the water supply obtained through Sungai Tosak Sungai Terjun and Sungai Bertam. Bukit Wang has two small water catchment areas and a source of water supply from the underground, at 0.5 KM distance. The supply was drawn directly from Sungai Terjun while first, Sungai Bertam was deviated into an impounding reservoir in the channel of the Sungai Tosak. In addition, to the intake weirs and the impounding reservoir, the headwork consists of two setting tanks with two detritus chambers in Sungai Terjun and Sungai Bertam.³⁶

The water passed through screen in the detritus chamber where the heavier matter in suspension is deposited. Then, it entered the setting tank where further classification took place before it finally reached the pipeline, it passed through small straining chambers at the outlet from each tank. The junction of the pipeline from the two setting tanks was about a quarter of a mile in the stream from which point a main pipe 12 inches a diameter, descended through a narrow and rocky gorge which was being supported throughout its length by concrete piers as protection from floods. After leaving the gorge, the pipeline continued through two miles of forest and the paddy fields as well as a rubber estate for another three miles before reaching the village in Jitra.

From Jitra it followed the road into Alor Setar for a length of twelve miles, supplying water along the route such as for the village of Kepala Batas. For water work, PWD hired 300-400 Indian coolies and played an important role in construction work.³⁷

Overall, the water catchment area in Bukit Wang has a total area of 2.6 square miles. The Bukit Wang Water Plant is one of the earliest water plants in Kedah. The rapid development in Alor Setar led to the need for clean water supply for living. The population of Alor Setar was estimated at 18,000 and it was divided into groups, such as residents living in small villages, agricultural communities, referring to paddy, fisheries and others. The construction of Bukit Wang Water Plant increased the access to domestic water supply by installing water pipes in northern Kedah with 6, 000 water pipes, in western Kedah with 10,000 water pipes, and 14,000 water pipes in southern Kedah. The total number of water pipes installed throughout the state of Kedah amounted to 48,000 - 50,000 water pipes.³⁸ The water supply is an untreated water supply and this situation is normal as the water supply also comes from untreated source of water from the nearby hills and springs in Arau and Kangar, Perlis.³⁹

By 1915, the Bukit Wang Water Plant was officially functioning and was responsible for distributing water supplies to nearby areas.⁴⁰ The total cost of building this water plant is \$ 670, 000.⁴¹ The main use of water supply is for domestic consumption and current economic-based activities undertaken by local residents. The current level of water consumption is calculated based on the number of individual uses of 0.0114 m³ - 0.019 m³ of water per day and 0.113 m³- 0.151 m³ of water was used by individuals living in villages and towns. Water pipes measuring 12 inches and 15 inches were installed to transport water to Alor Setar area, which is about 19 KM from Bukit Wang Water Plant. The installation of the water pipes enabled the distribution of 140.06 m³ of water per hour for water reserves of 9.14 meters depth. Whereas, water reservoirs with a depth of 6.1 meter, discharged 157.1 m³ of water per hour. However, in dry season, the amount of water supply supplied decreased to 37.9 m³ of up to 5.68 m³ per hour. The construction of the Bukit Wang Water Plant has given a steady shift of change and development to the water supply system in Kedah. The transition to a better life is made possible with the introduction of modern and efficient water supply system. This development had indeed made a big difference in the great landscape in the lives of the people at that time. Although not every resident enjoyed this change, it had led to a more systematic and good transition of life.⁴²

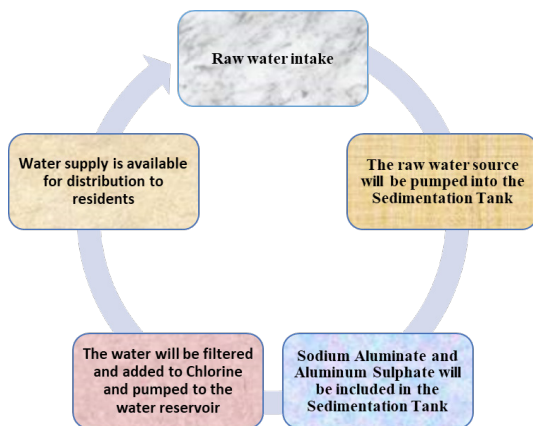
In fact, there were still weaknesses and shortages of domestic water supply systems at that point, which highlighted the construction of the Bukit Wang Water Plant. Referring to the file of the Kedah State Secretary (SUK), 1091-1355, Memorandum Dealing With The Water Supply To Alor Setar From Bukit Wang And Bukit Pinang, there was a warning from the Kedah State Secretary to PWD on the failure of Bukit Wang Water Supply Plant to

provide good water since it was built until 1915. There has been no increase in water supply since the water plant was built while much of its expenditures have been spent to further improve the quality and production of water supply. The three water catchment areas have failed to provide good water supply services to 30,000 users. This situation occurred due to poor management, low gravity pulls, low cost and low-quality equipment and equipment, water pump problems and other problems.⁴³

The construction of Bukit Pinang Water Plant in 1931 has given a new dimension to the access to domestic water supply lines in Kedah at that time until now. This is because the water plant is equipped with a variety of equipment, fixtures, work better, good compared to previous water plants and an important supply of treated water. The Bukit Pinang Water Plant is located at the Alor Setar area, which is only 17 KM from the city of Alor Setar and was officiated by His Excellency the High Commissioner in 4 November 1931. The Bukit Pinang Water Plant had water source obtained from Sungai Padang Terap, which branches off from Sungai Kedah. The plant has a large water catchment of 500 square meters. It consists of the usual pumping machinery which deliver the crude river water in a high-level reservoir.

Through this water supply plan, aspects of water supply technology have been given priority. Water supply technology has always been an important part of the water supply treatment process. Water supply technology is not only limited to the use of technology in the production of water supply alone, it also includes the method of distribution of water supply implemented in a state.⁴⁴ For water supply treatment processes, raw water sources must be treated before they can be used as they contain a variety of suspended solids and carriers of colorless diseases, odors and flavors.

Figure 2: Water Supply Treatment Process in Bukit Pinang Water Plant



Source: The figure above is modified from the reference: CO 716/1, Abdul Rahim Bin Yusoff, Mahfoz Bin Khalid, *Laporan Bekalan Air Alor Setar Peringkat III, JKR Kedah, 1967-1970.*

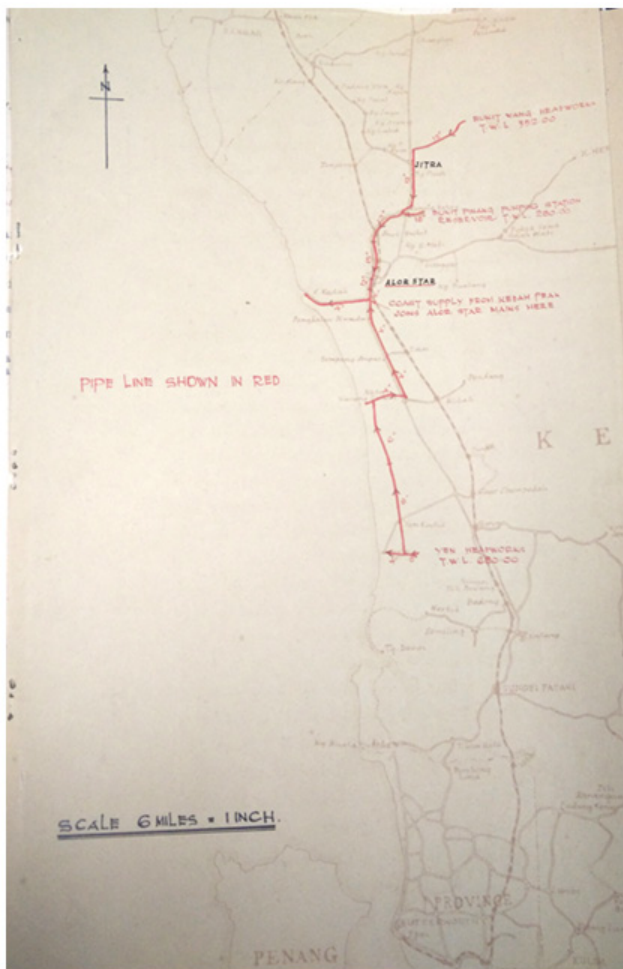
Figure 2 shows the process of water supply treatment at the Bukit Pinang Water Plant. The process of filtration of raw water sources at the Bukit Pinang Water Plant is based on established standards and begins with the extraction of raw water from the Sungai Padang Terap. The condition of the crude water source is slightly muddy, and smelly as it is pumped to the sedimentation tank. The process of removing the dirt is done by putting Sodium Aluminate and Aluminum Sulphate into the sediment tank. When the process is complete, the water will be filtered, and Chlorine will be added. It is later pumped to the pool before it is distributed and distributed for the people of Alor Setar. The supply of water is guaranteed in terms of quality and cleanliness.⁴⁵

In the early stages the Bukit Pinang Water Plant construction, the maximum production of water produced by this water plant is 2.0 million gallons a day. Report issued by J. S Boissier, Senior Water Supply Executive Engineer in Perak and Pahang in North Kedah Water Supplies 1936 stated that the Bukit Pinang Water Plant is capable of producing 166.6 m³ of water per hour and is capable of supplying water supply for domestic use with a distance of 82,296 meter from the area city. With this water reservoir and built-in water pipes in Alor Setar, water supply production increased up to 227.12 m³ per hour. Implications of the construction of the Bukit Wang Water Plant and Bukit Pinang Water Plant, whereby, Alor Setar district had a 6.1 meters water reservoir that could accommodate 3,785.4 m³ of water. With the use of electric machinery, it could produce 159 m³ of water per hour. This water reservoir utilized a full range of electrical machinery that helped increase the domestic water supply.⁴⁶ The total cost to build this water plant was \$ 480, 000 and it was undertaken by the PWD at the point.⁴⁷

At this point, domestic water supply charges were based on the usage per unit of \$ 0.10 cents. Total expenditure incurred by the PWD of \$ 30 per day. It was a management expense which comprised the cost of electricity, labor, equipment and other equipment. Implications for Bukit Wang Water and Water Plant Bukit Pinang in Kedah could be traced back to 1931: because of the projects, some locations in Kedah such as Anak Bukit, Pompong and Titi Gajah received full water supply. The population of Alor Setar including Jitra was 59,805 people who represented a high demand for clean water sources for the country. The use of domestic water supply that was recorded based on individual consumption is 0.113 m³ per person. Therefore, after being calculated, the water supply requirement is 6,710 m³ per individual per day. With the addition of maximum water consumption of 3,785 m³, the total water requirement is 10, 495 m³. Overall, based on this plan, several conclusions

were reached. For example, this plan is able to supply a satisfactory water supply for up to 15 years, and 18.29 to 21.34 meter size of dam is required to meet the demand for water supplies and other needs.⁴⁸

Figure 3: The Map of Water Supply in Alor Setar in 1936



Source: S. E. 1091-1355, Memorandum Dealing with The Water Supply To Alor Setar From Bukit Wang And Bukit Pinang.

Referring to the S. C. 3578-1356, Improvement to Water Supply, Alor Setar, Proposal For 1357 file, there is full information pertaining to the planning and implementation of the Alor Setar Water Supply Plan in 1938. This water supply plan saw the largest and longest water supply project in Kedah

before the independence of the Federation of Malaya.⁴⁹ The construction of domestic water supply at this location was inclusive of the entire Alor Setar area covering 64.37 KM north of Alor Setar and 16.1 KM west of the city and it spanned to the Jitra district.⁵⁰ The Alor Setar Water Supply Project was implemented as planned by the PWD Division of Water, since at that time that some locations in Alor Setar lacked access to modern water supply.⁵¹ The Alor Setar district currently has a population of 59,085 residents who require clean water sources for domestic use. With that figure, the amount of water needed to be channeled is amounted to 17,844.4 m³ of water a day, which is perceived to be enough to meet the water supply needs of residents in the location. Thus, the water supply project is planned for use of to 15 years and above. The project is expected to reduce water scarcity issues at target locations and the PWD is believed to have done its best in shouldering its responsibility by providing water supply projects to residents at the site. The Alor Setar Water Supply Project would channel water supply in several major areas of the Alor Setar region to the coastal area of the district.

Table 1: Project Planning List in Bukit Pinang Water Plant

Detail of the Implementation of the Water Supply Project	Total expenditure
1) The 12-inch water pipe will be replaced by a 15 inches water pipe	\$ 48,000
2) The new water pipe is 12 inches wide	\$ 22,500
3) Water pipe	\$ 5,000
4) Water supply reservoir	\$ 45,000
5) The cost of chemicals used for water filtration	\$ 5,000
6) Filtration and water tank in Jitra	\$ 7,000
7) Expected cost	\$ 13,600
8) Cooling Tool	\$ 6,000
Total	\$ 156, 000

Source: This table has been modified from S. E. 3578-1356, Improvement To Water Supply file, Alor Setar Proposals For 1357.

The project was carried out in 1938 until 1941. During the implementation of this water supply project, several reports were issued by state engineers on the progress of the implementation of the supply project. For example, S. E. 35-741 / 50, Improvements to Water Supply, North Kedah, Item 58.34.10 clearly stated the progress of the implementation of this project in detail and included the expenditure incurred for this purpose. Overall, the planned implementation was successfully implemented, and the project ended officially in 1941.⁵²

Table 2: List of Implementation of Alor Setar Water Supply Project In 1938

Detail of the Implementation of the Water Supply Project	Total expenditure
1) Water filtration equipment at Yan Water Plant	\$ 4, 685.03
2) Water-washing equipment, 18-inch water meter at Bukit Pinang Water Plant	\$ 5, 841.36
3) Cost of repairing water supply at Yan Water Plant	\$ 8, 988.15
4) Lime & Alum Stor, Bukit Pinang Water Plant	\$ 2, 929.08
5) Free water meter cost in Northern Kedah	\$ 7, 227.01
6) The exchange rate for Syphon in Jemalang	\$ 2, 521.59
7) New water supply plan in Tokai	\$ 12, 108.52
8) Cost of water supply experiment	\$ 2, 499.12
9) Costs of surveys and inquiries	\$ 2, 524.19
10) Variable and contingent cost	\$ 2, 885.57
Total	\$ 52 209.62

Table 3: List of Implementation of Alor Setar Water Supply Project In 1939

Detail of the Implementation of the Water Supply Project	Total expenditure
1) 15 inches of water pipe	\$ 56, 050.69
2) 12 inches wide of water pipe	\$ 21, 127.53
3) Wipe the water	\$ 6, 000
4) River crossing costs	\$ 4, 000
5) Water filtration costs and tanks in Jitra	\$ 7, 000
Total	\$ 94, 178.22

Table 4: List of Implementation of Alor Setar Water Supply Project In 1940

Detail of the Implementation of the Water Supply Project	Total expenditure
1) Water supply reservoir of 600, 000 gallons of water at Bukit Pinang Water Plant	\$ 45, 000
2) The cost of chemicals	\$ 6, 000
3) 6-inch water pipe in Kuala Kedah	\$ 40, 000
4) Variable and contingent cost	\$ 8, 333.61
Total	\$ 99, 333.61

Table 5: List of Implementation of Alor Setar Water Supply Project In 1941

Detail of the Implementation of the Water Supply Project	Total expenditure
1) The cost of water pipeline protection at Yan	\$ 30, 000
2) The cost of galvanized pipe conversion in Alor Setar	\$ 10, 000
3) Variable and contingent cost	\$ 6, 000
Total	\$ 46, 000

Table 6: List of Implementation of Alor Setar Water Supply Project In 1942

Detail of the Implementation of the Water Supply Project	Total expenditure
1) Cost of replacement of 12-inch water pipe at Bukit Wang Water Plant	\$ 5, 000
2) The cost of installing a 12-inch water pipe from Alor Setar to Kuala Kedah junction	\$ 6, 000
3) Cost of water supply dam investigation at Bukit Wang Water Plant	\$ 3, 278.55
Total	\$ 11, 278.55

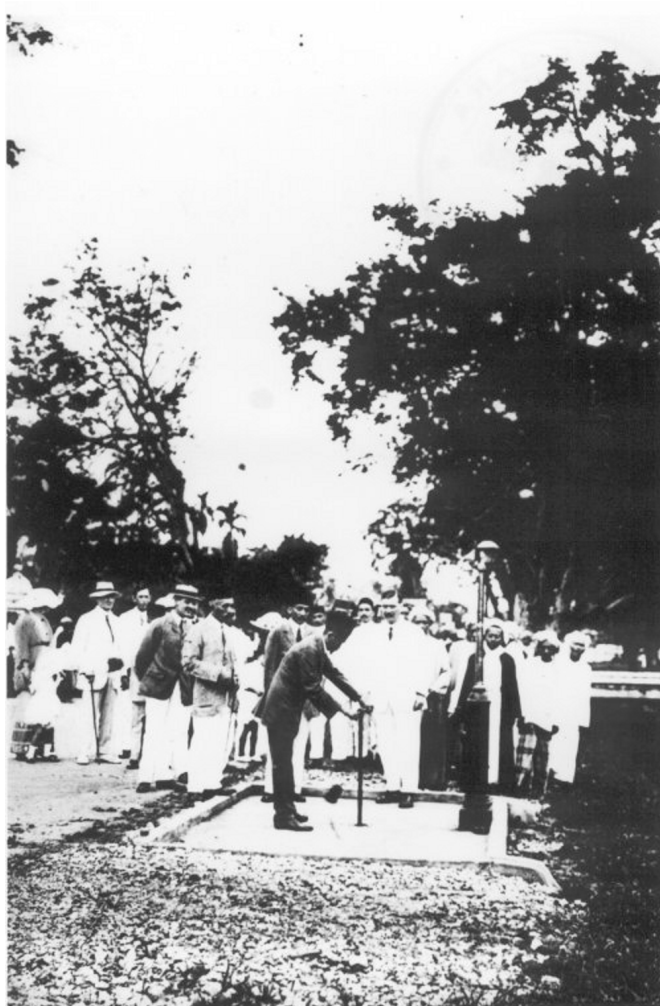
Source: This table has been modified S. E. 35-741 / 50, Improvements to Water Supply, North Kedah, Item 58.34.10.

Although this planned project only focused on empowering the Bukit Wang Water Plant, the prospect of this project encompassed the need for quality water supply claims throughout the Alor Setar district. This was because, the area near Alor Setar benefitted from it as it has undergone a phase of change in water supplies, involving areas namely Yan and Kuala Kedah. For example, by referring to the schedule given, there was a water supply route from Alor Setar to Yan and Kuala Kedah. This practice had assisted the authorities in introducing a better water procurement system to the residents and reducing the issue of water shortages faced before. Apart from Yan and Kuala Kedah, there was a water supply project in Tokai, which was the first water supply project in the area. The water supply plan which cost \$ 12,108.52 was fully completed in 1939: it indicated that rural locations also received fluctuations in the context of water supply for domestic consumption. Although not all rural people received modern water supply, they were able to change their lifestyle and reduce their dependence on natural water sources.⁵³

The Alor Setar Water Supply Project cost \$ 306,000 and the total expenditure included gradual empowerment at the Bukit Pinang Water Plant and Bukit Wang Water Plant. This was because both water treatment plants played an important role in distributing water supply to Alor Setar and the districts near the Alor Setar area. Activities such as the 15 inches water pipe installation at the Bukit Pinang Water Plant once completed, was able to distribute large quantities of water to residents and this proved that this water supply project made a difference in water supply in Alor Setar afterwards. The role of the Bukit Wang Water Plant was also upgraded through the installation of 12 inches water pipes at the site to increase the amount of water supply in the surrounding area.⁵⁴ Overall, Alor Setar Water Supply project was a huge supply project implemented in Kedah at that time. This project has shown that authorities have a great focus on water supply requirements and demands on quality water needs in life. The central government's position in Alor Setar has

influenced the development of the water supply system in Kedah as the process of water supply system development began at this location and is expanding on other areas of the state. It is evident that the development of water supply in Alor Setar has been used as a module when the authorities develop water supply systems in other areas. Suffice to say that, by establishing access to water supply networks of areas outside Alor Setar, the Water Supply projects were all fulfilled as they were previously discussed.

Figure 4: The Opening of Bukit Pinang Water Plant in 1936



Source: National Archives of Malaysia

When the Japanese occupied Malaya, Kedah, including Perlis, Kelantan and Terengganu, were restored to the Siamese government through agreements concluded by Japan and Siam on December 21, 1941.⁵⁵ The Japanese occupation had greatly changed the landscape of the Kedah government. Changes brought by the Japanese had disrupted the development in the state including the development of modern domestic water supply. Among the main problems were lack of allocation, insufficient materials to treat water such as chemicals, lack of equipment for water treatment, labor shortages, many rusty water pipes and other predicaments had caused the PWD to cease operation of water pumping at the location. Those issues were confirmed by Chong Boon Yok who was a PWD engineer in Alor Setar, Kedah.⁵⁶ The Japanese occupation in Kedah did not bring any positive change to the landscape of the water supply system in the state. This was because Japan focused on governance and administration aspects in Malaya, including in Kedah. From 1942 until 1945, it was a short period for Japan to carry out any development projects in the colony. Hence, the previous studies on Japan in Malaya have no direct information on Japanese actions to develop domestic water supply systems. Mohamad Isa Othman, through his study titled Japanese Occupation in Malaya 1942-1945 (Focus on The State of Kedah), also did not focus on the atmosphere and development by Japan to develop the water supply system in Kedah. Nevertheless, Japanese occupation had caused many planned water supply projects implemented in Kedah to be disrupted and damaged as discussed earlier.⁵⁷

After the end of the Japanese occupation of Malaya in 1945, the British reinstated the administration until the independence of the Federation of Malaya, on August 31, 1957. During this period, Federation of Malaya including the state of Kedah, had undergone phases of change towards self-government. Overall, the development conducted in Malaya including the one involving water supply was sluggish. PWD reported “Malaya had a water supply system and a standard of technical service second to none in the colonial Empire: it was regrettable if this should fail to meet the needs of tomorrow owing to pre-war financial methods”.⁵⁸ The British concentration on the colony was also interrupted by their involvement in World War I and World War II. The British encountered losses due to their involvement in the world war and the lack of income following the unstable world economic conditions which also directly affected the empire’s dominance over the colonies. However, there are still some projects which were related to water supply in Kedah at this time. The Kedah government chose to extend the installation of water pipes to Kankong which was located in the city of Alor Setar. Previously, this location was dependent on the water supply channeled from Kota Sala. Due to low water pressure problem, the distribution of water supply at this location to cease. The 6 inches water pipes then were replaced with an 8 inches water pipe and this provided high water pressure on the water supply at the site.⁵⁹

From 1950 to 1957, several of British planned water supply schemes failed and could not be implemented. This situation indicated that the British could not maintain the momentum of the successful implementation of the previous water supply plan in the state of Kedah and it was found that the British was facing financial difficulties to execute any water supply plan within the stated period. This situation could be linked with the Jerlun Water Supply Plan planned in 1952. Mr. Owen of the PWD produced this water supply plan paperwork to meet the needs of residents involved in the rice cultivation activities in Jerlun. This was because the residents of Jerlun depended on the water supply from the canals irrigating the rice fields. The Kedah government was worried that residents involved in paddy cultivation would suffer from health problems due to poor water supply. If the health of the population was affected, it was highly likely that the productivity of the population would also be disrupted. Consequently, the whole of Kedah would itself be affected. The water supply plan would utilize the raw water supply source from the canal in Jerlun and be processed to meet the water supply demand until 1975. Even with this water supply plan, the project would also extend the supply of water from the Bukit Wang Water Plant to the main road to Kangar via Jitra and Tunjang. This water supply plan had cost \$ 1, 727, 000.⁶⁰ Due to British financial difficulties the water supply plan could not be implemented at that time.⁶¹

In 1955, the British devised the Sungai Muda Water Supply Plan to meet the demand for water in Alor Setar and southern Kedah. This water supply plan was developed by the Kedah State Engineer, Mr. C. Gjertsen. Through this plan, several locations such as Jeniang and Kampung Kalar were ideally located as a source of raw water from Sungai Muda. The water supply plan was believed to meet the water supply demand in Alor Setar and the surrounding area by producing 12, 000, 000 million gallons of water until 1981. In addition, the water supply plan was also designed to prevent the spread of the Dysentery outbreak which resulted in two deaths in 1955.⁶² However, this water supply plan was considered impossible due to the high expenditure of \$ 37, 400, 000.⁶³

Prior to independence, the British saw some changes on the issue of water supply administration in Kedah. The British was no longer able to implement any water supply projects as they were more focused on the administrative transition process to the state government at that time. Nevertheless, it was obvious that the British was responsible for the issue of water supply development in Kedah through their role in the administration of water supply. The British was aware that all water supply projects undertaken by them were their sole responsibility and the change in the lives of the population was thus related to the effectiveness of supply projects implemented throughout Kedah. At this point, the British's focus was only on the administration of water supply which began in 1955 until 1956 following the occurrence of transfers and uncertainties in water supply affairs in Kedah.

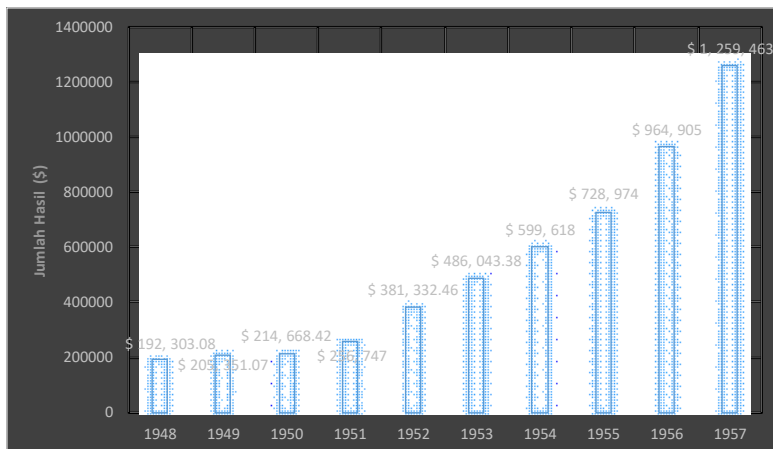
In 1955, the British provided current reports on water supply in the state and proposed repair of the water supply system even though they were not capable of implementing it.⁶⁴ In 1956, this situation was linked to the proposed amendment of the regulation under item 40 (1), Law No. 130⁶⁵

The proposed amendment was produced by W. W Davison to the SUK which specifically asked for a special arrangement on the installation charge and the closure charges account of the water supply in the state of Kedah. It was inclusive of the supply accounts, installation charges and water meter deductions, as well as charging water supply charges due to non-payment of monthly charge water. Residents in Kedah had to pay \$ 8.00 charges with water supply work comprising all the above- mentioned implementation processes. This amendment aimed to ensure clear uniformity and understanding of water supply installation charges and if approved, it could be applied by all parties involved in the water supply development process of Kedah. The SUK has provided the Sanitary Board an opportunity to discuss the amendment in more detail and depth. Finally, the discussion has agreed that only \$ 1.50 will be charged to the residents covering all aspects related to installation and deduction of water supply accounts in the state. Overall, the rate is seen to be quite high relative to the ability of the residents to pay the amount to enable their homes to acquire modern water supplies.⁶⁶

The Impact of Domestic Water Supply in Alor Setar, 1909-1957

The implementation of the water supply plan in Alor Setar had led to various effects such as water revenue recovery and reduction of contaminated water borne diseases such as Cholera and Dysentery. The benefits gained from the water supply plan was indicative of that the state government success in bringing about changes in people's life in Alor Setar within the stated period. In fact, the idea of modernizing the water supply by the British was deemed as introducing a better life through the use of clean water in the people's daily life. Referring to the state revenue obtained through the water supply plan, the water revenue record was kept since 1948 by the Kedah State Financial Statements. However, based on the financial statements, the water revenue was included with electricity bills collection and this study could not identify the actual amount of water yields from 1948 to 1957. In fact, Alor Setar's water supply has become a major contributor to the water supply throughout the state of Kedah. Water and electricity service revenue is listed in the table below:

Figure 5: The Water and Electricity Results in Kedah, 1948-1957



Sources: : Penyata Kewangan Negeri Kedah, 1948-1957

According to Fig. 4, the water and electricity revenue in Kedah had steadily increased from 1948 to 1957. The Water and electricity revenue began at \$ 192, 303.08 in 1948.⁶⁷ Until 1957, the water and electricity revenue totalled \$ 1, 259, 463.00 and increased by \$ 1, 067, 159.92 from 1948 to 1957.⁶⁸ The profits from water and electricity revenue helped the state government increased the state revenue. In fact, the continuous improvement over the period indicated that the well-prepared water supply plan by the PWD had reached its goal and was accepted by the people of Kedah. Although the revenue generated was not as great as the other economic sectors and the land tax in Kedah, it had changed the state of Kedah and made the lives of the people more comfortable.

Implementation of water supply schemes in Kedah especially in Alor Setar reduced the outbreak of Cholera and Dysentery outbreaks until 1957. This incident showed that water supply schemes could prevent the Cholera outbreak from further affecting the health of the population.⁶⁹ But after the end of the Japanese Occupation in Kedah, there were reports of an outbreak of Dysentery as the people of Kedah returned to using water from natural sources. In 1946, 164 cases of dysentery were reported in Kedah.⁷⁰ However, in 1955, only 2 deaths were reported as a result of the dysentery outbreak.⁷¹ The death toll was lower because the water plant located in Alor Setar was again functioning well to distribute water supplies throughout Kedah. The situation appealed to the state government due to its current focus on water supply management and the understanding that such outbreak incurred high medical costs to treat the people of Alor Setar who contracted the disease.

Conclusion

Domestic water supply is an important aspect of a human life. Hence, the issue of water supply for domestic use is a universal issue and the relevant authorities need to cope with the culture of life anywhere in the world. The human actions and ideas in their efforts to solve the problem of procurement of clean water supply are based on the ecosystem characteristics found in their lives. Water supply has provided a more pleasant life and contributes to a better life from time to time. An early settlement would have begun with an area close to the water sources, which referred to existing rivers that catalyzed the existence of human settlements. The early settlements of Alor Setar originated from the wide-ranging rivers as shown in Kedah's current map. Dwellers did not only depend on the natural rivers: the inhabitants within these locations had become more creative in the locating clean water supply for domestic consumption.

The construction of canals, artificial rivers, wells and others showed that the ideas expected in their lives were in line with living progress of the people in the state of Kedah at that time. At the government's mandate and direction, the smooth acquisition of water supply for domestic use can be maintained even if it is closely related to the development of paddy crop in the location. The arrival of British advisors in Kedah brought along a better and more modern water supply system to all. The introduction to a more efficient water supply is further strengthened by the construction of Bukit Wang Water Plant and Bukit Pinang Water Plant, which provides a new dimension to the domestic water supply system in Alor Setar to date. From time to time, there were many domestic water supply development projects planned and developed for the convenience of all parties in the state until the independence of the Federation. Indeed, efforts to develop the water supply system in Alor Setar from 1735 until 1957 were great success. This was because through numerous efforts made, the pattern of population dependence on water resources changed from time to time. Residents received substantial benefits as efforts to develop the water supply system at the site had a lasting positive impact and were a catalyst for water supply projects in Alor Setar and throughout Kedah.

Endnotes

1. Today, water is supplied for domestic, public, and economic uses in the industrial, economic, trade and other sectors. Please refer to: Nik Fuaad Nik Abllah, 1990. *Bekalan Air, Pembentukan dan Pengairan*, Pulau Pinang: Penerbit Universiti Sains Malaysia (USM), 1.
2. P.S.U (KEDAH) 383-1376, *Petition Regarding Rates Charged On Water Consumed For Dosomectic Purposer, 1956*.
3. There is some research on water supply that can be referenced through the list given in the description above. Please refer: Mohd Firdaus

- Abdullah and Arba'iyah Mohd Noor, 2018. "Kerjasama Kedah dan Perlis Dalam Pembangunan Sistem Bekalan Air Domestik Di Negeri Perlis, 1969-1978", *Jebat: Malaysian Journal of History, Politics, & Strategic Studies*, Vol. 45 (1), 56-78: Moo Hooi Ping and Joseph Fernando, 2018. "The Role Of The Public Works Department In The Development And Administration Of Waterwork In Kuala Lumpur, 1900-1941", *Jurnal Sejarah*, Vol. 27 (1), 26-42: Ruhana Padzil, 2007. "Analisis Isu Air Singapura-Johor: Permintaan dan Bekalan", *JATI*, Vol. 12, 55-69: A. Rahman Tang Abdullah, 2013. "Revisiting The Water Issue Across The Causeway: The Origins Of Water Supply From To Singapore (1904-32)", *Jebat: Malaysian Journal of History, Politics & Strategic Studies*, 40 (1), 1-20: A. Rahman Tang Abdullah, 2014. "The Water Agreement of 1927 and Singapore's Supremacy: The Origins And Implication For Water Supply Between Johor and Singapore", *Jurnal Kinabalu*, Vol. 20, 177-202: Ahmad Kamal Ariffin Mohd Rus and Mohamad Badrul Adzham Baharudin, 2013. "Sumber Air dan Pengaruhnya Terhadap Kehidupan Masyarakat Melayu di Selangor Sebelum Campurtangan British", *Prosiding Persidangan Intelektual Kebangsaan Malaysia 2013*.
4. Leonard Y. Andaya, 2018. "Water in the Study of Southeast Asia", *Kemanusiaan*, Vol. 25 (1), 21-38.
 5. There is some research on water supply that can be referenced through the list given in the description above. Please refer: Stern, W. M., 1954. "Water Supply in Britain: The Development of a Public Service", *Journal of The Royal Sanitary Institute*, 74(10), 998-1004: Geels, F., 2005. "Co-evolution of Technology and Society: The Transition in Water Supply and Personal Hygiene in The Netherlands (1850-1930)—a Case Study in Multi-Level Perspective", *Technology in Society*, 27(3), 363-397: Mays, L. (Editor), 2010. *Ancient Water Technologies*, Germany: Springer Science & Business Media, 1-280.
 6. British interests in Penang made the country the first state to introduce the modern water supply system in 1804. The British used a labor force comprised of prisoners to build the Aquaduct in the state. The process of transporting water from the mountains to the urban areas is done because the area is said to have good water supply and suitable for the people to use. Water fountains have been built along main roads in Penang's city to make it easier for residents to get water to use in their lives. This Aquaduct water supply system was replaced with cast iron man system in 1877 and its use was recorded only in Penang. The current supply of water is entirely from untreated sources of water. Sarawak was the second state in Malaysia introduced by the British modern water supply system in 1889. The water supply processing plant for domestic use was located in the city of Kuching and was in

- the process of supplying water to 8,000 households in Sarawak at that time. Please refer: *A Glimpse At Water Supply In Malaysia (Past & Present)*, JKR Malaysia.
7. Underwood, E. A., 1948. "The History of Cholera in Great Britain", *Proceedings of the Royal Society of Medicine*, 41(3), 165–173.
 8. Hill R. D., 2012. *Rice in Malaya, A Study in Malaysia, A Study In Historical*, Singapore: NUS Press Singapore, 55-70.
 9. Research on the development of water supply in Kedah by the mentioned researchers can be referred to: Mohd Firdaus Abdullah and Arba'iyah Mohd Noor, 2019. "Pelaksanaan Rancangan Bekalan Air Luar Bandar di Negeri Kedah, 1909-1957", *International Journal of the Malay, World and Civilisation*, 7(1), 55–67: Mohd Firdaus Abdullah and Arba'iyah Mohd Noor, 2017. "Sejarah Perkembangan Bekalan Air Domestik di Negeri Kedah Sehingga Tahun 1957", *Jurnal Sejarah*, 26 (2), 24-37: Mohd Firdaus Abdullah and Arba'iyah Mohd Noor, 2018. "Situasi dan Isu Pembangunan Bekalan Air Domestik di Daerah Alor Setar, Kedah, 1957-1970", *Jurnal Peradaban*, 11, 253-273. Mohd Firdaus Abdullah and Arba'iyah Mohd Noor, 2019. "Isu dan Masalah Bekalan Air Domestik Pada PRU14 (The Issue and Problems of Domestic Water Supply on GE2018)", *Asian Journal of Environment, History and Heritage (AJEHH)*, Vol. 3 (1), 47-62.
 10. Alor Setar and its surrounding area have been known for agriculture since before the British arrival. Please refer: De Koninck, R., 1988. "Alor Setar, The Capital of Kedah: A City to Govern Agriculture", *Archipel*, 36(1), 147-164.
 11. Buyong Adil, 1980. *Sejarah Kedah*, Kuala Lumpur: Dewan Bahasa Dan Pustaka, 15.
 12. The state of Kedah has 370 rivers that have been providing water to the state for a long time. Sungai Kedah and Sungai Padang Terap for example, play a role in supplying the raw water and processing it before it is distributed to the people. Please refer, *Sungai-Sungai di Negeri Kedah*, Pengarah Jabatan Pengairan Dan Saliran, Negeri Kedah Darul Aman.
 13. Ramli Ismail, 1996. "Terusan Tertua di Semenanjung", *Jurnal Warisan Indera Kayangan*, Vol. 8, 1-15.
 14. Muhammad Hassan Bin Dato' Kerani Mohd. Arshad, 1968. *Al-Tarikh Salasilah Negeri Kedah Darul Aman*, Kuala Lumpur: Dewan Bahasa dan Pustaka, 14-15.
 15. Ibid., 40-42.
 16. Penyata Perjalanan Dewan Negeri Kedah, Mesyuarat Yang Ketiga, Penggal Yang Kedua, 10-11 Disember 1960, 94.
 17. Buyong Adil, *Sejarah Kedah*, 16.
 18. The canals mentioned earlier were built before the Wan Mat Saman

- canal. Please refer: Buyong Adil, Sejarah Kedah, hlm. 16.
19. Wolters, O. W, 1999. *History, Culture, and Region in Southeast Asian Perspectives*, Ithaca, N.Y.: Southeast Asia Program Publications, Southeast Asia Program, Cornell University, 51.
 20. The first Sungai Korok is connecting the head water of the three-small stream between the Kedah/Perlis river, Kubang Rotan, Jerlun, Sanglang and Anak Bukit. The distance is three miles from Alor Setar tributary the Perlis River. Second Sungai Korok is connection from Kubang Rotan and Jerlun. Refer: CO 716, The Annual Report of The Advisor To The Kedah Government For The Year 1327 A. H (23 January 1909-12 January 1910), 23.
 21. CO 716, The Annual Report of The Advisor To The Kedah Government For The Year 1327 A. H (23 January 1909-12 January 1910), 23: Sharom Ahmat, 1954. "Kedah - Tradition and Change in Malay State: A Study Of The Economic and Political Development: 1778-1923", *Jurnal Of Malayan Branch Royal Asiatic Society (JMBRAS)*, 3-12.
 22. Johan Afendi Ibrahim, Norhanim Abdul Razak and Mohamad Zaki Ahmad, 2017. "Terusan Wan Muhammad Saman (1895-2015): Tinggalan Sejarah dan Potensinya Sebagai Sebuah Produk Pelancongan", *PERSPEKTIF: Jurnal Sains Sosial dan Kemanusiaan*, 9 (1), 1-15.
 23. The British have extensive experience in water supply in colonies such as India. Refer: Stone, I., 2002. *Canal Irrigation in British India: Perspectives on Technological Change in a Peasant Economy (Vol. 29)*, Cambridge University Press, 38-65.
 24. Mohd Shariff Abu Samah, 2012. *Modenisasi Pentadbiran Negeri Kedah 1895-1957*, Kedah: Penerbit Universiti Utara Malaysia (UUM Press), 1-172.
 25. Jabatan Kerja Air Kedah Utara dan Sejarah PKNK, Arkib Negara Malaysia Cawangan Kedah/Perlis, 1992.
 26. Noor Ain Mat Noor and Ahmad Kamal Ariffin Mohd Rus, 2011. "Kedah Pasca Perjanjian 1923: Kedudukan Orang Melayu Dalam Pentadbiran Kerajaan", *Jurnal Sejarah*, Vol. 19, 153-176.
 27. In Kedah, the Sanitary Board was built in 1911 for the purpose of managing and controlling the *Cholera* outbreak in Kedah. Starting in Alor Setar, the Sanitary Board also controls and detects outbreaks that have been reported up to Kulim, Krian, Kuala Muda and Kepala Batas. In Alor Setar, the Sanitary Board acted to control the villages reported to have been infected by the *Cholera* outbreak through the precautionary measures discussed earlier. Please refer to: CO 716/1, The Annual Report of The Adviser to The Kedah Government for The Year 1328 A.H., hlm. 15.
 28. Kedah General Order, 1925 Chapter XVI, Section 210, 241-243.

29. CO 716/1, Administration Report of The State of Kedah, September 1906 to Februari 1908, 21.
30. Cholera is a disease caused by the use of unclean water contaminated with human impurities, animal impurities, food waste and more. These outbreaks will infect humans if they do not have an effective water purification system. Please refer: Noryati Ismail, 2002. *Keracunan Makanan*, Kuala Lumpur: Utusan Publications & Distributors, 14-15. Dysentery is a disease caused by a bacterial infection of the gut that causes an individual to bleed or mucus. Dysentery will spread through hygiene practices and be infected by contaminated foods. Refer: Aiza Maslan @ Baharudin, 2011. "Sistem Kuarantin dan Pelaksanaan di Tanah Melayu Pada Sekitar Abad Ke-19", *Jurnal Sejarah*, Vol. 19, 79-103.
31. In 1910, action was taken by the state government to prevent the spread of Cholera in Alor Setar. The PWD has built a water tank to store rainwater for residents to use. Although the cost of construction of this tank is expensive, the PWD has no choice. By the end of the year, the PWD had bought a "tongkang" from Penang and had sold it in Alor Setar. This action reduced the outbreak of the Cholera outbreak at that time. Refer to: CO 716/1, Annual Report on The State of Kedah For the Year 1329 A. H, 15. In 1913, the state government banned the people of Kedah from drinking water from the river. The state government has provided clean water through government tanks and disinfected wells. The medical department has even asked residents to boil water before drinking it. Refer: 716/1, Annual Report on The State of Kedah For the year 1329 A. H, 10.
32. Ibid.
33. CO 716/1, Annual Report on The State of Kedah For the Year A. H 1332 (30th November 1913-18th November 1914), 11-12.
34. Ibid.
35. Public Works Department, 1934.
36. The Bukit Wang Supply Supply is designed by State Engineers and has been carried out under his direction with the help of Messrs. Butterfield and Jen Kins, assistant engineers. Please refer: CO 716/1, Annual Report On The State Of Kedah For The Year A. H 1332, 19
37. CO 716/1, Annual Report on The State of Kedah For the Year A. H 1332, 19.
38. The Indian coolies was involved in water work face serious health problems. For example, in January 1914, most coolies who diagnosed with Malaria and were sent to Alor Setar Hospital for treatment. In addition, coolies also cause certain problems such as toody's addiction. In 1914, 21 cases were recorded related to toody addiction. When the headwork was completed in April, the main coolies force

- was disbanded. Refer: CO 716/1, Annual Report On The State Of Kedah For The Year A. H 1332, 12.
39. Report by Messrs. Steen Sehested & Partners, Vattenbyggnadsbran (VBB), The State Government Of Kedah Federation Of Malaya, Report On The Development Of The Alor Star Water Supply, September 1962.
 40. Mohd Firdaus Abdullah and Arba'iyah Mohd Noor, 2018. "Kerjasama Kedah dan Perlis Dalam Pembangunan Sistem Bekalan Air Domestik Di Negeri Perlis, 1969-1978", 56-78.
 41. S. E. 1091-1355, *Memorandum Dealing with The Water Supply to Alor Setar From Bukit Wang And Bukit Pinang*.
 42. CO 716/1 The Annual Report of The Adviser to The Kedah Government for The Year 1334 A.H (9th November 1915-27th October 1916).
 43. Public Works Department, 1934.
 44. S. C. 1091-1355, *Memorandum Dealing with The Water Supply to Alor Setar From Bukit Wang*
 45. Nik Fuaad Nik Abllah, 1990. Bekalan Air, Pembentungan Dan Pengairan, 1-50.
 46. CO 716/1: Abdul Rahim Yusoff, Mahfoz Bin Khalid, Laporan Bekalan Air Alor Setar Peringkat III, JKR Kedah, 1967-1970.
 47. Report by Mr. J. S. Boissier B. Sc. M.I.W.E, AG. S. E. E, Waterworks Perak And Pahang On North Kedah Water Supplies 1355.
 48. The Annual Report of The Adviser to The Kedah Government for The Year 1932.
 49. Report by Mr. J. S. Boissier B. Sc. M.I.W.E, AG. S. E. E, Waterworks Perak And Pahang On North Kedah Water Supplies 1355.
 50. S. C. 3578-1356, *Improvement to Water Supply, Alor Setar, Proposal For 1357*.
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 61. Water revenue in Kedah in 1951 amounted to \$ 256, 747.00. Whereas in 1952 there were increases of \$ 124, 585. 46 to \$ 381, 332.46. However, Kedah state water revenue is not considered profitable and cannot be used for Jerlun Water Supply Plan. Refer: *Penyata Kewangan Negeri Kedah Pada Tahun 1951*. Also refer: *Penyata Kewangan Negeri Kedah Pada Tahun 1952*.
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 71. Residents infected with the Cholera outbreak and Dysentery will be treated at a nearby Hospital. For example, residents of Alor Setar will be treated at Alor Setar Hospital. The villagers will be vaccinated and quarantined until they recover. this step is implemented so that the outbreak does not spread to other residents. Even water sources used by residents like wells will be cleaned and chlorinated. Residents will also be given proper health briefings so that they can maintain good health and maintain good hygiene. Refer: R. C. Ps. 64-1946, *Monthly Medical Report (Kedah & Perlis) For the Year 1946*.

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