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HISTORY OF WATER RESOURCES DEVELOPMENT AND WATER RESOURCES MANAGEMENT IN THAILAND

Khemika Varitwuttikul

*Social Development Faculty of Social Sciences Department of Sociology and Anthropology,
Naresuan University, Thailand*

cheartam@hotmail.com

Supasit Tana

*Social Development Faculty of Social Sciences Department of Sociology and Anthropology,
Naresuan University, Thailand*

Supattra Wannasubchae

*Social Development Faculty of Social Sciences Department of Sociology and Anthropology,
Naresuan University, Thailand*

Rudklaw Pampasit

*Social Development Faculty of Social Sciences Department of Sociology and Anthropology,
Naresuan University, Thailand*

Abstract

This article is the study on "the evolutionary development of water resources in Thailand." It drew mainly on document research and data analysis using content-based analysis and data interpretation gathered from research document, along with descriptive analysis. The findings of this study revealed that the evolutionary development of water resources and water resources management in Thailand can be divided into five periods of time: 1) Pre-historical Period, 2) Dvarawati Influence Period, 3) Khmer Influence Period, 4) Thon Buri Period, and 5)

Rattanakosin Period until now. Based on this research study, the researchers suggest that this article can be used to compare the social geography of the basin that influences water resources management policies in Thailand through the description with the related theory in order to clearly understand the context of the community and be able to access and develop water resources management according to geosocial base sustainably.

Keywords

Water Resources Development, Water Resources Management, Evolutionary Development Thailand

1. Introduction

With regard to the water resources development of Thai society from the past to the present, there has been many forms of the development. At first, we learned about how to control the water for agriculture by ourselves, including the different methods for water resources management according the various contexts. Then, modern science and technologies have been used along with social and cultural processes of Thai people that have the living lifestyles tied to the river. It can be said that water resources and the knowledge about water management are the product of the history, and they are used as a guideline for water resources development and water resources management in each period of time. Moreover, the current policies of water resources management in Thailand have considered the social context, history and society, and sociology, economy, politics, cultures, and lifestyles of Thai people. These factors are connected and crucial for determining water resources management policies.

Water is one of the world's most important natural resources. Together with air and soil, water is the basis for life on planet earth. There are many important functions which are essential for life. It is evident that the development of water resources and the management of water resources in the past to now is the modern scientific development that goes along with the social and cultural processes of the Thais. This shows that the lifestyles of people have tied to the water since ancient times. Water is like a symbol that represents various lifestyles of people, such as the use of water routes in the past, settlements by the two banks of the water, and being an important food source (Sangkhamanee, 2012). It can be said that water resources and knowledge of water management are the products of history (Mosse, 2008). There is a link

between water management and cultures, traditions, living lifestyles, and settlements of people. This leads to the policy of water resources management in Thailand today with regard to social context, sociological history, and concept of sociology dimension of the policy. It can be seen from the traces and historical yields in the creation of the nation, the change of economy and politics, and the development of the nation into the modernity, including the way people live in various eras. People's interactions, behavior, culture, and activities of people are related to social conditions, including beliefs relating to water. The relationship is closely linked (Jumsai, 1996).

2. Literature Review

In the past, people used water for many purposes in their everyday activities, for example, for consumption or for washing of the families. However, people had less knowledge about how to store water or use water properly. Nowadays, since there has been a large proportion of total water use and geographical changes around the world, the water resources management of each particular region is crucial. The following research studies has shown how each particular region around the world develop, manage, and store water for a variety of water use.

Fang and Zhong (2010) found that there was a severe drought in the north east of China, and there was heavy rain in the rainy season, but the ground could not collect rainwater because of the evaporation of water. In addition, there was no clean water for drinking. Therefore, the ways to manage water resources had been conducted. Water cellar was used to collect the water under the ground for use in the summer. In the past, the well was built from clay and placed under the ground. It acts as the room to store water for agriculture and drinking. Now, the well is built from concrete and plastic or tile which is used for a well foundation. This aims to improve the quality in collecting the water. With regard to the building of water cellars, the government was the one who provided. People in the community were those who took care of them. It can be said that the water cellar is suitable for areas with drought. When the water cellar is built, suitable areas, the movement of water, and areas for water storage are considered. In addition, it needs to be close to the community. This aims to save time and energy of people in accessing the water.

McGrath and Thaitako (2010) indicated that the water resource management in Baltimore, USA, was well-managed. It had taken the form of a weir from Chiang Mai, Thailand

in order to improve water flow into the city. This is because Baltimore was a city that lost water from the geographic nature of the sloping area. The water from the hills flew into the city. When there were a lot of buildings, especially residential dwellings in headwater areas, this led to water restore problem, loss of forest areas, and flooding. When the weir was built, the water flow could be controlled and flow along the water routes under the city. It can be said that the weir was designed to match the characteristics of the area.

Nianthi and Jayakumara (2010) investigated the system of the irrigation in Sri Lanka. It was revealed that there were a number of water tanks built to store water for use in areas with drought of the country. They were built in many forms, for example, lakes, wells, and reservoirs. The government was responsible for providing and taking care of these tanks. There were many types of tanks as shown below.

1. Forest Tank is a tank built in forest areas. It is built as a water source of animals so that they can drink, and it is the way to prevent animals from entering villages.

2. Mountain Tank is built in mountain areas. It is used for agriculture. Currently, this type of tanks is not built anymore.

3. Twin Tank is built for protecting debris, rubbles, and sediment and storing water for agriculture and partly for consumption.

4. Village Tank is water storage for use in villages.

The purposes of building these tanks are 1) to reduce the drought, 2) to protect floods and slow down the speed of water when it rains, 3) to prevent the erosion of large reservoirs or act as a protection against the erosion of large reservoirs, 4) to moisturize the soil, 5) to balance the ecosystem, and 6) to build good relationships of people in the community when they involved in building tanks and talked with each other.

Marks and Davis (2012) investigated the cooperation of local people in terms of the ownership of water resources in order to use and improve water resources sustainably. The researchers collected the data from 1,140 households (50 villages) in Kenya. It was found that the majority of the participants had a sense of ownership of water resources. Interestingly, it was revealed that a sense of ownership probably resulted from the recognition of the importance of water and the difficulty in accessing the water resources. The findings of this study contributed to defining action plans for stimulating community involvement and the characteristics of the

people who were interested in the involvement. Moreover, the findings were useful for policy makers to develop and set a policy on sustainable water use.

Valinia, Hansen, Futter, Bishop, Sriskandarajah, and Folster (2012) indicated that the cooperation of agencies and organizations had an important role in water management, especially the cooperation of related organizations, scientists who studied water, and general public. This study proposed the water management guideline “Water Framework Directive (WFD).” It put the emphasis on the importance of good environment and the cooperation of general public which could be compared to the relationship between fish and water. However, the cooperation of each community varied since there were differences in terms of the recognition of values, knowledge, perceptions of people in each community, and related scientists and organizations on water management.

Church and Prokopy (2017) conducted the study on the influence of society which acted as the way to conserve the watersheds by drawing on the success of water management of Indian Creek, Illinois, USA. Based on the study, the main factors that led to the success of the water management were 1) basic condition of the community, people’s lifestyles, and water problems of the community, 2) activities or projects that would act as stimulus, including funds, regulations, and organizations, and 3) The overall responses of the activities or projects that stimulated the conservation of watersheds. Importantly, this study indicated that the activities or projects that would act as the stimulus needed to be well-organized and well-managed since the living of people would change due to the effects of these activities or projects.

Jujnovsky, Ramos, Caro-Borrero, Mazari-Hiriart, Maass, and Almeida-Leñero (2017) studied and improved the way to measure the quality of water in the watersheds around the big cities in Mexico City by focusing mainly on ecology. It was found that there were three main factors: environmental factor, economic factor, and social factor. Regarding the environmental factor, the emphasis was placed on the methods of measurement of water quantity and water quality, including the movement of water. With regard to the economic factor, the water management/water delivery needed to be operated economically. Lastly, regarding the social factor, the people who were in charge of water management/water delivery that related to the ecology needed to be considered, and this included those who would benefit from this service.

Musiyiwa, Harris, Filho, Gwenzi, and Nyamangara (2016) noted that the improvement of soil and water quality could reduce crop failure, especially the cultivation of crops that rely on

natural rainwater. Based on the study, it was revealed that the main source of information about soil and water management technology was from government agencies, the word of mouth of farmers, and private organizations. The important technologies consisted of mulching, how to plow soil for planting, and adjusting the place of planting to a higher ridge. The study also suggested that it was crucial to use appropriate technology to suit the condition of the planted area since this was also the way to conserve soil and water for using in agriculture effectively.

Chen, Chen, Shimizu, Niu, Nakagami, Qian, Jia, Nakajima, Han, and Li (2017) mentioned about the water management in urban areas of Lake Biwa in Japan. There was an evaluation for sustainable water management by focusing on non-polluting processes. There were four main aspects of the evaluation: 1) the water supply and maintenance of water, including aquatic animals and plants, 2) supervising and issuing rules or regulations to prevent flooding and water quality, such as wastewater management and treatment, 3) cultural tourism that emphasize tourism management and water activities, and 4) the supports in terms of environmental knowledge and biodiversity.

Al-Saidi (2017) noted that the problems of the traditional system of water management were that it neglected to focus on the environment or the facts in the area or in the local area. Therefore, there should be effective water management reforms by focusing on both environmental context and political context. With regard to environmental context, the water management needed to focus on access to water and did not harm the environment. Regarding the political context, it must not create inequalities in the distribution of water resources, it must not produce bad results to people's health, and it must not impact education and general people's income.

Takeuchi, Uy and Shaw (2010) mentioned that Japanese culture placed emphasis on water which means cleanliness, clarity, and beauty since Japanese people believe that water is crucial for life. Unfortunately, they have to fight floods. Therefore, Japanese people need to think about how to manage their water resources for using and protecting the floods at the same time. In 1960, the water resource was in the middle of the area, and the farms were along with the water resource. The water was mainly used for agriculture. The housing was also close to the water. When flooding occurred, dikes were built to act as a protection against the flooding. These dikes led to the reduction of farming areas. The areas, then, were replaced by houses, and there was rail transport instead of using water routes. When there were dikes, people did not rely on

water as in the past. As a result, the city plan was created to match between home and water routes, protect flooding, and create the pavement between the dikes. By doing so, people felt connected to the water. The model to create the connection between people and water is called "Gujo City" which can be divided into 4 patterns.

1. Large: The River is outside the city, and it is managed by the government for fishing, swimming, and laundry.
2. Medium: The water flows into the community. Wooden dikes are built to control the water, and water is only used for washing.
3. Small: There is a small canal in front of the house, and it is used for four purposes: 1) washing, 2) extinguishing a fire in the past. However, now, it is used for tourism, 3) sweeping snow into this canal for a clear pavement, and 4) using for household agriculture, but now it is used for tourism.
4. Water point: It is a water point that many houses in the community can use. There are four levels of the water point. The first level is on the top, and it is used for drinking. The second level is used for cleaning vegetables and fruit. The third level is used for keeping food fresh, and the last level is used as a pond for feeding fish.

As can be seen, there have been the evolutionary development of water resources in many parts of the world. Therefore, it is crucial to have a look at the evolutionary development of water resource in Thailand from ancient times to the present day.

3. Objectives

To study the evolutionary development of water resources in Thailand from ancient times to the present day.

4. Research Methodology

This article adopts the documentary research for constructing the overall understanding about water resources development in Thailand. The content analysis was employed as a major research analysis tool in order to analyze and interpret the details of the chronology of Thailand's water resources management from ancient times to the present day (6,000 B.E.-2016). Finally, the research findings and those phenomena will be described.

5. Results

Since the past, Thailand has had the ways of life tied to water resources. We use water in agriculture, transportations, and diverse activities that is related to water. From the past till now, the evolution of water resource development and water resources management in Thailand can be divided 5 Periods.

5.1 Pre-historical Period

Around 5,000 - 6,000 years ago in the Pre-historical Period, people find places to establish their communities where the areas were near the rivers or natural water resources because their communities were the agricultural societies which depended on water resources for cultivation. The examples of these communities were the Non Nok Tha Archaeological Site, Phu Waing District, Khon Kaen Province, and Ban Chaing Archaeological Site, Nong Han District, and Udon Thani Province (Hungsapruet et al., 2002).

About 3,000 years later, there was a change in economic conditions due to the discovery and the use of metal tools. As a result, paddy cultivation in that period was improved by using the irrigation system which increased higher products and did not need to move cultivated lands often. The evidence of this kind of cultivation was found in the Sakon Nakhon Basin. With the development of Sakon Nakhon basin, using the irrigation system and metal tools can help for labor saving, making community develop, and improving the communications in exchanging with outside communities. This changed from the agricultural society to urban society (Hungsapruet et al., 2002).

5.2 Dvarawati Influence Period

In this period, the people communicated and related more to other different communities; thus, it led to cultural exchanges in the river basin of the central region. This comprised Suphsn Buri and Nakhon Sawan Provinces. Moreover, it extended to the Northeast region of Thailand, covering Chaiyaphum, Khon Kaen, Udon Thani, Kalasin, Maha Sarakham, Roi Et, and Yasothorn Provinces. In the North, archaeological there were evidences found in Lamphun Province and the lower part of Phetchabun Province in the Pasak river basin (Hungsapruet et al., 2002).

In the Dvarawati, the city was planned in circular or oval shape which was surrounded by dikes or moats. The topographical features of the city showed that dikes or moats had been built for supplying water for people and controlling water for cultivation, not only for security purposes.



Figure 1: Aerial photographs of cities, Sri hosot Prachin buri province. Urban planning Khmer Angkor Thom (Royal Irrigation Department, 2002)

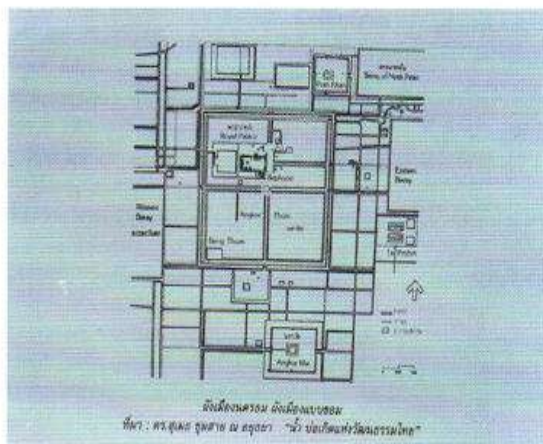


Figure 2: Dvaravati cities once located near the sea

6. Khmer Influence Period

During the 15th-18th Buddhist Centuries, there was the influence of Khmer. The stone inscriptions were found in various places, particularly in the areas of the Mun and Chi river basins and Lop Buri and Saraburi Provinces. These findings reflect Khmer culture which originated from the belief of Hindu and Mahayana Buddhism. The cities were square in shape, and they were surrounded by moats and walls. Moreover, the most important thing was the Barai, a large scale pond or reservoir, which was built inside or outside the city wall. The Barai was used to store water for consumption of people and cultivation of farmers. In this period,

water resources were greatly improved. Dikes were built to save water for domestic consumption, and city moats were excavated around the square-shaped cities. Some dikes and roads also were used to divert water from water resources to cultivated areas or into reservoirs. All of these reflect the development of technology in water control and retention. (Hungsapruet et al., 2002). In this period, there was a variety of water resource development and management in different ways as follows:

6.1 Sukhothai Region

In the 18th Buddhist Century, the Sukhothai Region was founded. The center was Sukhothai City and Si Satchanalai as a twin city. Later on, about the 19th -20th Buddhist Centuries, the communities were united with the Ayutthaya Kingdom, located along the Ping, Yom, and Nan river basins lying from Uttaradit Province down to Nakhon Sawan Province, including the area in the upper Pasak River Basin in Phetchabun Province.

The main topographical characteristic of Sukhothai and Si Satchanalai is foothill plains. Dikes were built to control water. These dikes were found throughout Sukhothai. The Sarid Phong¹, indicated that the water was controlled to flow into the drainage canal to be sent to the moats and ponds which were called Traphang. Some ponds received water through the pipes made of clay (Hungsapruet et al., 2002).

Because the area of Sukhothai sloped from the hills to the Yom River, the construction of weir were found in many places in order to maintain water. In addition, the embankments were constructed along the slope in the plain to divert water to the needed areas and for flood protection in rainy season.

6.2 Lanna Region

The history of Lanna Region appeared in the beginning of the 19th Buddhist century. The main topographical characteristic of the Lanna Region is mountainous terrain. The communities were settled in the valley plains, for example, in the Ping, Kok, Ing, and Wang river basins. Because of these features, the method of water control was required to support cultivation,

¹ There was a part in the stone inscription of King Ramkhamhaeng describing that "... at the center of Sukhothai, there is a pond with clear and edible water. ... in the east of Sukhothai, there are a temple lived by an old monk, a royal reservoir, orchards of betal nut, betel leave, mango, and tamarind. In the west of Sukhothai, there are a market, a castle, orchards of coconut and betel nut. In the central, there are upland crop areas, paddy fields, big and small houses. In the North, there are a temple lived by an old monk, Sarid Phong, orchards of coconut, fan palm, mango and tamarind and water for cattle feed ..." These evidences clearly reflect that in this period, the reservoir-typed irrigation was already created. In the reign of King Ramkhamhaeng, the reservoir called Sarid Phong (Sarid means water, Phong means barrage) was graciously initiated to be constructed.

especially rice which was the main food of the Lanna community. The weirs simply were built from natural materials across the stream to rise up and divert water to paddy fields through ditches (Hungsapruerk et al., 2002).

6.3 Ayutthaya Kingdom

In the 16th Buddhist Century, many rivers in the Chao Phraya Plain were shallow and changed to new courses. As a result, many main cities had to move to the fertile area nearby the water sources. Ayutthaya was an island, and it was formed by three main rivers which were the Chao Phraya, Pasak, and Lop Buri Rivers. Ayutthaya became the main center of administration, economy, society, and transportation, and also was the convenient port to go to the sea. It can be said that Ayutthaya was so powerful in that period of time.

At the end of the Ayutthaya Period, water control systems were built in many places, such as in the King Prasat Thong Reign in that there was the construction of Than Thong Daeng Reservoir in Saraburi Province. Moreover, it was also found in the reign of King Narai in that there was construction of Huai Sap Lek and Thale Chupson Reservoirs. Both reservoirs were built outside the city and at higher areas in order that pipes could be put to send water to the lower areas for consumption and forcing up fountains in the royal garden which was for recreation purposes, apart from cultivation and transportation (Hungsapruerk et al., 2002).



Figure 3: *King Ramkhamhaeng the Great Monument*



Figure 4: *Dam water by Natural materials for blocking the water.*
(Royal Irrigation Department, 2002)

7. Thon Buri Period

In the reign of King Taksin who was the Great and the founder of Thon Buri City, the development of water resources at the Chao Phraya Delta began. The water resources development in this period was mostly very similar to the water resources development in the Ayutthaya Period (Hungsapruerk et al., 2002).

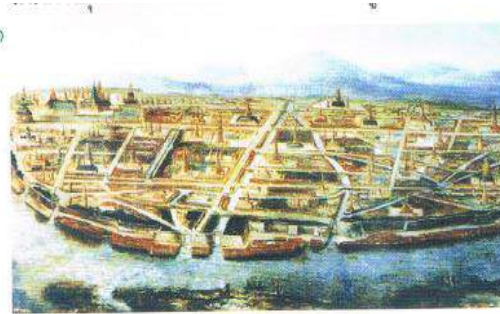


Figure 5: *Picture Ayutthaya drawings Hollander called Ayutthaya, that u-dia*
(Royal Irrigation Department, 2002)



Figure 6: *Banglamphu Canal*

8. Rattanakosin Period

During the reign of King Phra Buddha Yod Fa Chulalok, the Great or King Rama I, apart from the use of water for consumption, water resources were improved for military purpose (Hungsapruerk et al., 2002). In the next reign of King Phra Buddha Lert La Nabhalai or King Rama II, the King began the excavation of a canal which was called Sunak Hon, as shown in the picture below, in order to connect the Mae Klong River with the Tha Chin River. The canal

served as military route to Myanmar and Malaya, and it was used to transport goods, such as spices and salt and used for cultivation.

In the next reign of King Phra Nang Klao or King Rama III, because there always were flooding in the Central Plain, a stone water level gauge was installed in front of the Tham Mikkarat Temple in Ayutthaya Province, aiming at recording the water level. The stone became the first water gauge station of Thailand, and it has been used for over 170 years. The picture of this stone is shown below.

When King Phra Chom Klao or King Rama IV ascended to the Throne, several changes occurred in Siam. After the engagement in Bawring Treaty in B.E. 2389 (A.D. 1846), the communication and commerce with western countries occurred. The agricultural produce, such as rice and pepper was exported. Therefore, the King tried to develop water resources for agriculture by excavating more canals in order to increase rice cultivated land. So, many canals were dug to open new areas for the villagers to occupy rice (Phongpaichit & Baker, 2002). They are, for example, Phadung Krungkasem Canal which was the first canal of this reign as shown in the picture below.

In the reign of King Chulalongkorn the Great or King Rama V, due to the promotion of relationship with foreign countries, new techniques of water resources development were introduced and implemented. During this period, there was a study on feasibility of irrigation management and flood control occurring in the lower basin of the Chao Phraya Basin (Jarupongsakul & Kaida, 2000). Having considered that several canals undertaken by officials or Siam Lands Canal and Irrigation Company or private agencies were so shallow, he proclaimed the Canal Conservation Act Rattanakosin Era 121 for the purpose of preventing the shallowness of canals caused by different activities. In addition, His Majesty also set the rule of vessels transportation and authorized the Minister of Agriculture to collect money from vessels passing the maintained canals. This Act has been enforced until the present.

In addition, the arrangement of irrigation systems and management of water resources in the Chao Phraya River Basin in the past is an example of the introduction of scientific knowledge into one of the most important natural areas in Thai ecological history, and that is what makes Thailand a modern nation. The way to manage water resources is tangible and useful (Scott, 1998). The ideas and plans of water management in the Chao Phraya River showed the beliefs of colonial policy-makers of that era on engineering knowledge and on the conviction

about the use of science and technology that are not harmful. Besides, it will bring good results, but only to Asian countries (Brummelhuis, 2005). This shows that the government of Thailand in those days had different canal management from the earlier ones. Previously, it was mainly for traveling. But after the irrigation system was introduced, irrigation systems were planned and laid out to deal with agricultural land, especially for growing rice around Bangkok in that era.

In the reign of King Mongkutkiao or King Rama VI, during B.E. 2454-2457 (A.D. 1911-1914), drought continually occurred. This resulted in the damages to rice cultivation in the Chao Phraya delta plain. This problem led to expensive goods and high costs of living in the region. In this era, a large dam had been built, reputedly the dam named "Rama VI" to indicate the reign of the founding of modern water management knowledge in Thailand, and it was reported to His Majesty that day.

In order to nurture cultivated cereal varieties for the better, it is the only way to dispose of water in a scientific way in order to 1) help rain water that falls and flows unusually to become normal and 2) be the good result for cultivation. This aimed at enriching the country and the cities (Royal Irrigation Department, 2002).

During the World War II, the water resources development of the Royal Irrigation Department was slowed down because of the economic recession. After the end of World War II, irrigation development began in every region of the country in order to support the increase of rice production. The government set the first act to control irrigation activities in the North which was called Weir and Dike Control Act B.E. 2477 (Hungsapruet et al., 2002). This act was changed twice in B.E. 2478 (A.D. 1935) and B.E. 2480 (A.D. 1937) in order to control weir and dike systems effectively. Then, many irrigation projects were made throughout Thailand.

His Majesty the King Bhumibol Adulyadej or King Rama IX is the center of the Thai people. He has realized that villagers in every part of Thailand rely mainly on water for various activities, especially agriculture. He graciously introduced initiatives for water resources development projects for the well-being of all the villagers. Due to his great wisdom and prestige, water resources development of Thailand has been effectively done. In B.E. 2488 (A.D. 1945), the Royal irrigation Department began the construction of water resources development projects, especially in the Chao Phraya river basin which was the important granary of Thailand.

His Majesty the King himself has realized the problems of water which is a basic need for living of people in the country. He had visited all parts of Thailand, and he stated "water is

compared to life of human-beings.” He was very interested in studying and gave initiatives on water resources development to the Royal Irrigation Department to take into consideration. According to the Royal initiatives, the water resources development projects can be classified into 6 categories, namely for water resources development for agriculture and domestic consumption, for electricity generation, for watershed conservation, for drainage from low-lying area, for flood protection and mitigation, and for solution of polluted water problem. (Hungsapruet et al., 2002).



Figure 7: *Sunak Hon Canal*



Figure 8: *Phadung Krungkasem Canal*



Figure 9: Stone Water Level Gauge
(Royal Irrigation Department, (2002))

9. Discussion and Conclusion

The development of water resources and water resources management in each era reflects that it is trying to overcome nature rather than learning about nature. This can be achieved by bringing scientific knowledge into the irrigation system and the effective management of the water resources of the authority. Importantly, it is crucial to consider the way people live in Thai society, cultures, traditions, and practices that serve as a guideline for managing water resources in the community. In fact, the development and the management of water resources of people in Thai society cannot be separated in terms of both "science" and "sociology."

The evolution of water resources development and water resources management in Thailand from the past to the present is inversely dependent on fluctuations in time. One side reflects technological advances in water resources management. On the other hand, the process reflects the failure of non-systematic water resources management and is a separated operation. One important factor is the clashes between the two concepts: 1) the concept of governmental management according to the Royal Initiative, 2) the management by the government of the political group and the groups that focus on sharing benefits between beneficiaries.

Therefore, for future studies, in-depth analysis of water resources development and water resources management in Thailand should be conducted in order to reflect the various dimensions, be a step toward modern society to meet capitalism, and improve the transformation of the agricultural society into an industry, including the government budget allocation to develop water resources in various areas, flood assistance, or disaster caused by water. This also includes the context of Thai society that looks at the social history and the conceptual framework of sociology advocates for policymaking.

In this research, the limitations are the access to resources since there is little evidence regarding the history of water management in Thailand. Furthermore, watersheds in Thailand have changed over time. Thus, the images found in the references and the current condition are very different.

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