

## **CHAPTER II**

### **LITERATURE REVIEW**

This research aims to study technology and innovation of communities for environmental and resource management using Ban Na Mai, Tambon Wang Pai, Amphoe Huaikrachao, Kanchanaburi Province, as a case study. Many concepts, theories, and related researches are reviewed to correctly identify and explain problems as well as to ensure that all details are covered in this study. This chapter then includes:

- Concept of water resource management
- Related concepts and theories of public participation
- Situation of water resource and water shortage
- Technology and innovation of the community for resource and environmental management
- Background and baseline data of the community
- Related researches

#### **2.1 Concept of Water Resources Management**

People use water for agricultural activities, industrial needs, domestic consumption, navigation, electrical generation, and safeguard of ecological system. (Noppawan Teerapancharoen, 2000; Manoo Srikajorn, 1994) Therefore, water resources management is a very important to ensure that there is enough water for all afore mentioned activities. As a result, the study and analysis of water supply and the water demand for human activities especially for agriculture is highly necessary. Because each society has different methods of water management, water resources

management systems can be divided as follows (Kraiut Teeratayanun, 1997; Mingsun Khawsaard and Adis Isarangkul Na Ayuthaya, 1995):

- Water management by the community
- Water management by the government
- Water management by private sector
- Integrated water resources management

### **2.1.1 Water Management by the Community**

People learn how to live and share natural resources among each other by creating regulations for the coexistence and the use of natural resources. In Thailand, water management varied by geographical areas. In the north, people employ Mueng Fai water management while people in the central, northeast and south use overflow water by saving it in ponds and reservoirs for consumption and in canals for transportation.

Muengfai water management is a community's irrigation system which has been legalized by Mungrai Law. This irrigation system is the mixture of local technology and ways of living to take care of water resources. There are solid regulations and penalties for water usage which everyone in the community must follow. Muengfai system has a leader called "Kae Mueng" who oversees the management system including power distribution for proper water allocation. This water management reflects local culture and tradition that has been exist in this community for generations (Natedaw Patkul and Montri Chanwong, 2000). For other regions, the water management system aims to manage water by building dams, ponds, and reservoirs to save water flowing down from the upstream (Yunyong Inmueng, 2003).

Overall, each region's water management system is suitable for each society because it has been adjusted with each way of living through the coexistence of water and human. Thus, the water management by the community is the collective local technology and knowledge that has been passing down from ancestors to the next generations.

### **2.1.2 Water Management by the Government**

The water management by the government has been existed long before the technological development of modern irrigation for agriculture, communication, and national defense. For example, during the reign of King Mung Rai, the creation of Muengfai was to ensure that there was enough water supply for cultivation activities and for flood and drought solving (Royal Irrigation Department, 2005). Later, the government developed the water management system aiming to raise national economy by employing western concept of development and modernization during 1902-1976. Clearly, the irrigation system was acquired with the restructure of water management division for water control and distribution in 1961. In addition, the government took control the leaders of Muengfai under the new laws and regulations, and announced water as a national treasure to support commercial production for export (Mingsun Khawsaard and Adis Isarangkul Na Ayuthaya, 1995).

Present problems of water resources such as water shortage, flood, and poor quality of water affect the society, economy, and people's ways of living. As a result, the government attempted to set up an organization for water resources management (Mingsun Khawsaard and Adis Isarangkul Na Ayuthaya, 1995) and created a sustainable water management plan. This plan covers a system design of water distribution network, management efficiency, and researches which agree upon the National Water Policy as to relieve and solve water shortage, flood, and water quality problem.

Presently, the management of water by the government is aiming to integrate all stakeholders especially from various sectors and individuals who are affected by water management policies to help together set up goals and policies so that we can gain the effective water management system which could lessen existing conflicts.

### **2.1.3 Water Management by Private Sector**

It is, in fact, the government's idea to bring in private sector to help manage water resources because the government admits that its management system is not as effective as it should be as shown by the 15-30 percent of water storage in

various dams and reservoirs. Moreover, the government tries to reduce its expense in irrigation management and service improvement by raising authority to agricultural organizations (Saowakon Sudsavad, et al., 2001). Therefore, the government believes that local people will receive a more efficient public service and water will be used wisely for highest benefits (Yunyong Inmuang, 2003).

There are many types of operation for water management by private sector: 1) joint public-private venture, 2) contraction out, 3) franchising, 4) leasing, 5) user charge, and 6) service contract (Kraiut Teeratayanun, 1997). In order to choose the right type of operation, it depends on community's satisfaction. For Thailand, the conversion of water management from public to private sector occurs in the East and around Greater Bangkok. The type of operation currently using is the joint public-private venture by having the private sector operates water pipeline system and collects water fees while the Royal Irrigation Department takes the duty of allocating water resources. However, the performance of this operation is not as effective as expected because there is still water shortage for both agricultural and industrial sectors. This also creates conflicts between two groups of water users who fight for water supply.

Although, many people believe that the operation of private company will help increase efficiency and reduce government (Yunyong Inmuang, 2003), it is still not widely accepted due to past conflicts between end users and the management of private sector.

#### **2.1.4 Integrated Water Resources Management**

Pramote Maiklad et al. (1999) defines "water management" as the integration of various human activities for water problem solving in according to other relevant natural resources. Such activities are water resources development, water allocation and distribution, and water conservation for the wise use.

Presently, the social and economic development of the country has directly created water shortage, low water quality, flood, and drought. These problems urgently need attentions and solutions. Integrated Water Resources Management (IWRM) is a system that can help manage and solve water problems in a sustainable way. As the country has witnessed the failure of the old way of

management in which the power is centralized at the top of the organization and each department only does its own duty trying to solve problems and fails to integrate, IWRM is the process that can help sustainably manage water problems that are chronically existing due to the operation of former management by understanding the relationship between each element in the ecological system, hydrological cycle and other natural resources.

### 2.1.5 Relevant Factors of Water Resources Management

There are factors that are relevant to all types of water resources management. Viboon Boonyatarokul (2009) concluded that those factors are engineering, agricultural, management and social and economic factors.

- a. **Engineering factor** consists of enough and credible water resources, the good planning of water distribution system, the development of pipeline system, efficient control tower, soil surface adjustment, land formatting, watering system for cultivation, irrigation system that has been designed to suit the capability of officers and farmers to use and maintain.
- b. **Agricultural factor** includes growing plants that are suitable for the soil condition, climate, and other local factors.
- c. **Management factor** consists of effective organization establishment that has a suitable number of qualified staff to manage the system with enough budget to carry on projects as well as proper laws and regulations for water distribution system.
- d. **Social and Economic factor** comprise a group of water users that have strong determination in improving the management system and a group leader that is devoted to his/her duty. The group should be involved in the planning of water distribution, maintaining water delivery system, realizing the importance of the

development of water usage, and educating farmers on how to use water effectively.

All the above factors clearly show how they are relating to one another as a system. Therefore, a successful and effective water resources management relies on learning and participation processes to solve problems and to find the right technology for the area being managed. However, environmental and policy have not appeared at here.

## **2.2 Related Concepts and Theories of Public Participation**

### **2.2.1 Definition of Participation**

Participation is the concept derived from the problems and failures of the past national development so that there has been a review of previous difficulties as to gain clarification. As a result, there should be people or public participation of problem analysis, development planning, and decision making in important issues. As seen in the Eighth National Social and Economic Development Plan and the Constitution of 1997, the concept of public participation and power decentralization to locals would solve the hard and complicated problems in Thai society (Anuchart Pounsamlee and Kritya Archavanichkul, 1999).

As mentioned, the participation process let people or stakeholders share ideas and make decisions together for the development (Narongsak Jakkorn, 2005; Patcharee Siroros et al., 2003; Supot Saengngen et al., 1998). Moreover, the process encourages their understanding from the real experience with learning by doing. This action causes sense of project ownership, which helps operate any project more effective (Wanruk Mingmaneeakin, 1988). When we consider in the case of Ban Na Mai Community, local people can participate in analyzing its water shortage and finding solutions by themselves.

### **2.2.2 Steps of participation**

Many scholars suggest that there are steps of public participation which are as follows:

1) Share ideas and opinions in exploring problems and their causes: Akin Rapeepat et al., (1996) and Anake Nakabut (2002) stated that apart from participating in problem exploration, participants should analyze and prioritize problems. This action would stimulate the learning process of the people to learn about their community such as conditions, lifestyle, natural resources, and environment which will be beneficial for the development of the community (Parichart Valaisathien, 2000; Anake Nakabut, 2002).

2) Participate in designing implementation plan: all stakeholders could share opinions for the policy formulation, objectives, guidelines, action plans and resources sharing by themselves (Parichart Valaisathien, 2000; Akin Rapeepat et al., 1996).

3) Mutual investment and support: everyone could contribute materials, labors, money, or participate in the operational function fund raising from outsider sources (Parichart Valaisathien, 2000).

4) Project monitoring and evaluation: all participants could follow up and assess the projects in order to ensure the project directions.

5) Appreciate end benefits: they could equally make use of public assets (Parichart Valaisathien, 2000; Jermsak Pinthong, 1999; Prapokklao Institute, 2001).

In general, people of Ban Na Mai Community participate in different activities of the community but they have no leaders who can explore their problems and needs. Since they often depend on resources and knowledge from the outsiders, they have a weak cooperation so that they have mixed steps of participation.

### **2.2.3 Influential Factors of Public Participation**

Factors of community participation depend on their self-conscious to the facing problems and mutual benefits. Moreover, they depend upon how much the people will get involved in water resources management mainly depends on career

and land ownership status. Other factors include politics, society, economy, culture, leadership, management system, community's capability, seniority, benefits, sense of group belonging, role model acceptance, and other factors that are from the government in the form of public policy, regulations, and operational levels that open up the opportunity and encourage public participation (Kamontip Jamkrajang and Wutthisarn Tunchai, 2001; Parichart Valaisathien et al., 2000).

### **2.3 Situation of Water Resources and Water Shortage**

There are three types of earth's water resources: 1) ocean, 2) surface water such as rivers, canals, ponds, waterfalls, reservoirs etc, and 3) ground water. However, surface water is the most useful for agricultural, industrial, communication, drought prevention, and research activities with its different quantity in various sources depending on the season (Office of the National Water Resource Board, 1996).

From the study of water resources in Ban Na Mai Community, this community is in the area of rainfall; therefore, its important water resources is surface and ground water from manmade ponds and wells built by the community. These water resources are limited for their living activities such as domestic consumption and agricultural activities. When water demand increases from the expansion of agricultural area and the rising local population rate while water supply remains the same, the community faces water shortage. The reasons for water shortage in Thailand are (Pramote Maiklad et al., 1999):

1) Environmental and climate changes as well as environmental pollution have caused lower rainfall rate bringing in drought.

2) The demand for water usage has increased due to the increase of country's population and rapid development which have caused higher demand for agricultural activities, consumption, and other activities thus resulting in the imbalance of water demand and supply (Noppawan Teerapancharoen, 2000).

3) Water users are not using it wisely and do not take care of water resource.

4) There is not enough natural and manmade water reservoirs, or perhaps the geography, society, and environment in the area are not suitable for the development (Sampan Techaatik, 1993), or natural water resource have been used more for personal benefits or there are burdens for the development of reservoirs.

5) Natural resource especially forests have been invaded and damaged leaving no tree to hold up water resulting in drought.

6) Management methods in government and local people levels are not in harmony for problem solving (Department of Water Resource, 2004; Department of Environmental Quality Promotion, 2000; Office of the National Water Resource Board, 1996).

It can be concluded that causes of water shortage are from human actions; thus, the problems must be solved from the actual cause, which is human. The important factor that would help solve problems is by integrating everyone in the society to study and understand the problems and finally find the way to solve.

## **2.4 Technology and Innovation of the Community for Resource and Environmental Management**

Innovation mean something newly introduced. To begin or to introduce as for the first time or object that members of the society agree that it is new. Its newness can be measured from the time the object has been used or found to effectively develop and manage environmental problemes. Innovation consists of two components: idea and object. Every innovation must consist of idea, but not all innovations need to be tangible or be an object. However, innovations that are tangible tend to be accepted by the public than those that are not because they create actions. Innovations that only consist of idea are accepted in the form of symbolic decision such as political or religious ideology. Symbolic decision can make a difference to the society through three steps which are invention, diffusion, and consequence. As for technology, it is a result of the adaptation of idea, knowledge,

method, device, object, tools and scientific knowledge that can be systematically used to manage the environment (Pramahasutit Arpakro, 2005).

Innovations that have been discovered to solve natural and environmental management problems especially water resource such as floods and water shortage tend to be the local technology that is suitable for the environment of the specific community. Tamrong Preedee (1996) mentioned that technology that is most suitable for the community must be easy enough for community members to operate including materials that can be found locally. Remarkably, Kol Promsamlee (2005) found that “Airware” water pump, an innovation for effective water resource management developed by Ban Phachan Community, Ubonratchathani Province, has helped the community manage water shortage during drought resulting in enough water available year round.

In Praknamdaeng Community, Samut Songkram Province, by getting together to study water management framework of older generations, the people in the community has found the way to solve the chronic water conflict between the two sides of the river that had been going on for years due to ineffective government’s water gate operation. They noticed that the gate can be opened and closed automatically by the flow of water so that the water gate was redesigned to better operate and finally stopped the conflict (Kedsuda Sitthisuntikul, 2004).

Lim Thong Community, Nang Rong District, Buriram Province, which is an old community situated on Lumplaimat river basin, a branch of Moon river basin, in the past, often faced flooding during raining season and drought in summer because it mainly consists of sandy soil and is situated higher than water level making it hard to obtain water from Lumplaimat River. The community also lacks water reserves thus does not have enough clean water for consumption during drought. Without any knowledge or tools, people in the community had tried to plan a water system by walking and counting their steps exploring the area and drawing up plans and projects. Finally, they were supported with technological information with photos taken by IKONOS satellite and GPS system and able to see the whole picture, thus able to plan their own water system to obtain enough water for consumption and agriculture.

These cases clearly show that each community does realize and want to solve the problems they are facing. People learn with their experience and develop the collective knowledge into local technology to solve their problems. Discovering a solution for the area and the need of the community through local knowledge, tools, materials, and resources is easy and suitable for the community. However, finding solutions and new technologies to solve community's problems require each community member to see the importance of problems and to be eager to solve them.

## **2.5 Background and Baseline data of the Community**

### **2.5.1 Geographical condition**

Ban Na Mai Community, situated at Mu 5, Tambon Wang Pai, Amphoe Huaikrachao, Kanchanaburi Province, is a rolling plain with mainly sandy soil. Its weather temperature is around 38-40 degree Celsius and is situated above the mean sea level around 43-45 meters. Totally, there are 586 people or 149 households living in 22,760 rai. (Huaikrachao Agricultural Office, 2008)

#### **Territory**

- |              |   |
|--------------|---|
| <b>North</b> | Connected to Amphoe Laokwan, Kanchanaburi Province.   |
| <b>West</b>  | Connected to Nongko Village, Mu 10, Tambon Wang Pai Subdistrict, Amphoe Huaikrachao, Kanchanaburi Province. |
| <b>East</b>  | Connected to Nongcharoensuk Village, Mu 7, Tambon Sralongrue, Amphoe Huaikrachao, Kanchanaburi Province.    |
| <b>South</b> | Connected to Ban Na Ta Ming Village, Mu 4, Tambon Wang Pai, Amphoe Huaikrachao, Kanchanaburi Province.      |

### **Weather Condition**

According to the statistical information from Huaikrachao Agricultural Office, the average high temperature is between 38-40 degree Celsius in April and the average lowest temperature is around 18 degree Celsius from December to January while the raining season has continuous rainfall from May to October (Huaikrachao Agricultural Office, 2008).

### **Soil Condition**

The soil condition of Ban Na Mai can be divided into three main types: Chantuek, Kularonghai, and Sikew, which are sandy soil to sandy loam respectively. Another word, these soil types cannot hold water (Geographic Information Systems for Planning, Land Development Department, 2002)

#### **2.5.2 Career and the use of land**

From the survey on land use of the Huaikrachao Agricultural Office in 2008, Ban Na Mai's land is used as follows:

- Agricultural area      16,763      rai
- Public area              550      rai

**1) Agricultural area** of 16,763 rai is used to produce the following produces

- |               |           |
|---------------|-----------|
| 1. Cassava    | 9,164 rai |
| 2. Sugarcane  | 2,557 rai |
| 3. Rice       | 2,040 rai |
| 4. Watermelon | 375 rai   |

Besides, people in Ban Na Mai Community raise livestock which are 379,029 chickens and 838 cows. Farmers would dig up their own ponds or wells to keep water and receive supports from the government to help dig up ponds and wells on farmers' land and in public areas (Huaikrachao Agriculture Office, 2008).

**2) Public area** of 550 rai consists of public water resources making a total of 32.6 rai and empty space and areas used to hold community's activities of 517.4 rai.

**2.5.3 Cultivation patterns**

According to the data collected and analyzed from the study of cultivation process such as land preparation, fertilization, production rate, produces, production problems from related organizations like Department of Agriculture and Department of Agricultural Extension, geographical condition and how the land is being used, it can be concluded that most of the land has been used for agricultural activities. There is a total of 22,760 rai, of which 22,210 rai has been used for cultivation. Important produces are rice, sugarcane, and cassava. Of all the products stated, cassava takes up majority of the land which is 9,164 rai (Huaikrachao Agriculture Office, 2008) because farmers can grow cassava year round. Table 2.2 shows the months that rice and the rest of the produces are grown.

**Table 2.2 Crop Calendar of Ban Na Mai**

Type of Plants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice												
Cash crop												

Source: Field survey, 2009

**2.5.4 Condition of major water sources**

Ban Na Mai Community is located around 10 km away from Amphoe Huaikrachao Reservoir and is around 12 km away from the irrigation canal in Paisi Village, Tambon Dornsalab, Amphoe Huaikrachao (The Royal Thai Survey Department, 1997). Aside from these two sources, there are private man-made water sources such as pools and wells spreading around the community.

**2.5.5 The adaptation of the community**

After 1977, there are fewer newcomers leaving the community because most of them have already started to settle down on some pieces of land to make a living. This is one of the results from the government’s development which aims to improve the economy. Technology and media are the main reasons that help persuade community members to produce for commerce. With the government’s

motivation for monoculture, commercial agriculture has changed the way people produce from producing for a living to produce for sale and use money as the mean of exchange instead of its original barter system. (Community's member, interviewed on May 12, 2009)

During 1987-1992, the community changed its product from rice to sugarcane due to the soil condition that had been deteriorated. Later, more water sources were created to support agricultural activities and allow farmers to grow produces that were suitable to the climate and condition of the area. For example, farmers had changed from the type of rice that required longer time to harvest to the species that takes shorter. There were more pools and wells to reserve water to use during drought. (Community's members, interviewed on 12 May 2009)

## **2.6 Related researches**

Many studies and researches related to water shortage, water management, and participation on water management have been reviewed as they are beneficial to this research as described below.

Related researches on water shortage indicated that reasons of this problem are 1) ineffective use of water, 2) water contamination, and 3) deforestation (Network of Community and National Powers - Sukhothai Province, 2006; Noppadon Inna, 1994). Moreover, water shortage has been evolved from both controllable and uncontrollable factors, which are from the government development projects without public participation. As a result, the government actions created conflicts in the community, especially on water management.

For this reason, the government has started encouraging everyone in the community to help finding solutions. The review of academic documents confirms that the best solution is to receive and exchange correct information about the problems from each other and together discuss to find the way to solve problems. The local people should help set up rules and regulations for water management to reach community's objectives of household consumption and agricultural production (Chutiwan Sitthilerd, 2003; Pornthip Tienteerawit, 2000).

Main problems and obstacles of water management are (Saroj Sirimueng, 2003) geographical limitation, reservoirs condition, economical and environmental status, lack of effective water resource management knowledge, and profusely use of water. These reasons inevitably cause water poverty. Not knowing how to manage water wisely and growing crops that are not suitable for the season and climate are some of the examples of why the country is facing water problems. (Manya Narkpon, 2005; Amnart Wongbandid, 2004)

Irrigation engineering factors are geographical condition, designating irrigation area, pre-designing, designing, and building, hydrological condition, soil condition for agricultural purposes, agricultural system, farming irrigation, project budgeting, maintenance, social, economical, and environmental conditions, and water supply volume that could affect water allocation in the society. These factors are important information that is needed to set the capacity to hold water of water resource. (Pramote Maiklad, 1981; Apai Sriwattanasombat, 1987; Royal Irrigation Department, 2009; Warawut Wutthiwanitch, 1982)

Considering all the factors related to water resource management such as technological factors and irrigation engineering factors, problem solving will be successful only with the help from everyone in the community and the people involved in the society. According to the studies on factors influencing the participation of people in water resource management (Wittawat Klawtanong, 1998), sex, age, occupation, the time people immigrate (Somrak Kingrunkaew, 1998), and housing location do not have any effects on participation, but other factors such as household income (Srisakul Uthaiham, 2000; Warat Yantasanakit, 2003), education, information perception, social status (Jirayu Tongkaawon, 1994), career status, land ownership, opinion on environmental conservation (San Chuensiwa, 1995), and individual differences in perception (Nongyao Leepan, 1994; Kanueng Nawong, 2002) do have influences on people's participation. Knowing and understanding how to reserve water (Rung Sanpakaew, 2007) is also very important for public participation as many people still misunderstand that water is an unlimited resource and building and maintaining water resource are only government's duty. These factors affect how people conserve water resource. (Taklaew Dejdamong, 1995)

Factors that would result in a successful water resource management are 1) leadership factor, which consists of leadership personality such as being educated, talented, and able to lead the people, 2) community factors such as accepting and listening to community leader, accepting and understanding problems facing, having sense of ownership for projects and activities within the community, establishing an organization within the community, community kinship, community knowledge, and community attitude toward water resource management (Dusadee Yolao et al., 2000; Supoj Saengngan et al., 1998; Sataporn Sappapan, 1998; Pramuan Jaroenyong et al., 2006) that see the value and importance of problems; do not view problem solving and development as some specific person's duty but a task that needs participation from everyone to determinedly and continuously solve the problems.

However, once considering the approach toward problem solving, the study has found that (Surajit Chirawate, 2006; Katesuda Sitthisantikul, 2004; Panas Pruksunan et al., 2003; Tawat Wichaidit, 1992) most people believe that water is a gift of nature and how water is being used depends on their way of living, thus it is hard to manage water in the society. In addition, existing problems occur from lacking an effective and suitable water resource management. Therefore, the following factors must be put into consideration in order to establish an effective water resource management. Those factors cover social and cultural condition, institutions or organizations or associations and management process, regulations and laws as well as understanding and lesson learned about water resource management.

The research has found that the reason of water shortage is from the deposit of problems and their causes. There are many factors involved such as government development that has affected the use of land and water, water management system that lacks contribution and participation from the community and other stakeholders but rather from a specific person or organization, and community's economic development that is not suitable for the ecological condition of the developing area. All these factors reflect how each problem has long been existed and related to one another. In the meantime, once considering the capability of the community, the research finds that people in the community are capable of managing water by themselves. Outsiders such as educational institutions or related

government agencies cannot find the right water resource management system that is suitable for the area and community's way of living. The community must learn from exploring the area, understand its ecological system, and knowing its own capacity to know its expertise and limitation, which will lead to integrated learning and eventually create community participation to solve problems. (Keadsuda Sitthisantikul, 2004)

In conclusion, the participation of Ban Na Mai Community, Tambon Wang Pai, Amphoe Huaikrachao, Kanchanaburi Province is the most appropriate approach in solving water shortage because all stakeholders can help and learn each other to look after their own natural resource by thinking, implementing and solving problems together.