Participatory Descriptive Diagram for Irrigation Management in Left Main Canal Scheme, Chiang Rai Province

แบบจำลองเชิงพรรณนาการมีส่วนร่วมเพื่อการจัดการชลประทาน ในพื้นที่คลองฝั่งซ้าย จังหวัดเชียงราย

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บทคัดย่อ: การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อบ่งชี้ถึงถ้อยแถลงปัญหาของระบบชลประทาน ณ พื้นที่คลองฝั่งซ้าย ในจังหวัดเชียงราย ซึ่งพืชหลักที่เพาะปลูกในพื้นที่ชลประทานนี้ คือ ข้าว โดยผ่านการวิเคราะห์แผนภาพเชิงพรรณนาของกระบวนการมีส่วนร่วม ภายใต้หลักแนวคิดเชิงระบบของ Chambers (1988) และ Small and Svendsen (1992) แผนภาพเชิงพรรณนาของกระบวนการมีส่วนร่วมแสดงถึงความสัมพันธ์ของระบบชลประทานในพื้นที่ศึกษา โดยส่วนประกอบของระบบชลประทานถูกจัดหมวดหมู่เป็น สี่ หมวด (หมวดเทคนิค หมวดเกษตร-ชลประทาน หมวดสถาบัน และ หมวดการเงินงบประมาณ) ซึ่งข้อมูลที่เกี่ยวข้องสำหรับการศึกษาได้ถูกรวบรวมผ่านกระบวนการมีส่วนร่วมที่เรียกว่า “การวิเคราะห์ชุมชนแบบมีส่วนร่วม” ซึ่งข้อมูลเชิงคุณภาพและข้อมูลเชิงปริมาณถูกรวบรวมโดยผ่านกลุ่มผู้มีส่วนเกี่ยวข้อง ได้แก่ กลุ่มเจ้าหน้าที่รัฐ (11 คน) และสมาชิกกลุ่มผู้ใช้น้ำ (22 คน) ในปี พ.ศ. 2563 โดยแผนภาพเชิงพรรณนาของกระบวนการมีส่วนร่วมได้อธิบายถึงถ้อยแถลงปัญหาของระบบชลประทานในฤดูฝน และ ฤดูแล้ง ที่ว่าปัญหาหลัก คือ ในฤดูฝน น้ำท่วมคลองส่งน้ำหลักเป็นปัญหาหลัก โดยมีสาเหตุหลายสาเหตุ เช่น ปริมาณน้ำฝนที่มากในช่วงเดือนกรกฎาคมถึงเดือนสิงหาคมทำให้ปริมาณน้ำที่ไหลเข้าด้านข้างของคลองส่งน้ำหลักในฤดูฝนจากร่องน้ำตามธรรมชาติ ความจุปริมาณน้ำของคลองส่งน้ำหลักในบริเวณปลายคลองส่งน้ำ และ ระบบระบายน้ำที่ไม่มีประสิทธิภาพ ส่งผลให้เกิดน้ำท่วมหนักในบริเวณปลายคลองส่งน้ำ สำหรับฤดูแล้ง ปัญหาหลัก คือ การขาดแคลนน้ำสำหรับการเกษตร โดยมีสาเหตุมาจากสามปัจจัยหลัก ได้แก่ พื้นที่ปลูกข้าวที่มากเกินไปโดยไม่สัมพันธ์กับปริมาณน้ำชลประทาน การจัดการชลประทานที่ไม่ดีเนื่องจากความอ่อนแอขององค์กรของผู้มีส่วนเกี่ยวข้องกับการใช้น้ำและประสิทธิภาพของระบบการกระจายน้ำที่ไม่ดี

คำสำคัญ: แผนภาพเชิงพรรณนาของกระบวนการมีส่วนร่วม วิธีการเชิงระบบ การวิเคราะห์ชุมชนแบบมีส่วนร่วม ระบบชลประทาน การจัดการชลประทาน

Abstract: The objective of this study aimed to identify the problem statement of the irrigation system in the left main canal scheme (LMC scheme) in Chiang Rai province, which had rice as the mainly cultivated crop, through the participatory descriptive diagram (PDD). Under the system approach concept presented by Chambers (1988) and Small and Svendsen (1992), the PDD shows the relationship of irrigation systems with the components categorized into four domains (technical domain, irrigated agricultural domain, institutional domain, and financial domain). Relevant data in this research was collected by the participatory method called the participatory rural appraisal (PRA), in which quality and quantity information were collected through relevant stakeholders; 11 persons from the government sector and 22 persons from groups of water users in 2020. The PDD described the problem statement of irrigation systems in both rainy and dry seasons. In the rainy season, flooding in the main canal level was a major problem, caused by many factors, i.e., extremely lateral flow in the main canal from several natural streams from July to August, low capacity at the downstream-end section of the main canal, and inefficient drainage system. In the dry season, water scarcity was a major problem, caused by three main factors, i.e., over paddy rice cultivation with insufficient irrigation supply, incompetent management of the irrigation system of the stakeholders, and low conveyance efficiency of the canal distribution networks.

Keywords: Participatory descriptive diagram, system approach, participatory rural appraisal, irrigation system, irrigation management

Introduction

Mae Lao Irrigation Scheme (MLIS) is a large irrigation scheme, which is located in the upper northern Thailand, Chiang Rai province. The Left Main Canal scheme (LMC scheme), which is dominated by the MLIS, is one of the irrigation districts in the MLIS. The LMC scheme was poorly managed, which led to unsatisfactory performances, for example, poor water distribution, damaged hydraulic infrastructures, flooding in the main canal, etc. (Wongtragoon *et.al*., 2010); moreover, social co-operation among government sector and water user sector also created negative effects to the LMC scheme. All obstacles are complexity in terms of physical factors, human factor, and bio-economic factors in that irrigated agricultural system according to the description by Chambers (1988). So, these obstacles were complex situations of irrigation management in the LMC scheme. To capture these obstacles, the system approach, integrated with the participatory method for investigating unstructured data, will be applied to identify relevant problems in terms of the problem statement in order to define all criteria and problem solutions in a decision-making process of irrigation management. Moreover, the concept of participation was supported and driven as a policy, called as the participatory irrigation management (PIM), by the Thai Royal Irrigation Department (RID). The RID has defined the PIM policy as the participation of water users in the management of the irrigation system for better management in all aspects and at all levels of its aspects including planning, design, construction, operation and maintenance, financing, decision rules and the monitoring and evaluation of the irrigation system. In Thailand, the PIM policy has been introduced as the main policy by the

RID since the year 2005 (Wongprasittiporn, 2005), which is stated that Thai rice-based irrigation system should be changed and adapted irrigation to be effective management in some terms that 1) increasing time of a canal maintenance, 2) changing the management of irrigation supply from continuous flow to rotation flow, 3) decreasing inequitable sharing of water among head-end and tailed-end water users and 4) gaining complaints and disputes from water users (Wongprasittiporn, 2007). The objectives of this study were to generate the participatory descriptive diagram (PDD) for perceiving the complex situations and to define crucial managerial problems and some factors that were related to problems.

Framework Methodology

Study area

In the Figure 1. the LMC scheme was the study area, which was dominated by the MLIS in Chiang Rai province, Thailand. The LMC scheme covers 5,440 hectares in the wet season. The main crop was paddy rice that was divided into five zones of irrigation districts. But in the dry season, the irrigation service area (ISA) will be decreased by 2,080 ha.

Conceptual framework

In the Figure 2. the conceptual framework of this study could be divided into two major phases. The first phase, which was called the problem situation phase, involves collecting all relevant information about an irrigated agricultural system in order to find out some systematic problems of the irrigation system, which the PRA tools are applied for collecting both quantitative and qualitative data through the workshop of both government sector and water user group. The second phase is the development phase of the PDD, in which the participatory descriptive diagram is generated by relevant information in the first phase. Moreover, the PDD will be extracted to generate the problematic statement for further decision-making.

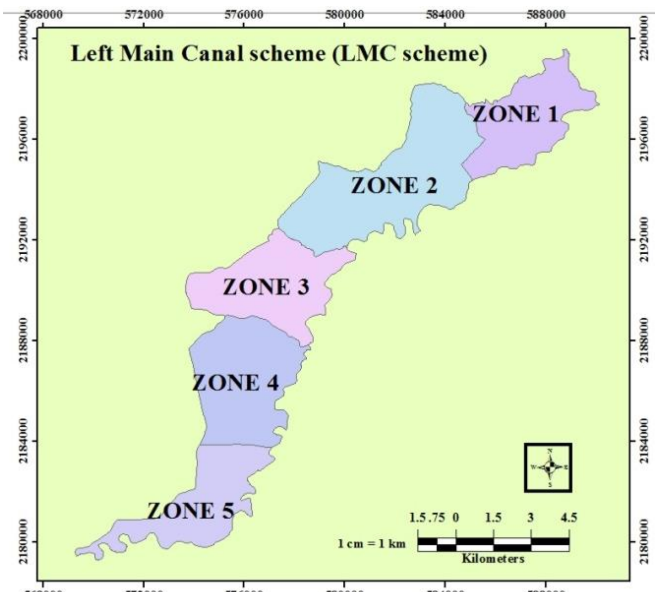

Figure 1. The Left Main Canal scheme (LMC scheme) (sourced by the Mae Lao irrigation department)

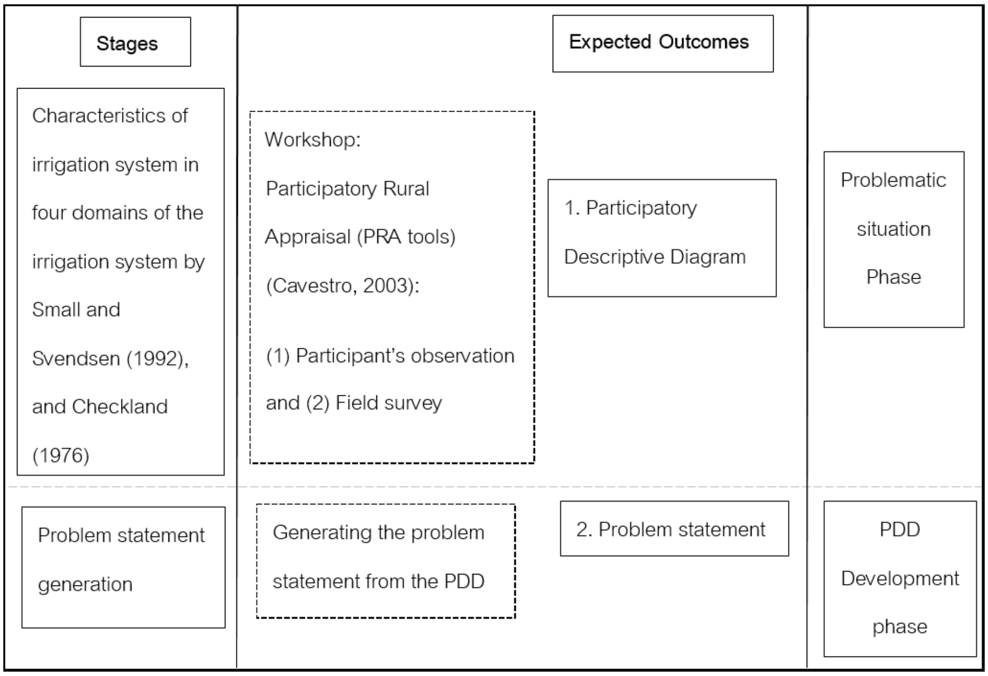

Figure 2. Conceptual framework of the study for generating of the PDD

Characteristics of irrigation system

To fulfill an understanding of the characteristics of irrigation system through under four domains of irrigation systems, suggested by Small and Svendsen (1992) and Checkland (1976), the data collection process was gathered in the workshop in the problematic situation phase through an activity of the participatory rural appraisal techniques (PRA techniques) (Cavestro, 2003). Two activities in the workshop were (1) participant observation in a focus group meeting and (2) the field survey for investigating the conveyance of irrigation system.

Participant observation

The participant observation process was held by a facilitator through an annual focus group meeting before starting irrigation supply season at the head quarter office in May 2020. All relevant stakeholders, i.e., the government sector (11 persons; 2 irrigation engineers and 9 operation staffs) and representatives of water user groups (22 persons; 4 head of villagers, 5 irrigation volunteers and 13 general water user members from zone 5 to zone 2) were addressed to join a group in the first round meeting in order to extract all relevant information of irrigation characteristics. After the first round of meeting, all questionnaire checklists were introduced to extract all required information by the facilitator to all participants in the meeting. Relevant checklists were considerately selected under the outlined components of the irrigation system (Table 1.). Such relevant domain components, three domains of the irrigation system (irrigated agricultural, institutional and budget domain) and some outlined topics in technique domain were developed to be relevant questionnaire checklists for investigating all required information of characteristics of irrigation system in both dry and wet seasons that several conceptual issues were shown in Table 2.

Table 1. Category of irrigation system components

Domain	Components
Technical	• Physical conditions related to design and operation: climate, topography, soil, water resource • Conveyance system: main canal system, roads and hydraulic structures
Irrigated-agriculture	• Distribution networks • Agricultural system
Institution	• Types of Organization, structure and functions • Legal framework of the institution • Role of water usage
Budget	• Fraction of financial management; operation and maintenance, disaster, improvement

Table 2. Conceptual issues of questionnaire checklists in each irrigation system components

Domain	Checklists	Participants/information sources
Technique	1. Water source 2. External/internal water storage 3. Irrigation supply 4. Physical characteristics: rainfall/soils/topography, natural streams	Government sector/ documents, GIS data, map data
Irrigated agriculture	1. Agriculture/ irrigation project/irrigation service area 2. Agricultural system: paddy rice, maize, animal farm	Government sector/ documents, GIS data, map data
Institution	1. Water user groups/ government sector organization 2. Functions of water user groups and government sector 3. Strength of water user group	Government sector and water user groups/ documents, meeting information, observed information
Budget	1. Fraction of financial management: operation, maintenance, disasters and improvement fractional budgets 2. Local irrigation budget	Government sector and water user groups/ documents, meeting information, observed information

Field survey

The field survey information was collected the required data by survey observation before the irrigation season in the wet season, in 2020 for two days from the upstream section (zone 5) to the downstream section (zone 2). Characteristics of the main canal level were focused on this survey observation. All relevant checklists, which were introduced in the modern water control and management practices in irrigation-impact on performance (FAO, 1997 and Allen, 1998), were shown in Table 3.

For the integrated information process in order to generate the Participatory Descriptive Diagram process, relevant information, collected by participants observation and field survey, were categorized in each four domains of the irrigation system to generate the participatory descriptive diagram (PDD) in the next step.

Problem statement generation

Relevant information from the problem statement was transformed and extracted relevant information by the PDD. Selected information in four domains were generated to a problem statement under the relationship of the system approach, introduced by Smyth and Checkland (1976).

Results

Participatory descriptive diagram (PDD)

The PDD was generated to analyze a relationship between the irrigation system in both wet and dry seasons (Figure 3 and Figure 4 respectively). Flow water resources and irrigation procedures of the LMC scheme were described under four irrigation domains in Table 1 as follows.

Technical domain consists of three major sub systems: (1) delivery canal system, (2) drainage system and (3) internal water storage system. For the delivery canal system, the main canal, which canal characteristics were 24.1 km in length, rectangular lined canal shape. The most canal capacity is in zone 5 (119,280 m^3) and the least canal capacity is in zone 2 (13,094 m^3). The irrigation supply was 34 ± 4 million cubic meters (MCM) in the wet season and was 59 ± 9 MCM in the dry season (in the year 2015 - 2020). The irrigation schedule was set by the rotational flow in each irrigational zone. The internal water storage system stored water in the wet season (0.3 MCM) and supplied the water in the dry season (0.2 MCM). For the drainage system, the main canal had a function to drain excessive water in the wet season, in which seven natural streams and

Table 3. Main canal level inspection checklists for searching characteristics of the main canal

Checklists	Conveyance system level
1. Canal section: Vegetation obstruction of flow, Rubbish obstruction flow at siphons, aqueducts, culverts, etc.	Main canal level
2. Canal embankments: Siltation, Seepage through embankment, Erosion	Main canal level
3. Structures: Seepage through concrete or masonry	Main canal level
4. Gates: Leakage through closed gate	Main canal level
5. Measuring structures: Drowned out or damaged measuring structures	Main canal level

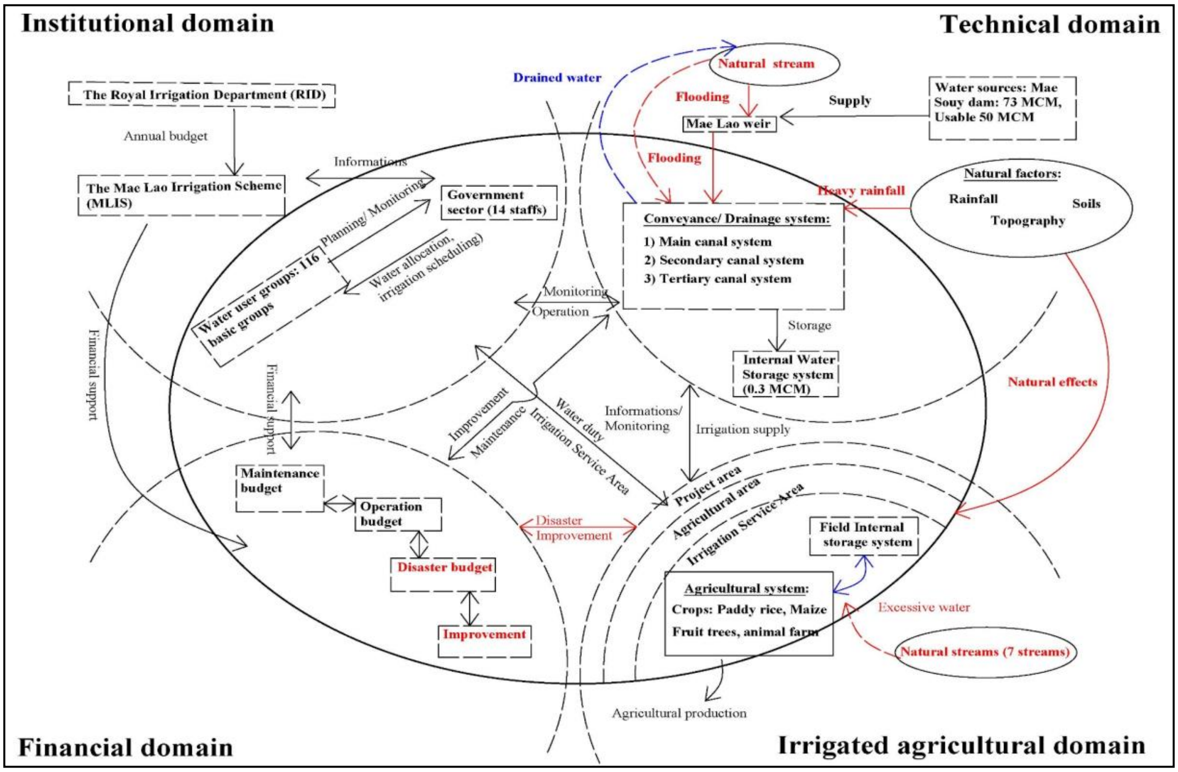

Figure 3. Diagram relationship of the irrigation system in the wet season

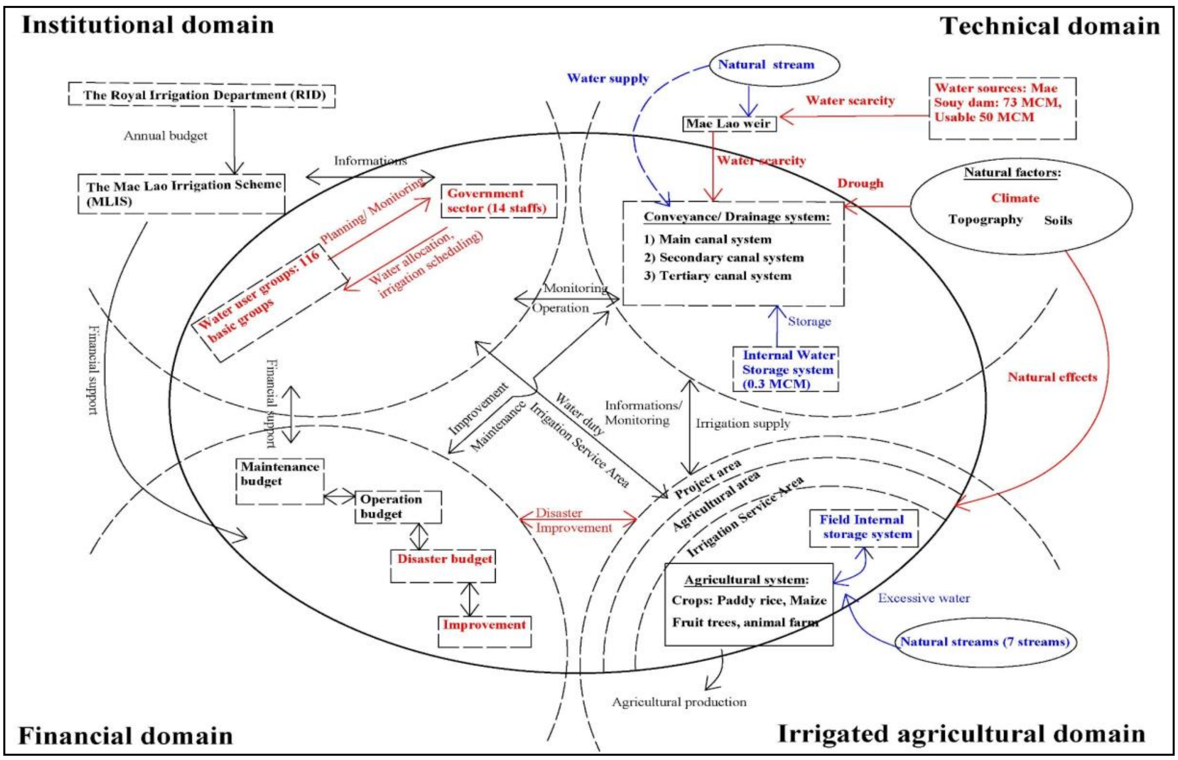

Figure 4. Diagram relationship of the irrigation system in the dry seasons

drained water of paddy nearby area were drained into the canal. Moreover, more effects of natural factors (rainfall 129 ± 22 mm/wet season and 29 ± 21 mm dry season) and topography (the main canal across several natural streams) affected the performance of the system.

Irrigated agricultural domain consists of two major sub-systems, i.e., the agricultural system and irrigated agricultural system (from the secondary canal to the field level). The main agricultural cultivation areas were paddy rice fields (over 80 %), some vegetable crops (4 %), fruit farms and fish farms (1 %) were minor agricultural areas respectively. Seventeen secondary and several tertiary canal levels supplied irrigation water to serve these agricultural areas (5,628 hectares in the wet season and 1,920 hectares in the dry season). In addition, the field internal water storage system (0.7 MCM of capacity) was more important for supporting the irrigation supply (0.07 MCM of capacity) of the outer boundary of the agricultural area in the dry season.

Institutional domain consists of two main sectors, i.e., the government sector and the water user group. For government sector (14 government staffs; operation staffs (12 staffs) and 2 irrigation engineers), dominated many relevant responsibilities to manage only the main canal level, such as operation, maintenance, fixing, checking and building infrastructures. Moreover, the government sector also supported and encouraged the water user groups to participate in irrigational activities, such as setting a group meeting before irrigation season, and setting and supporting the strength of water user groups. The water user groups, which consists of 116 basic groups in each five zones of irrigation districts, had a major responsibility for maintaining some part of the canal system from all secondary level to field distribution level in irrigational districts.

Budget domain is the expenditure (average 11.8 ± 2 million Baht/year from 2016 to 2020) for irrigation management in the study area. The annual budget was allocated by the RID through the MLIS. The budget could be divided into four fractions of financial management (operation budget, maintenance budget, disaster budget and improvement budget), including expenditures for secondary and tertiary canal systems. In the budget domain, the improvement fraction was more than 85 % of the total budget and this amount of budget was used to build hydraulic infrastructures, broken by disasters in both wet and dry seasons.

Problem statement

According to the PDD, the problem statement of the LMC scheme states that in the wet season, flooding in the main canal level was the main problem, caused by many factors, i.e., heavy rainfall situation (from July to August), extremely lateral flow in the main canal level by several natural streams, less capacity at the end of the main canal and poor of the drainage system. In the dry season, water scarcity was the main problem, caused by two major factors, i.e., over paddy rice cultivation area, which was not match with the amount of irrigation water supply, poor irrigation management due to weak institution led to conflict among water users, and low conveyance efficiency of the canal distribution networks.

Discussion

Participatory descriptive diagram (PDD)

The PDD was the diagram of the irrigation system (Figure 3 and Figure 4) purposed to reveal relevant irrigation systems and sub-systems in four domains. These relationships among irrigation domain systems, sub-systems in each irrigation domain and the components of each irrigation domain could be categorized. Starting of water resource from the Mae Souy dam water storage was supplied to paddy rice field through a canal conveyance system to the field distribution systems were defined as a relationship of irrigation flow in a hierarchical conveyance system. In addition, environmental factors (climate, soils, topography) were also defined as effects of irrigation problems in the LMC scheme in the technical domain and irrigated agricultural domains. Moreover, the human activity system (HAS) between water user groups and the government sector was illustrated by a relationship between irrigational activity procedures in both dry and wet seasons.

To simplify the complex irrigation system, four domains of irrigation were defined as relevant checklist information of system components by a concept of the nested hierarchy of the irrigation system, presented by Small and Svendsen (1992). These components of the system were set in four components of the system according to four domains that cover the physical and social dimensions of the irrigation system. To simplify the relationship under four domains, the PDD was generated by relevant information in the form of a diagram of that water resource flow, and a process and output in each system component.

The PDD supported decision makers to manage irrigation systems effectively through a setting of the goal achievement in each irrigation domain and to take action in each irrigation domain for achieving the goals. This DM process involved the participatory method that was a more powerful tool to not only deal with the problem that it was able to deal with a conflict among stakeholders in irrigation management under the soft system method (Smyth and Checkland, 1976) in order to raise a collaborative social learning (sharing knowledge among stakeholders acquire) and collective skills through better understanding the perceptions in a complex situation (Hare, 2011). Moreover, the participatory concept was also supported by the PIM policy, which has been promoted by the Thai Royal Irrigation Department since 2005 because almost irrigation problems in Thailand were unstructured problems (Chittaladakorn, 2013).

Problem statement

The problem statement was generated by the PDD, in which four domains of the irrigation system (technical, irrigated-agriculture, institutional and budget domain) were set according to the system approach. The statement described problem situations that complex situations were combined among four domains of irrigation system. In problem, natural, physical, agricultural, social and economic factors affected each other. Generally, the problem of irrigation management was very difficult to involve stakeholders. Due to more complex problems of irrigation systems among infrastructural, environmental, social and economic aspects, suggested options for irrigation development, published by the FAO (1997) in an issue as modernized irrigation that six options for irrigation improvement could be suggested for improving the irrigation management, i.e., (1) improving yield, financial sustainability of the project, including collection water fee, (2) eliminating of anarchy among institution, (3) improving irrigation efficiency, (4) increasing of environment degradation, (5) reducing maintenance and operation cost and (6) improving recovery of operation and maintenance cost. These options could be set as feasible choices for problem solutions through a decision-making approach for irrigation management, which was based on the participatory method by relevant stakeholders in the LMC scheme.

Conclusion

The participatory descriptive diagram (PDD) described the relationship of an irrigation system according to four domains (technical domain, irrigated agricultural domain, institutional domain and financial domain). The technical domain involved the relationship of physical factors (climate, topography, soil, and water resource) and the conveyance system, irrigated agricultural domain involved the relationship of distribution networks and agricultural system, the institutional domain involved the relationship of the related organization, the legal framework of the institution and role of water usage and budget domain involved relation of operation and maintenance, disaster and improvement budgets.

The PDD described the problem statement in both wet and dry seasons in the study area. It was stated that in the wet season, flooding in the main canal level was a main problem caused by heavy rainfall, extremely lateral flow in the main canal level, less capacity at the end of the main canal and poor of drainage system led to a flood in this area. In the dry season, water scarcity was a main problem, caused by over paddy rice cultivation, poor irrigation management and low conveyance efficiency of the canal distribution networks. All of these led to water scarcity for cultivation.

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