Improving water use efficiency in the Upper Central Irrigation Area in Thailand via soil moisture system and local water user training

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Abstract

Water loss is one of the typical but challenging problems in water management. To reduced water loss or increase water efficiency, the pilot projects were implemented in the TTD's irrigation area. Modern soil moisture technology and local level water user training were conducted together as a mean to achieve improved water efficiency. In terms of technology, soil moisture sensors and monitoring system were used to estimate crop water requirement to reduce unnecessary irrigation. This was found to save 16.47% of irrigated water and 25.20% of irrigation supply. Further improvement of water efficiency was gained by means of local level water user training in which stakeholders were engaged in the network of communications and co-planning. The lessons learnt from the TTD pilot project was translated into good water management practices at local level.

Keywords : water use efficiency, Thor Thong Daeng Irrigation Project, soi moisture data, local water user training.

1. INTRODUCTION

Water resources are for living organisms and fundamental to economic activities. Water management has became more challenging than ever before due to a number of factors such as higher variations in climate, more frequent floods and drought, growing demand for water, competition for water, conflicts and environmental degradation of etc. To address water issues in Thailand and to support the National Strategy and the Ninth National Research Policy and Strategy (2017-2021) of the National Research Council of Thailand (NRCT) which is the main national research policy and innovation organization dealing with and supporting research, the Spearhead Research Program on Water Management (SRPW) was initiated in 2019 and continued until now. The Spearhead Program consists of 4 main themes including 1) the development of water planning system in the Eastern Economic Corridor (EEC), 2) the improvement of water management efficiency in the Upper Central irrigation area, 3) the development of supporting technology and 4) the driving of policy and water user mechanism. This paper focuses on presenting the results and lesson-learnt from the projects implemented under the second theme of the program.

2. OBJECTIVE AND SCOPE

The objective of the second theme is to reduce 15% of the average loss in water conveyance system in the upper central irrigation area in Thailand. Several research projects were developed to serve different detailed objectives that will ultimately contribute to the success of the objective theme. In this paper, we demonstrated how the increased water use efficiency could be achieved by the two synergized projects which are the development of the soil moisture monitoring system and local level water user training. The Thor Tong Daeng(TTD) irrigation project was selected as a study are because it is the largest area of irrigation project in Thailand with irrigated area of 550,688 Rai (about 88000 hectares) located in the Ping basin under the Bhumibol Dam. 80% of the irrigated area is growing rice which is one of the most exported rice product in Thailand. The intake of water supply to the irrigated area is from the Ping River through the Thor Thong Daeng (TTD) Gate controlling with maximum capacity of 70 CMS. There are 3 main canals (MC) allocating water as shown in Figure 1. Water issues in the TTD are loss/leakage of water flow through natural canal, mismatch on water supply delivering cycle and actual demand, manual data processing and monitoring, and conflicts among water users especially in dry season.

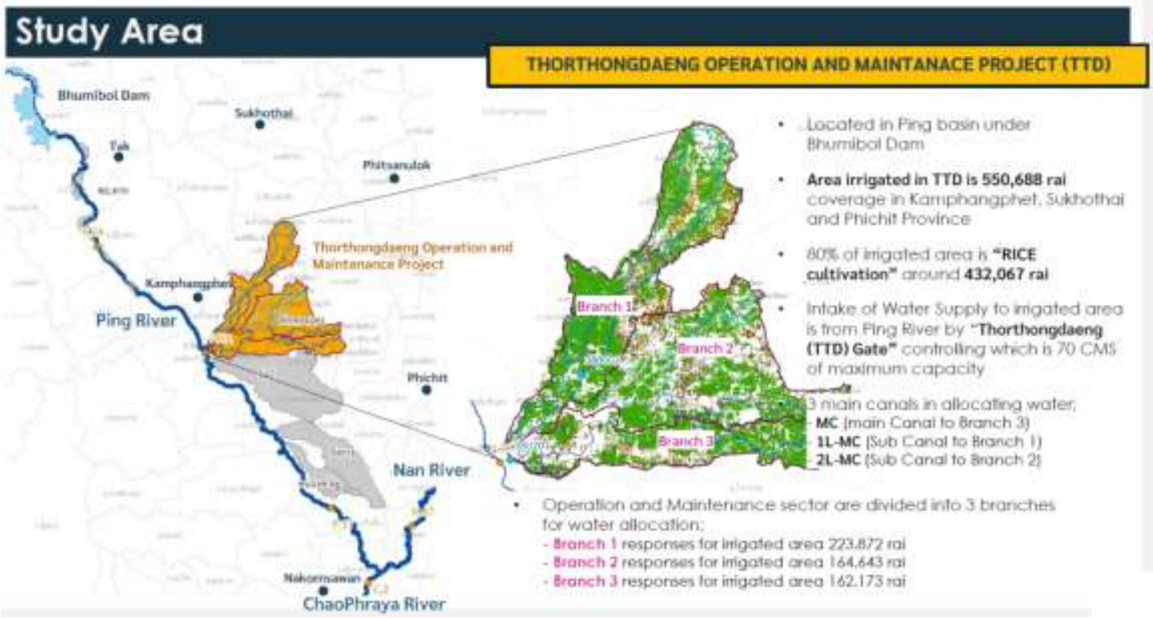

Fig. 1. Thor Thong Daeng Irrigation Project Area (Pinthong, P. et al. (2022))

3. METHODOLOGY AND RESULTS

3.1 The development of the soil moisture monitoring system

The soil moisture monitoring system was designed to link with crop water requirement estimated based on real-time soil moisture content and available water supply. A Time-domain reflectometry (TDR) was used for soil moisture sensor because it was found to be more precise in measuring soil water content than other commonly used instrument. The TDR sensor was used in combination with microcontroller unit (MCU) to read the percentage of soil content output and sent to a cloud server connected through internet using 3G/4G sim card at every 3 hours. The power was supplied by solar energy connected to a battery. There were 120 soil moisture sensors installed in 20 water user zones at the upstream, downstream, lowland, and highland. The soil moisture system is linked with gate automation and canal water level monitoring system. Crop water requirement is modeled based on the FAO method for various root zones and crop types together with the soil moisture content data obtained from sensors. Effective rainfall was accounted as primary supply to simulate supplementary irrigation water needed in cropping. Rice cultivation area was obtained from weekly surveying data. Four cases of supply scenario during rainy season are applied in simulation period covering dry year in 2015, normal year in 2016, wet year in 2017, and present year in 2019. It was found that mostly TTD's irrigated area is clay soil and field capacity is between 16.4% to 48.5% by volume. The irrigation water supply for all crops in the TTD irrigation area is 168.06-524.50 million cubic meters (MCM). With the soil moisture monitoring system, the amount of irrigated water was reduced 16.47%. The model suggested to supply the irrigation water of 202.33 MCM, which is about 25.20% of water supply saving shown in figure below.

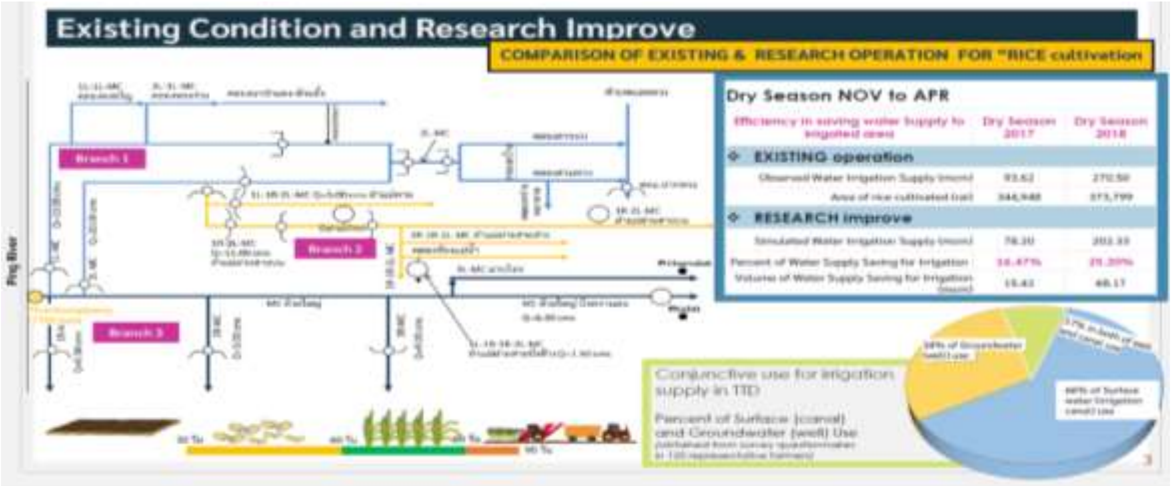

Fig 2. Irrigation Canal Network and water conveyance efficiency improvement

3.2 Local level water user training

Community-based action research (CBR) approach was used for local level training to engage community leaders (Water Community Organization) to support water use efficiency. Activities conducted included small group meetings, in-depth interviews and online data collection. Examples of the collected data were community funds, waterway maps, crop calendar and crop cultivation timeline which helps increase understanding the context of the community. Three key steps were conducted starting from the study of content and training processes/co-operation mechanisms among stakeholders. Then, the impacts of water management in the project were assessed. Finally, the process/patterns/mechanisms/method that could enhance knowledge and practice to water management was synthesized with the data (soil moisture, water level in the irrigation canal).. The designed training process helped to create 1) group power, and joint vision, 2) local coach on water community organization management process and practices and 3) powerful data analysis and synthesis for the preparation of water community organization plans. The above-mentioned approach was implemented in the pilot sub-districts in 3 zones where water conflicts issue was presented. It caused the necessity for the representatives of water users in each sub-district from upstream, midstream and downstream to communicate with each other to exchange information on problem situations. The common water management action plan was developed and information of soil moisture monitoring, water allocation and water delivery were shared. This was found to help raise mutual understanding across the water user groups and irrigation management agencies and to help improved water conveyance efficiency (about 25.20% of water supply saving as mentioned in 3.1). A guideline for good water management practices at local level was recommended to include the aspects of 1) social, economic and environmental aspect, 2) engineering and technology aspect and 3) management aspect. This showed good results of the new training approach in water management at local level in the irrigation area achieving a viable and more sustainable solution.

4. FUTURE TRENDS

IoT and digital transformation are key enablers for smart water management. Thailand is developing towards smart agriculture and water management (Visessri and Duangmanee, 2020). Examples of research projects implemented under SRPW and other research institutes are listed below.

- The development of soil moisture and weather sensor system for water allocation at a field scale under the Spearhead Program to save delivery irrigation water through monitored data (Koontanakulvong, 2020).
- The use of sensor system and recycled water for greenhouse farming under the Spearhead Program to control water use with forecast weather data to save water (Koontanakulvong, 2020).

- Demand Water management in EEC under Spearhead Program to save water/energy/labor in the factory site by using 3R+IOT technology (Koontanakulvong, 2020).
- Weather forecast and reservoir operation in the Greater Chao Phraya River Basin under the Spearhead Program to save dam water release in the rainy season for next dry season (Rittima 2022)
- NECTEC's WiMaRC (Wireless sensor network for Management and Remote Control) that provides monitoring and control for agriculture.
- NECTEC's smart irrigation for organic farm project to save water and organic fertilizer.
- NECTEC's smart melon farming using IoT, AI and big data to control water in the farm level
- NECTEC's NETPIE (Network Platform for Internet of Everything) project driving Thailand 4.0 with Internet of Things.

These sensor/IOT/automation research programs could help enhance the water use efficiency and also save more labor force and energy cost in the same time in line with future smart water policy.

Fig. 3 Local Water User Training activities and pictures

5. CONCLUSIONS

Water loss is one of the typical but challenging problems in water management. To reduced water loss or increase water efficiency, the pilot projects were implemented in the TTD's irrigation area. Modern technology and local level water training were used together as a mean to achieve improved water efficiency. In terms of technology, soil moisture sensors and monitoring system were used to estimate crop water requirement to reduce unnecessary irrigation. This was found to save 16.47% of irrigated water and 25.20% of irrigation supply. Further improvement of water efficiency was gained by means of local level water training in which stakeholders were engaged in the network of communications and co-planning. The lessons learnt from the TTD pilot project was translated into good water management practices at local level. Based on the success implementation of the TTD project, the future development can be expanded by combining existing infrastructure and system with emerging technologies (technical side) such as IoT, big data and coupling with local level water user training (social side). These supportive synergized measures will help improve water operational efficiency, minimise costs and improve decision-making which will enhance well-being of the farmers. These sensor/IOT/automation research programs could help enhance the water use efficiency and also save more labor force and energy cost in the same time These technical and social measures should be jointly implemented in the smart water management scheme to cope with future trend of smart water policy.

8. ACKNOWLEDGEMENT

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