Internal Ex-Post Evaluation for Technical Cooperation Project (SATREPS) [1]

conducted by Thai Office: January, 2020

Country Name	Research and Development for Water Reuse Technology in Tropical Region (SATREPS)
Kingdom of Thailand	

I. Project Outline

Background	Thailand has issues of water resource management associated with vulnerability to droughts in the dry season and floods in the rainy season, while climate change tends to increase such vulnerability. In addition, the recent industrial concentration and the rapid urbanization in the major cities, including Bangkok, has induced water related problems, such as water shortages, water pollution, land subsidence and water salination by over exploitation of groundwater. Securing quantity and quality of safe water and mitigation of vulnerability of water resources are key development issues for socioeconomic growth of the country. Under this situation, the necessity of research and development on technologies for reuse of untreated wastewater has increased in order to expand available water resources as well as to initiate sound water resource management.		
Objectives of the Project	Through development of institutional framework for research, development and promotion of water reuse technology, new energy-saving decentralized water reclamation and reuse systems, new water reuse technology with resource production, and effective management and monitoring systems for community-based water reuse, the project is aimed at development for appropriate water reuse technology and establishment of institutional framework for promotion of water reuse technology, thereby contributing to wide application with appropriate water reuse technology for effective water resource management. 1. Overall Goal: N.A. 2. Project Purpose: Appropriate water reuse technology is newly developed for wide application with an establishment of institutional framework for effective management in Thailand.		
Activities of the Project	1. Project site: Bangkok 2. Main activities: 1) Preparing a work plan, staffing, budgeting for the Water Reuse Center (WRC), 2) Research on IT-OD-MBR process, TSIT-MBR process for wastewater recycling, the Single and Two-stage AD system for food waste and sewage sludge, 3) Construction and operation of pilot-scale photo-bioreactor with MF membrane, itMBR-RO (Inclined-Tube-Membrane Bioreactor-Reverse Osmosis) for leachate treatment and global warming mitigation system in wastewater treatment, 4) Conducting risk assessment of water quality on health and ecology and economic impact of water reuse technology and installation and operation of water reuses system. 3. Inputs (to carry out above activities) Japanese Side 1) Experts: 14 persons 2) Trainees received: 54 persons 3) Equipment: Analytical apparatus, reactors, flowmeters, autoclaves, measuring instruments, etc. Thai Side 1) Staff allocated: 27 persons 2) Land and Facilities: Office space 3) Local cost: Consumable goods, communication cost, travel expense, etc.		
Project Period	May 2009–September 2013 (Extension Period: April – September 2013)	Project Cost	(ex-ante) 390 million yen, (actual) 386 million yen
Implementing Agency	Environmental Research and Training Center (ERTC) Chulalongkorn University (CU) Kasetsart University (KU)		
Cooperation Agency in Japan	University of Tokyo, Waseda University, Ritsumeikan University, Tohoku University, Yamagata University, Kanazawa University		

II. Result of the Evaluation

< Special Perspectives Considered in the Ex-Post Evaluation >

[Overall Goal]

No specific Overall Goal was set forth for the project. Since the Project Purpose was "development of new appropriate water reuse technology for wide application in Thailand", "the wide application of the newly developed water reuse technology" can be considered as an envisaged utilization of research outputs/outcome or "the envisaged Overall Goal". This ex-post evaluation assessed the status of application of the technologies developed by the project as the envisaged Overall Goal which can be a part of expected positive impacts of the project.

[Continuation Status of the Project Effects]

The Indicator 3 for the Project Purpose is "Institutional and organizational mechanism for promotion of water reuse technology at the Environmental Research and Training Center" and WRC was established. Since establishment of WRC was an organizational arrangement for project implementation and continuous R&D activities for promotion of water reuse technology, the status of the indicator at the time of ex-post evaluation was assessed for the institutional aspect of "Sustainability" rather than continuation of the project effects.

1 Relevance

<Consistency with the Development Policy of Thailand at the Time of Ex-Ante Evaluation and Project Completion>

The project was consistent with the Thailand's development policy such as "Thailand's Water Vision" (2000) aiming at securing sufficient quality and volume of water for all the users by 2025 and "the 11th National Economic Social Development Plan" (2012-2016) prioritizing promotion of efficient water management through close collaboration between local administration organizations and

[1] SATREPS : Science and Technology Research Partnership for Sustainable Development.

communities.
<Consistency with the Development Needs of Thailand at the Time of Ex-Ante Evaluation and Project Completion >
The project was consistent with Thailand's development needs for effective water reuse system in order to ensure sufficient quality and volume of water.
<Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation>
The project is consistent with the Japan's ODA policy for Thailand as a middle income country to prioritize cooperation covering support for coping with issues associated with maturation of society, such as environmental management and urban problems in the "Economic Cooperation Plan for Thailand" (2006).
<Evaluation Result>
In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Status of Achievement of the Project Purpose at the time of Project Completion>
The Project Purpose was achieved by the time of project completion. Seven technologies related to water reuse were developed by the project (Indicator 1). Four on-site water reuse systems were operated for the demonstration during the project implementation (Indicator 2). The Water Reuse Center (WRC) was established at ERTC for promotion of water reuse technologies (Indicator 3).
<Continuation Status of Project Effects at the time of Ex-post Evaluation>
The project effects have been continued by the time of ex-post evaluation. All the technologies developed by the project have been continuously utilized (Indicator 1). The four technologies have been used in the on-site operation and the treated water has also been practically used (Indicator 2). In addition, outputs from the Water Quality Information Platform (WQIP) were presented at the meeting on "Pharmaceuticals in the Environment" as a new emerging issue under SAICM by German Federal Environment Agency and SAICM (Strategic Approach to International Chemical Management) Secretariat and the United Nations Environment Programme (UNEP), on April 8th and 9th, 2014; CU also extended the research application to textile industrial wastewater recycling in order to promote the system application. WRC utilized WQIP in conducting a research project on Pharmaceuticals and Personal Care Products (PPCPs) contamination in Bang Pakong River during 2014-2016. The project was a flagship project of the National Commission on Development of Chemical Management Strategies in 2016. WQIP provided inputs to the Joint Committee of Thailand's National Strategic Plan on the Antimicrobial Resistance (AMR) in 2018.
The researchers of WRC/ERTC, CU and KU have been continuously conducting research projects related to the water reuse technologies developed by the project and the research outputs produced by the project. Furthermore, other research organizations/institutions, such as the Regional Environment Office 10 and Mahasarakham municipality, and Chulabhorn Research Institute, have started new research projects based on the research outputs by the project.
<Status of Achievement for Overall Goal at the time of Ex-post Evaluation>
The Envisaged Overall Goal was achieved at the time of ex-post evaluation. The water reuse technologies developed by the project have been widely applied by public and private organizations in Thailand. In addition, WRC introduced the water reuse technologies developed by the project in Cambodia, Lao P.D.R and Myanmar under JICA's follow-up cooperation in fiscal year 2014. Furthermore, the Water Reuse Guidelines developed by the project have been utilized by the Pollution Control Department and the Office of Natural Resources and Environment Policy and Planning for preparing water reuse guidelines in Thailand. Also, the Bangkok Metropolitan Administration used the guideline for developing a master plan for reuse of treated water from central wastewater treatment plants. Several municipalities have been using it as reference for treatment of domestic wastewater and reuse.
<Other Impacts at the time of Ex-post Evaluation>
There are some positive impacts of the project confirmed at the time of ex-post evaluation. The research team at ERTC has developed expertise in operation and maintenance of MBR and artificial wetland, and analytical method for molecular technology. The research team at CU won the "Best Paper Award- First Prize" from the water reuse research at European-Mediterranean Conference of the International Conference on Integrated Environmental Management for Sustainable Development (ICIEM) 2016 at Tunisia (the conference was supported by Springer Publishing). Also, the team leader of CU was appointed to be the International Conference' Scientific Committee for the Conference in 2017 and 2018 as well. The research team at KU has applied their knowledge gained from the project for the promotion of water reuse technologies in Thailand. They are involved in the water reuse project of Bangkok Metropolitan Administration (BMA) and several committees of Department of Drainage and Sewerage at BMA.
No negative impact on the environment was confirmed by the ex-post evaluation.
<Evaluation Result>
Therefore, the effectiveness/impact of the project is high.

Achievement of Project Purpose and Overall Goal

Aim	Indicators	Results
(Project Purpose) Appropriate water reuse technology is newly developed for wide application with an establishment of institutional framework for effective management in Thailand.	(Indicator 1) Number and contents of newly developed technology	Status of the Achievement: Achieved (Continued) (Project Completion) The following new technologies have been developed by the experimental study under the project. ➢ WQIP in Chao Phraya River Basin ➢ Artificial wetland at ERTC for water purification by 30 aquatic plants ➢ ➢ Grey water reuse system at Infantry Division 11, Bangkok ➢ Treated water at the Burirum Purification Plant ➢ IT-OD-MBR ➢ TIST-MBR, ➢ Anaerobic Photobioreactor, ➢ itMBR-RO

		(Ex-post Evaluation) The following technologies developed by the project have been utilized: ➢ WQIP: several organizations/institutions have used for environmental management such as the Department of Health, Ministry of Public Health and WRC/ERTC ➢ Artificial wetlands for water purification by aquatic plants: Four municipalities of Mahasarakham, Amnat Charoen, and Warin Champrap constructed the artificial wetlands. Also, Chaophraya Abhaibhubejhr Hospital in Prachinburi province has utilized advanced constructed wetland for treating PPCPs. ➢ Treated water at the Buriram Purification Plant: The plan has been used for treatment of municipal wastewater ➢ IT-OD-MBR and TIST-MBR: CU has used the technologies in prototype systems for the Building Water Recycling application. ➢ Anaerobic Photobioreactor: A pig farm in Chonburi province planned to conduct field experiment under the Kurita Water and Environment Foundation (KWEF) ➢ itMBR-RO system: The Bangchak Petroleum Industry operated at and Kasetsart University demonstrated for the treatment of cafeteria wastewater. ➢ MRB technology: ERTC has used for treating domestic wastewater, Saraburi municipality has used for treating leachate wastewater, Srinakharinwirot Universityhas used for greywater treatment and reuse
	(Indicator 2) Performance of on-site test operations of developed technologies	Status of the Achievement: Achieved (Continued) (Project Completion) ● The following four on-site water reuse systems had been operated for the demonstration. ➢ 3 sites at ERTC: Artificial wetland at ERTC, greywater reuse system at Infantry Division 11, Bangkok, and treated water at the Buriram Purification Plant ➢ 1 site at CU: IT-OD-MBR ➢ 1 site at KU: itMBR-RO (Ex-post Evaluation) ● As mentioned for the Indicator 1, all the four technologies have been continuously utilized and the treated water has been practically used as well. ➢ Artificial wetland: for treatment of domestic wastewater from dormitory of ERTC ➢ Greywater reuse system at Infantry Division 11, Bangkok ➢ Treated water at the Buriram Purification Plant: for treatment of municipal wastewater ➢ IT-OD-MBR: for treatment of wastewater from CU as a part of actions to promote and achieve the Green University Practice ➢ itMBR-RO: for treatment of in-plant wastewater of the Bangkok Petroleum Industry.
	(Indicator 3) Institutional and organizational mechanism for promotion of water reuse technology at the Environmental Research and Training Center.	Status of the Achievement: Achieved (Continued) (Project Completion) ● The Water Reuse Center has been established at ERTC. (Ex-post Evaluation) Refer to the Institutional Aspect of "Sustainability"
(Envisaged Overall Goal) The newly developed appropriate water reuse technology is widely applied in Thailand	N.A.	(Ex-post Evaluation) Achieved ● Artificial wetland has been applied at the following places: ➢ ERTC dormitory for treating domestic wastewater ➢ Chaophraya Abhaiphubejhr Hospital for treating PPCPs from treated wastewater and reuse water for gardening and toilet flushing, and ➢ Mahasarakham and SingBuri municipalities for treating domestic wastewater with aquatic plants. ● MBR has been applied at the following places: ➢ ERTC for treating domestic wastewater and reuse and also for training of wastewater treatment technology and for site visit (2016-present) ➢ Saraburi municipality for treating leachate wastewater (2016-2017) ➢ Srinakharinwirot University for treating greywater and reuse (2018-present) ● IT-OD-MBR: The research team at CU has presented the technology in various conferences and workshops in Thailand, and has received expressions of interest from other Thai research organizations. CU has

		also received support to continue the research study for textile industrial wastewater recycling. ● itMBR-RO: Public and private firms in Thailand, e.g. Nonthaburi Provincial Administrative Organization (pilot-scale unit for the treatment of landfill leachate), Rangsit municipality (full-scale mobile unit for the treatment of leachate from solid waste transfer station) and Bangchak Petroleum Industry (full-scale mobile unit for the treatment of process wastewater) have utilized and applied the technology.

Source：Terminal Evaluation Report, Information provided by WRC/ERTC, CU and KU

3 Efficiency

Although the project cost was within the plan, the project period exceeded the plan (the ratios against plan: 99% and 113%, respectively) The worst flooding of Chaophraya River lasting over six months since July 2011, interrupted the project activities, including the experimental works and installation of the pilot plant for water reuse, and damaged some research instruments and consumables. As a result, the project period was extended for six months in accordance with the reschedule of the research plan. the project outputs were produced as planned. Therefore, the efficiency of the project is high.

4 Sustainability

<Policy Aspect>

Under the "Sustainable Consumption and Production Policy" of the Ministry of Natural Resources and Environment, ERTC and the Department of Environmental Quality Promotion have improved wastewater treatment and reuse. However, the policies to promote application of water reuse technologies developed by the project are still limited to apply within the organization level only and there is no specific policy to promote them at the national level.

<Institutional Aspect>

WRC/ERTC has sustained their role and responsibilities for promotion of water reuse technologies developed by the project. There are many organizations/institutions utilizing the research outputs produced by the project, including the water reuse technologies, not only ERTC, CU and KU but also other public and private organizations/institutions in Thailand and international organizations including Japanese private companies. Therefore, it is highly expected that the related research activities and application of the water reuse technologies developed by the project will be sustained in the future.

<Technical Aspect>

The technical level in the research organizations/institutions (the implementing agencies) for utilization of the research outputs by the project has improved continuously and significantly. The researchers engaged in the project have been continuously conducting the research activities related to the project. In addition, the researchers of ERTC are able to provide advice and consultation, as well as giving lecture on water reuse technology.

<Financial Aspect>

The research organizations/institutions and the government authorities have secured financial resource to continue the related research activities and to utilize the research outcomes. They also receive research funds from time to time. In addition, the government of Thailand have continuously provided the budgets for relevant activities for application of the water reuse technologies through ERTC. Also, each of WRC/ERTC, CU and KU has continuously secured the budget for maintenance of the research facilities and equipment installed by the project.

<Evaluation Result>

Therefore, the sustainability of the effects through the project is fair.

5 Summary of the Evaluation

The project achieved the Project Purpose and achieved the envisaged Overall Goal through development and application of the practical water reuse technologies. As for sustainability, although the research activities and application of the water reuse technologies developed by the project have been sustained, the backup policies have been still limited.

Considering all of the above points, this project is evaluated to be highly satisfactory.

III. Recommendations & Lessons Learned

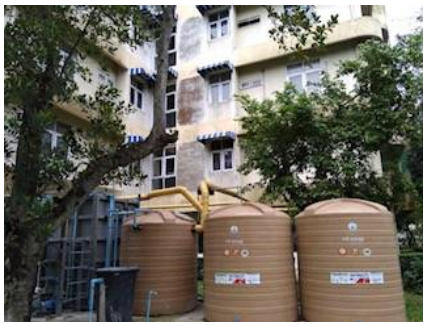
Recommendations for Implementing Agency:

- Encourage private sector to use water reuse technology in order to establish flagship water reuse project in Thailand
- Continue collaboration research with partners in private sector because role of private sector become larger in the actual implementing stage

Lessons Learned for JICA:

- It is necessary to identify appropriate stage of water treatment for incorporating water reuse technology in order to assess the potential to utilize water reuse technology when future projects try to apply water reuse technology in developing countries in order to promote water reuse technology. Since promotion for utilizing water reuse technology require broad coverage by drinking water supply network in a developing country, it is necessary to assess the development status of drinking water supply network in the country in order to consider introduction of water reuse technologies. In addition, it is essential to analyze the development status of sewage collection and treatment facilities which can incorporate proposed water reuse technologies.

Artificial wetlands for water purification by aquatic plants



MRB technology in Srinakharinwirot University for greywater treatment and reuse