Mekong River Commission

Report on the RAP Training Workshop and Initial Assessment of Irrigation Scheme Performance

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Photos of RAP Training Workshop

Opening Remarks

Cambodian Participants

Lao Participants


Thai Participants


Vietnamese Participants

Photos of RAP conducted in the Komping Pouy Scheme


Photos with FWUC


Interviewing farmers


Cross regulator


Explaining to the team


Secondary canal


Main Canal

Photos of RAP conducted in the Num Houm Scheme


Reservoir


Observing irrigation structure


Secondary canal


Turnout


Paddy field


Meeting with farmers at village temple

Photos of RAP conducted in the Huay Luang scheme

Meeting with the project staff

Observing irrigation structure

Inlet structure

Tertiary canal

Main canal

Meeting with farmers

Photos of RAP conducted in the Go Cong scheme


Sluice at Long Hai station


Irrigation canal


Water delivered by individual pump


Observing HL 6 sluice


Paddy field


Analysing data

Table of Contents

Annexes

LIST of ABBREVIATIONS and ACRONYMS

AEWEPF	Programme to analyse and evaluate water and ecosystem in Asian paddy fields
AIFP	Agriculture, Irrigation and Forestry Programme
CEO	Chief Executive Officer, MRC
CHO gate	Canal Head Orifice gate
CNMC	Cambodia National Mekong Committee
DMPF	Project to Demonstrate the Multi-Functionality of the Paddy Fields over the Mekong River Basin
ESPIM	Evaluation Study of Paddy Irrigation under Monsoon Regime
EC_e	Threshold saturated paste extract of the crop
FAO	Food and Agriculture Organisation of the United Nations
FAO-RAP	FAO Regional Office for Asia and the Pacific
FWUC	Farmer Water User Community
ICO(s)	Irrigation Community Organiser(s)
IIEPF	Improvement of Irrigation Efficiency on Paddy Fields in the Lower Mekong Basin project
IMC	Irrigation Management Company, Vietnam
INWEPF	International Network for Water and Ecosystem in Paddy Fields
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
ITRC	Irrigation Training and Research Centre of California Polytechnic University
JC	Joint Committee
Kc	Crop Coefficient
LA(s)	Line Agency (ies)
LMC	Left Main Canal
LNMC	Lao National Mekong Committee
MAF	Ministry of Agriculture and Forestry, Lao PDR
MAFF	Ministry of Agriculture, Forestry and Fisheries, Japan
MCM	million cubic metres
MOWRAM	Ministry of Water Resources and Meteorology, Cambodia
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MSL	Mean Sea Level
NMC(s)	National Mekong Committee(s)
OPD	Operations Division, MRCS
OPEC	Organisation of the Petroleum Exporting Countries
PDOWRAM	Provincial Department of Water Resources and Meteorology, Cambodia
PIM	Participatory irrigation management
RAP	Rapid Appraisal Process
RID	Royal Irrigation Department, Thailand
RMC	Right Main Canal
SIWRR	Southern Institute of Water Resources Research, Vietnam
TNMC	Thai National Mekong Committee
USD	US dollar
VNMC	Viet Nam National Mekong Committee
WB	World Bank
WSI	Water Saving Irrigation
WUA(s)	Water User Association(s)
WUG(s)	Water User Group(s)

Report on RAP training workshop and initial assessment of irrigation scheme performance

1. Introduction

The Mekong River Commission Secretariat (MRCS) is implementing the project "Improvement of Irrigation Efficiency on Paddy Fields in the Lower Mekong Basin (IIEPF)" in order to contribute to improve irrigation efficiencies of the schemes through the introduction of basic guidelines covering institutional, managerial and technical aspects of irrigation facilities operation. The project applies the Rapid Appraisal Process (RAP) as a tool to evaluate irrigation system performance.

This report covers the outline of the RAP training workshop and the result of initial scheme assessment conducted prior to the field observation in each selected irrigation scheme in the member countries, which were conducted as a part of the project.

The RAP is a simple but very strong and systematic tool to assess irrigation scheme performance, which was jointly developed by the Irrigation Training and Research Centre (ITRC) of California Polytechnic University and FAO in the late 1990s and since then has been successfully used by FAO and the World Bank in various Asian countries to appraise several irrigation projects.

The methodology uses modern concepts of canal operation and water use efficiencies and is based on the understanding that the irrigation systems operate under a set of physical and institutional constraints and with a certain resource base. The systems are analysed as a series of management levels, each level providing water delivery service through the system's internal management and control processes to the next lower level, from the bulk water supply to the main canals down to the individual farms or fields.

With the service quality delivered to the farm under economic, agronomic constraints, the system and farmers' management produces results (crops yields, irrigation intensity, water use efficiency etc.), while symptoms of poor system performance and institutional constraints are manifested as social chaos (water thefts, vandalism), poor condition of infrastructure, poor cost recovery and weak water users associations.

The RAP allows qualified personnel to systematically and quickly determine key indicators of irrigation projects. The RAP can generally be completed with two weeks or less of field and office work provided that some readily available data on the project have been organised by the project authorities in advance.

Key performance indicators from the RAP help to organise perceptions and facts, hence facilitate informed decision regarding

- The potential for water conservation within a project,
- Specific weakness in project operation, management, resources, and hardware,
- Specific modernisation actions that can be taken to improve project performance.

Furthermore, it also provides initial indicators that could be used as benchmarks in order to compare improvements in performance of the system once Modernisation plans are implemented. A good assessment of current situation gives a clear idea on where situation must be improved and helps in prioritising the areas for improvements. The RAP could also be used to compare the performance of the different projects.

The RAP is considered useful for IIEPF as it provides good indication, in relatively short time, of the constraints and bottlenecks in the system and thus helps in identifying options for improvements at different levels of the irrigation system. Among other things, it gives information on the following:

- Water allocation and distribution practices;
- Operation rules and procedures;
- Irrigation efficiencies (conveyance, field, overall project efficiencies);
- Physical infrastructure (hardware) of the system;
- Involvement of water users in the decision making process (stakeholders involvement).

All the above-mentioned information is a part of the detailed data collection work of IIEPF, thus the information from the RAP will complement the data collection and measurement work of IIEPF. Then IIEPF conducted the RAP training workshop and the RAPs themselves in each selected irrigation scheme twice during the project's life.

- Once at the beginning of the project, before the field data measurement work starts; and
- Second time when field data measurement work ends.

These activities were fully supported by FAO Regional Office of Asia and the Pacific (FAO-RAP) under the collaboration framework agreed between MRC and FAO-RAP. Two FAO experts (Mr. Thierry Facon and Dr. Chen Zhijun) joined these activities as lecturers and trainers.

2. Overall schedule

A four-day workshop in Vientiane was followed by six days (composed of two days field observation, another two days for data input, analysis and reporting in general and additional two days for transportation except in Lao PDR). The RAPs in four member countries were carried out from the middle of July to the end of August 2006. Outlined schedule of each activity is as follows:

Table 1: Overall schedule

	Duration	Venue	Resource persons
Workshop	18 to 21 July 2006	MRC conference room	Mr. Facon & Dr. Chen
Lao PDR	24 to 27 July 2006	Nam Houm project, Vientiane province	Dr. Chen
Cambodia	31 July to 5 August 2006	Komping Pouy project, Battambang province	Dr. Chen
Thailand	7 to 12 August 2006	Huay Luang project, Udonthani province	Mr. Facon
Viet Nam	21 to 26 August 2006	Longhai district, Go Cong project, Tien Giang province	Mr. Facon

3. RAP training workshop

3.1 Agenda and Participants

This four-day workshop basically included four sessions a day, two in the morning and two in the afternoon. The first two days were mainly spent on general information of

- What is the irrigation system modernisation and why it is important,
- Water control methods in order to realise irrigation modernisation, and
- Modern concept of water balance, irrigation efficiency and productivity including multiple use of irrigation water.

Last two days were mainly spent for the RAP itself, which included:

- Outline of the RAP,
- How to interpret indicators from the RAP,
- How to set up modernisation plan from the RAP result, and
- Reviewing filled the RAP worksheet prepared by the participants.

Workshop agenda is attached as Annex 1.

A total of 22 participants attended the Workshop. These included four (4) participants each from member countries, two (2) resource persons from FAO-RAP, one (1) from FAO Lao PDR office and two (2) professional staff and one (1) support staff from the MRC Secretariat.

A list of the participants is given in Annex 2. (Dr. Tu and Dr. Vitoon were absent, although listed.)

3.2 Opening remarks

The workshop started at 9:00 on Tuesday, 18 July 2006, in the MRC conference room, Vientiane, Lao PDR with an opening statement prepared by Dr. Dao Trong Tu, OPD Director of the MRCS. Since Dr. Tu and other senior staff of AIFP were unfortunately on mission, Mr. Okudaira, on behalf of Dr. Tu, read out the statement.
The statement quickly reviewed the objective and the progress of the project, and then explained two major purposes of this workshop as:

- Contribution to disseminate the RAP to member countries, and
- Expectation to apply the RAP to the IIEPF field activities.

The statement was concluded by the appreciation to FAO and their kind cooperation to the project.

This statement is in Annex 3.

3.3 Initial assessment of development needs

Prior to the presentations, a questionnaire was distributed to all the participants. This questionnaire was asking three questions as:

- Major objectives to achieve through irrigation system performance improvement,
- Main issues or problems to reach those objectives, and
- Priority actions to achieve those objectives.

The questionnaire, answers and their summary are shown in Annex 4.

15 responses were received. In the result table, the figure means the number of responses. "National" means the response from the national level viewpoint and "project" means the one from the project level.

Regarding measures to achieve improvement of irrigation system performance, answers from Thai participants varied widely from system level management issues for water distribution to social issues such as water fee collection, income generation of water users and environmental issues. Answers from Vietnamese participants mostly concentrated on how to secure water supply including efficient and economical water use. Their answers also cover environmental aspects. As the Lao Government is enhancing PIM (participatory irrigation management) through WUG (water users' group), their answers put emphasis on improvement of water distribution and enhancement of WUG. Cambodian participants put more emphasis on physical (infrastructure) improvement for water resources development than other three countries.

Insufficient water resources and incomplete irrigation system are a common constraint of all the member countries. Lao PDR again emphasised the weakness of WUG, farmers' participation and contributions (on water fee) and a weak supporting system of scheme operation including supporting WUG. Answers from Thailand also had the same tendency to point out weak irrigation management system including farmers' involvement.

As Thailand is a relatively developed country in the region, their objectives for irrigation development is more diversified than other three countries. Through all the questions, Lao PDR puts emphasis on WUG as the key irrigation policy of the country, while Cambodia tended to focus more on physical aspects.

3.4 Presentation

3.4.1 Introduction of the Workshop

The first presentation was delivered by Mr. Facon, and introduced and overviewed purposes of the workshop. Mr. Facon referred to the IIEPF project document, especially "Background and Justification" of the project, and emphasised that:

- Regarding irrigation systems in the region, little evidence on their performance is obtained, thus understanding of actual irrigation performance, such as irrigation efficiency, is the first and essential step for system modernisation,
- As irrigation water in paddy fields is used for multiple purposes rather than simple crop production, modernisation should take this multi-functional role into account, and
- Once present constraints and bottlenecks are clearly understood, then improvement for modernisation can be planned and carried out.

He also briefly reviewed:

- The essential concept of the RAP and its detail in terms of technical aspects,

- How the RAP contributes to irrigation system modernisation through evaluation of system performance, which includes,
  - Modern water balance concept,
  - Analysis method of obtained data,
  - Interpretation of the RAP indicators, and
  - How to make recommendations to improve systems.

The presentation handout used for this session is available in Annex 5.

3.4.2 Evolution of Irrigation system modernisation

Dr. Chen made a presentation on what comprises a modern irrigation system.

- He revealed the constraints of traditional irrigation system as:
  - No control filling the gap between rainfall and evapo-transpiration,
  - Proportional distribution system without reflection of changing demand from command areas,
- He highlighted the requirements of modern system as:
  - Storage for flexible water supply,
  - Flexible water supply reflecting demand, and
  - Efficient water use, i.e. high irrigation efficiency.

Then he concluded that analysis of traditional irrigation systems, recognition of constraints and identification of gaps between present and required functions of the system were the steps of modernisation. To summarise, "Supply driven to demand driven" is the key concept of modernisation.

The presentation handout used for this session is available on http://www.watercontrol.org/training/itrc/Evolution%20Modern/page_001.htm
Most of the presentation handout used at this workshop is also available on http://www.watercontrol.org/training/itrc/contents.htm, unless it is attached as an Annex.

3.4.3 Lessons learnt from previous RAP activities in the region

The first afternoon session of the first day presented by Mr. Facon focused on the RAP, its historical background of why it is needed, interventions made by FAO, its application to the South East Asia region, outline of the RAP and the steps needed for assessment and application, and case studies with photos.

The presentation handout used for this session is available in Annex 6.

3.4.4 Irrigation project modernisation
Concept of service

These two sessions were made as a consecutive presentation from the first day afternoon to the second day morning by Mr. Facon.

This presentation started from the explanation of vocabulary used for modernisation. Some of the words and terms he defined and explained briefly were: "Check Structure" "Turnout" "Manual & Automatic" "Remote, Remote Monitoring, Remote Control &

Local Control" "Flow measurement" "Flow Control" "Upstream Control & Downstream Control" "Water Delivery Service."
Most of these terms are familiar to irrigation engineers, but some of them, such as Remote Monitoring and Remote Control, were not familiar to the participants. Definitions and brief explanations of this terminology can be obtained from http://www.watercontrol.org/training/itrc/Vocabulary%20for%20canals/page_001.htm.
Mr Facon then moved into what irrigation system modernisation is. The presentation emphasised that the major reason for irrigation projects to exist was to serve the farmers, the obligations of irrigation engineers were to have vision and to plan ahead for the service farmers would need, because farmers may not fully understand modern irrigation technologies, and advancements were required by various external pressures related to the environment.

Irrigation modernisation was explained as a process of technical and managerial upgrading of irrigation schemes, but not a single action nor specific type of hardware. The modernisation process is, as the presentation explained , to identify the present conditions, to define objectives, to develop a plan and to progressively implement the plan.
The benefits of modernisation were crop yield improvement, reduced environmental degradation, and financial self-sufficiency, easier operation of the project and less social conflict.

More detail can be obtained from
http://www.watercontrol.org/training/itrc/Intro%20to%20Modernization/page_001.htm

3.4.5 Water management and control

This presentation by Mr. Facon was composed of four slide shows obtained from
http://www.watercontrol.org/training/itrc/Upstream%20Control%20part%201/page_001.htm
http://www.watercontrol.org/training/itrc/Upstream%20Control%20part%202/page_001.htm
http://www.watercontrol.org/training/itrc/Upstream%20Control%20part%203/page_001.htm
http://www.watercontrol.org/training/itrc/Upstream%20Control%20part%204/page_001.htm
which dealt with hydraulic issues. Upstream control was used as an example to explain how to control flow rate through the canal system.
Firstly, the necessity of water level control was explained to ensure constant water delivery to outlet. Then the function of check structures (such as cross regulators) was explained and how to reduce travel time when flow rate has fluctuated. How the accuracy of flow measurement is different between weir and orifice was also explained. Then several types of check structures and methods (or facilities) of flow measurement were introduced with their advantages and disadvantages.

3.4.6 Water Balance

This presentation by Mr. Facon explained the modern concept of water balance accounting, incorporated in the IIEPF project, with comparison to classical water balance. A simple and easily understandable presentation can be obtained from http://www.watercontrol.org/training/itrc/Water%20Balance/page_001.htm

The key concept of this presentation is to compute water inflow and outflow of a predefined three-dimensional spatial boundary within an appropriate temporal boundary (three to five years average computation was recommended.)

The presentation pointed out that errors under classical water balance were non-or improperly defining of spatial and/or temporal boundaries, then it added some rules for water balance accounting "to keep things in perspective"; "to identify confident intervals"; "to use multiple years of data"; "to count water once only, not to double count" and "to be careful with assumed values."

Figure 1 represents the concept of water balance with its components.

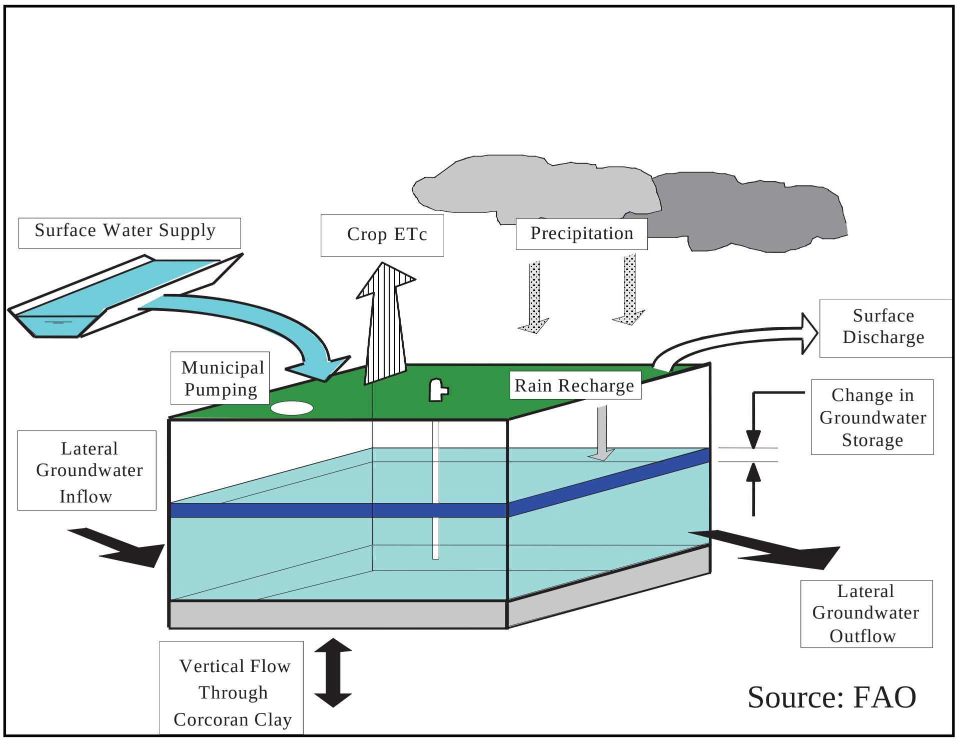


Figure 1: Water Balance Components

3.4.7 Multiple use of water

This presentation by Mr. Facon was made replacing the originally planed presentation of "Irrigation efficiency and productivity" as the last session of the second day.

This presentation cited results of research in Sri Lanka. The presentation citing various examples of multiple use of irrigation water (such as domestic use, animal husbandry and fisheries) through impressive photos, and then focused on an irrigation scheme in a semi-arid area located in the southeast part of Sri Lanka. The illustrations revealed a good comparison within and outside of the scheme command area. Outside the command area was covered only by bush because of scarce rainfall. On the other hand a lot of big trees grew within the command area thanks to water supplied by the irrigation scheme. A water accounting analysis of the Kirindoi Oya irrigation scheme shows that in 1998 48% of water supplied comes from rainfall and 52% from irrigation and 23% is used for irrigation of 8,600ha of rice field, 44% are consumed by 15,500ha of forests. Fallow land consumes 8% and 6% is lost by evaporation, 16% is counted as run-off to the sea and 3% is as excess drainage to lagoons. People in this area gain major benefits from the forest and trees, which the irrigation system supports indirectly. In 1998 the area introduced irrigation system modernisation. This included introduction of a dispersed management system with a reinforced communication system and recycled use of drainage water. As a result, the scheme achieved irrigation intensity rises from 140% to 200% and generated US$4 million per year with less than US$100,000 per hectare of investment.

The presentation also briefly introduced another example of scheme modernisation in France in 1980. The scheme originally had low irrigation efficiency and improvements were proposed. However the analysis revealed that infiltration contributed to recharge groundwater in this scheme. So the modernisation plan was adapted to maintain surface irrigation upstream to allow groundwater recharge and to introduce drip irrigation downstream, supplied by pumping from groundwater.

A presentation handout used is made available in Annex 7.

3.4.8 Issues of scales in water productivity - A case study of Zhanghe irrigation system, China -

The first presentation on the third day made by Dr. Chen started with several examples of water saving irrigation (WSI) practices in China, and followed to background of a case study as below.

1. How the on-farm water saving irrigation techniques saves water?
   Reducing in application of irrigation water to the field allows reduction in field water input and reduction in percolation and seepage.

2. What's the impact to overall system?
   Less well understood, because the percolation and seepage flowing out of fields (without being depleted by rice) can be reused at some points in the irrigation system.

3. In order to understand if and how farm-level WSI techniques scale up basin-level savings, a case study was conducted in a typical large-size irrigation system with intensive rice area – the Zhanghe irrigation system.

The presentation introduced the Zhanghe irrigation system, the methodology of the study, and Intermittent Submerged Irrigation practice for WSI at the study site. The study concluded that at on-farm level there was: "No significant yield difference between WSI and traditional irrigation, but higher water productivity" and at mezzo scale "Water productivity of irrigation water dropped sharply" and "Other factors become important, such as water storage and other non-rice land uses (roads, houses, trees)." The study also concluded that at sub-basin scale "water productivity of the reservoir water had increased over time because of 'Economic and institutional reforms initiated in 1978', 'Shift in cropping pattern from two to one crop of rice', 'Volumetric pricing of water', 'On-farm and system WSI practices', 'Development of alternate sources of water (reservoirs, ponds)' and 'Recapture and reuse of return flows.'"

A presentation handout used is made available in Annex 8.

3.4.9 Introduction of RAP (Rapid Appraisal Process)

The outline and basic concept of the RAP was introduced by Dr. Chen as the second presentation of the third day.
Presentation material used here is made available on
http://www.watercontrol.org/training/itrc/RAP%20Presentation/page_001.htm

Dr. Chen's presentation started a question to the participants that "What should we do for irrigation system evaluation?" What to evaluate, how to evaluate and how to interpret the results are the key points of successful evaluation, and a standard approach is required for a reliable result. Dr. Chen recommended the RAP approach.
In addition to the presentation, he added that the RAP could cover irrigation schemes with 5,000ha to 500,000ha of command area within a few days to two weeks.
Indicators for comparison between different projects and baselines for specific project improvement were explained as two major functions of the RAP. The RAP provides external and internal indicators as its outputs.
External indicators mainly show physical performance of the irrigation system by various values of rating and internal indicators provide evaluation of managerial and institutional aspects. Another two indicators, IPTRID (International Programme for Technology and Research in Irrigation and Drainage) indicators and WB (World Bank) indicators, are also the outputs from the RAP. The RAP is composed of 14 worksheets in Excel file, which covers entry forms for date related to irrigation water use, such as command area, estimated irrigation efficiency, crop water requirement, rainfall, planted area etc. for three years (sheet 1 to 3), output sheet (sheet 4) for external indicators from sheet 1 to 3, questionnaires to the project office, project employee and water users' association (sheet 5 to 7), data entry forms for physical and managerial conditions of four layers of irrigation canal system (i.e. main, secondary, tertiary canals and final deliveries) (sheet 8 to 11) and three kind of indicators (i.e. internal, IPTRID and WB) (sheet 12 to 14). (Please refer to the slide #12 and #26 to #37 for more information.)

3.4.10 How to interpret RAP

This presentation, originally scheduled as the last one of the third day, was conducted on the fourth day by Dr. Chen.
The presentation referred "RAP and Benchmarking, Explanation and Tools" is available on
http://www.watercontrol.org/tools/rap-eng-2002/contents.htm
especially "Summary of the Interpretation Process" from
http://www.watercontrol.org/tools/rap-eng-2002/RAPeng2002p10.htm#summary

The key steps for modernisation were summarised as

1. Eliminate the discrepancy between "actual" and "stated" service.
2. All levels of staff must understand and adopt the "service mentality."
3. Examine instructions that are given to operators, and modify them if needed.
4. Understanding of what actually happens in the monitoring system.

5. Communications at all levels.
6. Mobility of staff through better roads, motorcycles, trucks, etc.
7. Flow rate control and measurement at key bifurcation points.
8. Existence of recirculation points or buffer reservoirs in the main canal system. "Loose" water control may be very adequate in the main system"
9. Improved water level control throughout the project.
10. Re-organisation of procedures for ordering and dispersing water.
11. Remote monitoring of buffer reservoirs, drains, and tail ends of canals.
12. Remote manual control of flow rates at the heads of the main canal, and heads of major off takes (turnouts) from the main canal.
13. Provision for spill, and the recapture of that spill from ends of all small canals.

3.4.11 Making a Modernisation plan

After the explanation of the RAP itself and how to interpret the RAP outputs, the presentation stepped forward to how to set up an irrigation modernisation plan based on finding from the RAP. Presentation material is available on http://www.watercontrol.org/training/itrc/Making%20modernization%20plans/page_001.htm

The presentation started by providing four key concepts for better irrigation service; adequacy, reliability, equity and flexibility, and their definitions in the case of irrigation and drainage. Then it continued to list tools for water control to realise that service as: water level control, flow rate measurement, flow rate control, a communication system and reservoir storage. For modernisation, the presentation suggested selecting the simplest option with good performance for structure type selection and to concentrate problems at the ends of the canals. "Responsiveness" was emphasised as requirement of modern irrigation system to provide better service and then importance of communication in each level was also underlined. The presentation concluded by illustrating several typical modernisation actions. (For detail, please refer from page 51 to 58 of above web site.)

4. Initial assessment of the pilot schemes in four member countries

4.1 Introduction

Following to the RAP training workshop on 18-21 July 2006 in Vientiane, the initial scheme assessment by the RAP was conducted at the pilot project site in each member country. This work was conducted by selected members of IIEPF field observation team of the countries in cooperation with 2 resource persons from FAO and with facilitation by AIFP/MRCS. The members are listed in Annex 9. Some IIEPF field observation team members who had not been trained at the RAP training workshop were also invited to this assessment in order to get familiar with the RAP fieldwork practices.

The purposes of this activity were as follows.

- Initial assessment of performance level of the pilot schemes based on currently available data
- Identification of missing data to complete the final RAP
- On the job training to follow up the RAP training workshop

- Identification of options for scheme improvement

4.2 Procedures of fieldwork

Prior to the fieldwork, a discussion was held to fix the schedule of observation and to confirm preparation including appointments with representative farmers in advance. The detail is given in Annex 10.

The field observation started from interviews with the project staff regarding their service to irrigation water users in general and moved to check actual conditions in the field from main canal level down to secondary, tertiary, and farm ditch canal level. At each level, physical conditions of irrigation structures and canals were observed and farmers were interviewed concerning their satisfaction with the services provided by the irrigation project.

4.3 Scheme Outline

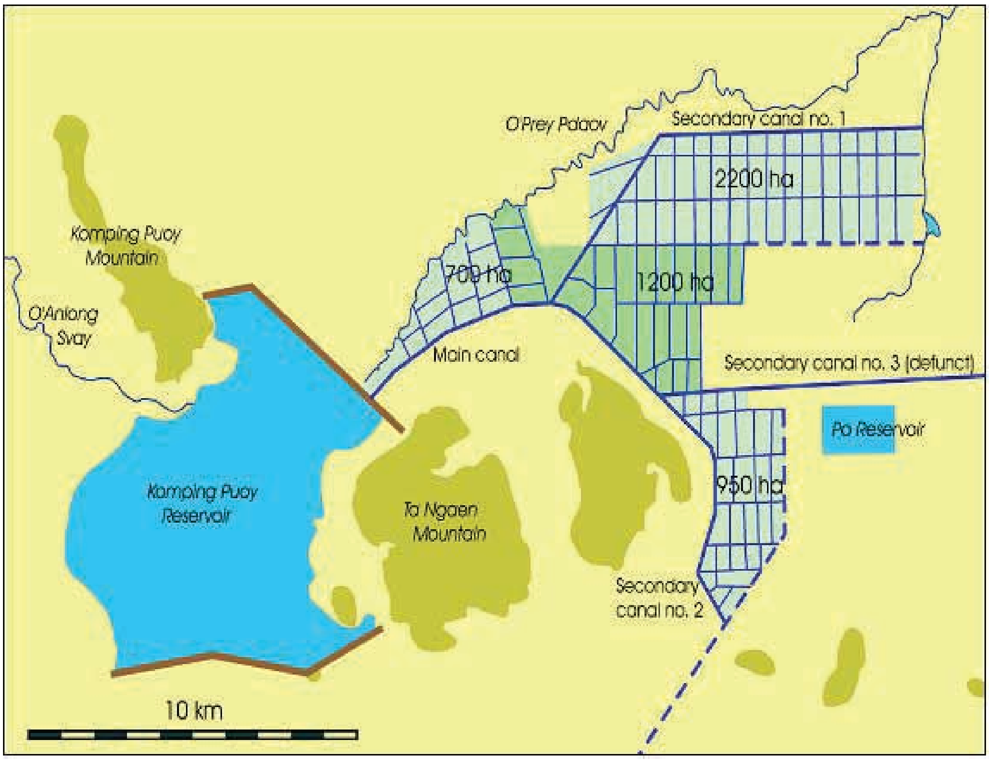
Initial assessment was conduced at pilot schemes, one in each member country. These are Komping Pouy project of Cambodia, Num Houm project of Lao PDR, Huay Luang project of Thailand, and Go Cong project of Viet Nam. The location of these 4 irrigation projects is shown in Figure 2.

Figure 2: Pilot Project Locations

4.3.1 Komping Pouy Irrigation Project, Cambodia

(1) Outline

The system was initiated during 1975-1979 with national budget. The project is located in Ta Ngen Village, Ta Kream Commune, Banan District of Battambang Province. It is located approximately 32km west from Battambang town. A schematic plan of the project with photos of major facilities is given in Figure 3 below.



Reservoir

Main Canal

Figure 3: Komping Pouy Irrigation Scheme

(2) Physical Conditions

The reservoir is surrounded by Ta Ngen and Komping Pouy mountains with original designed capacity of 110 million cubic metres (MCM). However, the survey conducted in 1999 found that the reservoir had only 90 MCM. Recently the diversion weir was constructed to deliver water from the Mongkol Borey River to the reservoir via a 13km-long canal . These additional structures contribute to increase inflow into the reservoir and secure storage with maximum use of the reservoir capacity. The dam is an earth type measuring 6.5 km long, 5 to 8 m high, and 10 to 20 m wide. There are 2 main intakes: the right main canal intake has 10 gate structures and the left main canal intake has 8 gate structures. The right main canal is considered as the most important structure as it has the potential to irrigate large paddy fields up to 10,500 ha. While the left main canal, which has not yet been rehabilitated, has a potential irrigated area of 3,000 ha. Figure 3 shows only the right main canal and its command area.

At present only the right main canal, which was rehabilitated in 2002, is in operation, while the left main canal is permanently closed. The rehabilitation of the right main canal was divided into 3 zones: up-stream zone (with command area of 700ha) and middle-stream zone (1,200ha) supported by Australian government, and down-stream zone (950ha) supported by Japanese government. The end of right main canal will be extended 9km to provide an additional irrigation area of 2,200 ha in the future.

The second dam extends westward from Ta Ngen Mountain and is 7.5 km long, 3 to 4 m high and 4 to 5 m width. It is equipped with 4 outlet structures supplying water to a small area of paddy fields in the south of the reservoir.

(3) Irrigation Practices

Irrigation water supplements water requirements for a total of 3,500 ha of rainy season crops and fully supplies 2,850 ha of dry season crops through the main canal of 9.02 km and 3 secondary canals with a total length of 29 km. Although it was expected that the rehabilitation work would make it possible to cover whole 2,850 ha, only 800ha could be irrigated in 2005 dry season due to limited storage in the reservoir. For the 2007 dry season, from February to May it is expected that the full 2,850 ha can be irrigated.

In the 2005, the yield was 3 tonnes/ha in the wet season and 4 tonnes/ha in the dry season. The water fee rate was US$10 per ha.

(4) Management

The project is owned by Battambang provincial irrigation office under supervision of the MOWRAM. The Farmer Water Users Community (FWUC) plays important role in the operation and maintenance works in association with MOWRAM staff assigned to the province.

The organisational chart of the project management is shown in Figure 4.
Apart from the main intake, other gates at 16 intakes of tertiary canals are operated by Water Users Groups (at each intake, one WUG is established to be responsible for intake operation and management). Water distribution at farm level is the responsibility of sub-units of WUGs. The project has 96 sub-units with 1,200 members in total.

The FWUC is responsible for whole project management activity under the supervision of the MOWRAM. Before every cultivation season, the MOWRAM staff hold meetings with the community and heads of WUGs to make plans on crop planting, structure maintenance and water distribution. The schedule for operating main gates is planned, discussed and agreed by MOWRAM, FWUC and farmers at this community meeting. The FWUC has 3 main activities: operating the main gate according to the planned schedule; coordination with MOWRAM; and monitoring water distribution. Management of the lower system including operating gates along the main canal is conducted by the head of each WUG. The head of each WUG also collects water fees from members and submits them to FWUC for system maintenance.

The project faced a shortage of irrigation water in the dry season, which resulted in insufficient water fee collection. Only 50% of total areas contributed water fees in the 2005 dry season, due to insufficient and non- timely water distribution. Low collection rates are especially observed at the areas located far from the main canal.

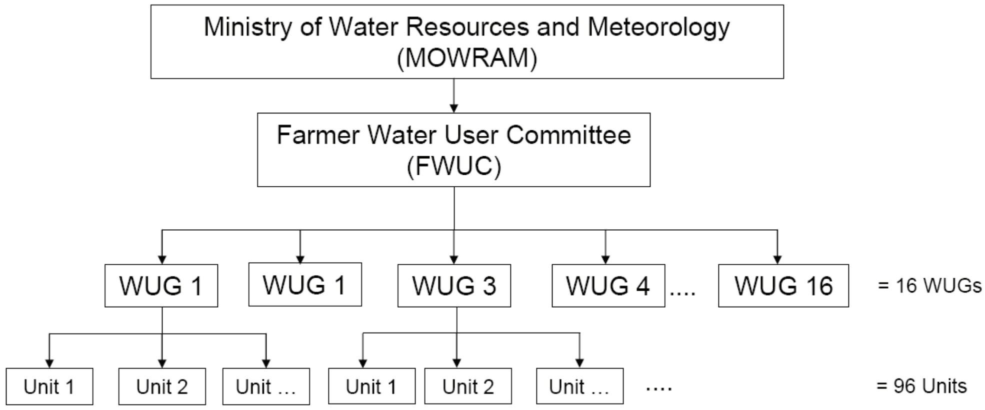


Figure 4: Organisation Chart of Komping Pouy irrigation project

4.3.2 Num Houm Irrigation Project, Lao PDR

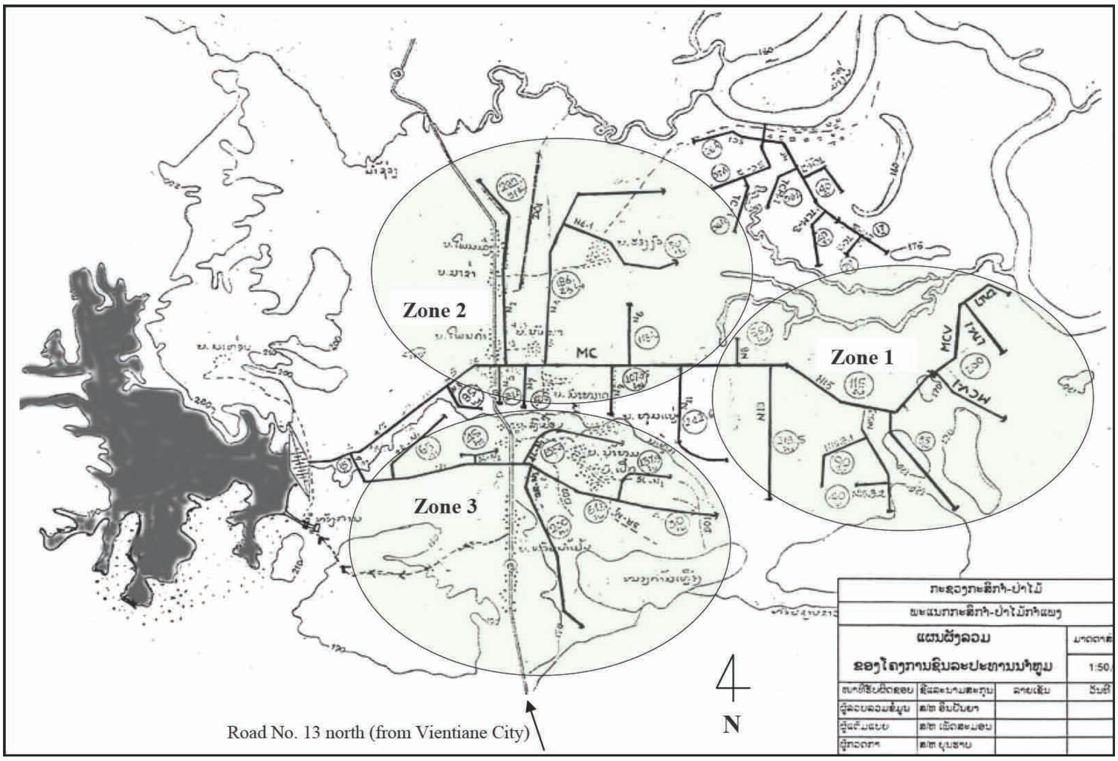
(1) Outline

The Num Hum irrigation project is a gravity irrigation system located around 35 km north of Vientiane on Road 13. The schematic map of the project with photos of major facilities is given in Figure 5. The command area covers Naxaythong and Xaythany districts with total planned command area of 2,400 ha. The beneficiary families live in 17 villagers with a total of 19,879 people.

The purpose of the scheme is to supply water mainly for dry season cultivation and asc a supplement for wet season cultivation. The command area is classified into 93% of paddy crops, 5% of fishponds, and 2% of cash crops.

The reservoir has a catchment area of 108 km^2 with annual inflow of 149.5 MCM. The maximum storage is 60 MCM (active of 54 MCM, and dead of 6 MCM.) The estimation of maximum flood level is 190.1 m and crest of dam of 192.2 m, spillway at 189.1 m and intake at 178.8 m.

The water is supplied by earth-open canals with total length of 60.635 km, of which the main canal is 9.3 km, the secondary canals are 30.014 km long, the tertiary canals are 16.827 km, and the quarterly canals are 4.5 km. There are 367 structures in total.



Reservoir

Main Canal

Figure 5: Map of Num Houm Irrigation Project

(2) Background

Construction of the dam was in 3 phases. Under phase 1 in 1978-82, the work included construction of reservoir, main intake, spillway, main canal and some on-farm canals with an irrigated area of 150 ha. This was financed by the national budget, a loan from OPEC and grant aid from the Japanese Government. Phase 2 (1990-93) comprised construction of a secondary canal and irrigated areas of 400 ha with financial assistance from the Italian Government through the Interim Mekong Committee. In phase 3 (1997-2000), the main canal was extended and the full system was completed, with an irrigated area of 2,400 ha. This was financed by the national budget.

(3) Irrigation practices

For water distribution practices, water balance is considered before every cultivation season. If storage is kept as high as 189.1m (in other words 60 MCM) at the end of rainy season, a constant amount of water will be supplied continuously with no limitation. However a rotation method is applied when water in the reservoir is insufficient. To do this, the irrigated area is divided into 3 zones as shown in the Figure 5. Cultivation starts at zone 1, followed by zone 2 and 3 at different periods in order to cut peak of water demand. The cultivated areas are limited according to available water. Water delivery is limited to one zone at the same time with regular rotation from zone 1 to zone 3. Some areas are abandoned, especially the areas which are located far away from the canals.

(4) Management

The project is operated by Num Houm project office belonging to the Agriculture and Forestry Department of Vientiane capital under the Ministry of Agriculture and Forestry. As shown in Figure 6, there are 4 main units under Num Houm project office namely an agriculture and extension unit, an irrigation unit, a livestock unit and a forestry unit. The irrigation unit is fully responsible for irrigation water management through 3 Water User Associations (WUAs). There are 11 WUGs in total working under WUAs, of these there are 960 permanent members and 380 temporary members.

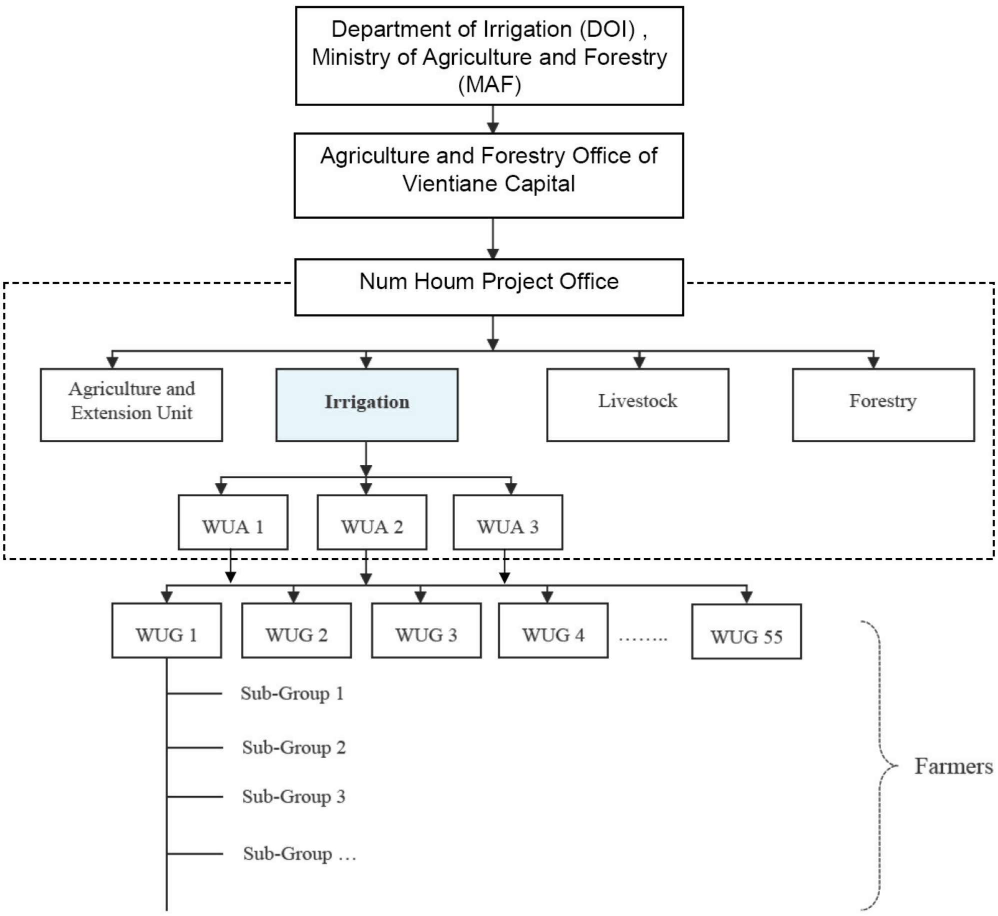


Figure 6: Organisation Chart of Num Houm irrigation project

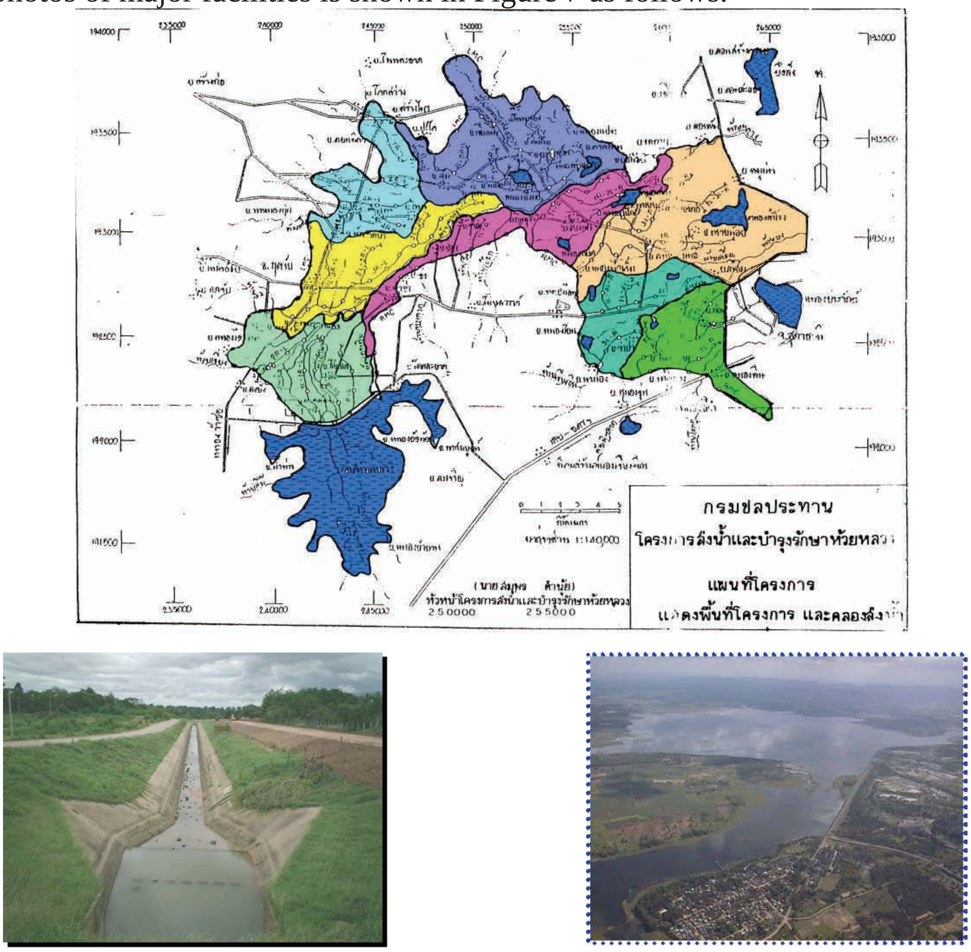
The management and service level are conducted in the following way. The reservoir and the main canal operation is responsibility of the WUAs under the project office. The WUGs are responsible for operating of the secondary canal level coordinating with the project office and their sub groups. The sub groups cover activities at the tertiary and on-farm level. The water fee is collected by head of WUGs.

The obvious constraint of water management is poor canal condition, which causes much water leakage, low skills and know-how of staff in proper management, lack of enforcement regulation, difficulty of water fee collection from farmers due to weakness of participation and weak sense of responsibility of farmers.

4.3.3 Huay Luang Irrigation Project, Thailand

(1) Outline

The Huay Luang irrigation project is located in the North East of Thailand or the East of Udon Thani Province, Kud Jab district at the topographical coordinates of 17.3N latitude and 102.0E longitude, about 7.5 km west of Udonthani city along the road No.210 between Udonthani and Nong Bua Lamphu provinces. The map of the project with photos of major facilities is shown in Figure 7 as follows.



Left Main Canal Reservoir

Figure 7: Huay Luang Irrigation Project

(2) Background

There were two phases of construction. The first construction in 1940 completed the reservoir with a designed capacity of 1.5 MCM. This also included the spillway and the Right Main Canal (RMC), however the storage was too small and water availability was not always steady. Since the water scarcity problem was not fully solved especially in dry season, the second construction started in 1970, which included the Left Main Canal (LMC) and a new dam located up stream of the old one.

(3) Physical Conditions

The full system was completed in 1984. The maximum storage of the reservoir is 135.567 MCM and the dead storage is 6.594 MCM. The storage water is not only for irrigation water supply, but also serves for domestic water use in the region.

The total command area is 16,095 ha irrigated by 2 main canals: RMC and LMC with total length of 81.1 km. The RMC with the maximum capacity of 6.1 m^3/s and 28.5 km long covers irrigated areas of about 8,120 ha and the LMC with the maximum capacity of 6.3 m^3/s and 52.6 km long covers 7,975 ha. There are 17 lateral canals with a total length of 136 km. The cultivation is divided into 2 seasons: the rainy season usually from June to October and dry season from November to May. The annual average rainfall in this area is around 1308mm.

(4) Management

The project is managed by Huay Luang irrigation project office under the Royal Irrigation Department (RID). For managing water allocation and distribution, the organisation is structured into a Water Master, Assistant Water Master and Zones Man officially under the Chief of Operation and Maintenance of the project office. In addition, Irrigation Community Organisers (ICOs) are employed permanently. The canal network is divided into 4 irrigation management zones in each main canal. There are 501 Water Users Groups in total with 6,600 farmers. Figure 8 shows the organisation chart of the project management.

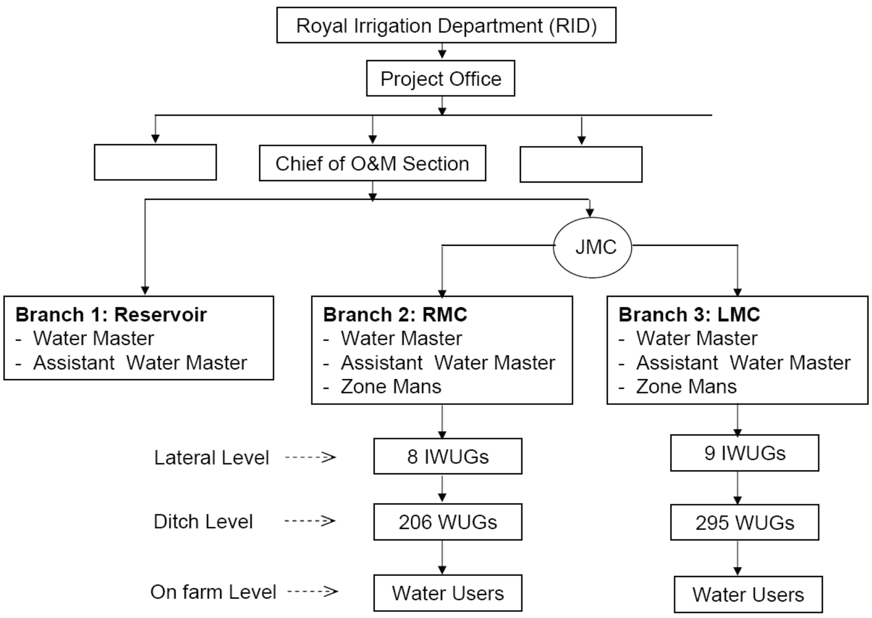


Figure 8: Organisation Chart of Huay Luang Irrigation Scheme Management

4.3.4 Go Cong Irrigation Project, Vietnam

1) Physical conditions

The Go Cong project is one of the typical tidal irrigation projects in the Mekong delta region. The project is located in My Tho City, Tien Giang province around 100 km from Ho Chi Minh City. It was initiated in early 1980s and completed in 1990. In 2001 the automatic measurement system for monitoring water level and salinity was installed. The project area covers 3 districts: Go Cong East, Go Cong West and Chogao district. The project area is bounded by a costal line of 166.7 km including 21 km of sea dike on the east and Tien Giang River on the south.

The project was constructed with two main objectives:

- Irrigation and drainage, and
- Prevention of salinity intrusion

The project has command area of 54,000ha and benefits 480,000 farmers in 36 villages of 3 districts. There are 14 canals composed of the main canal network with total length of 157km. The cropping seasons is composed of 3 rice-crops, the same as the typical pattern in the Mekong Delta, including Winter-Spring from mid November to mid March, Summer-Autumn from the beginning of May to the end of August, and Autumn-Winter from the end of August to the beginning of December.

2) Characteristics of Tidal Irrigation

In the Go Cong project water is supplied to the system through automatic gates at the main intake from the river. Almost all canals within the irrigation system are linked together and also with natural rivers without any control structure. The classification of the main, secondary or tertiary canals is not clear, but basically is made by its service area or dimensions.

Irrigation and drainage are practiced as combined activity within very dense canal network. Because of no gate control at on-farm canal level, farmers can take as much water as they need. During high tide period, flow from the Mekong River is diverted into the canal system and most of areas can receive water by gravity because of the high water level in the canals. During low tide period, however, water flows from the canal system back to the river and water levels become low. Farmers usually use their own pumps for providing water to relatively high elevation areas and use natural flow by gravity to relatively low area, depending on the level of water in the canals. Therefore the main point for facility operation is to maintain the canal water level as high as possible for gravity irrigation during each daily tidal cycle in order to avoid pumping cost.

The canals not only serve for irrigation purpose but also for navigation, environmental flows, and on-farm storage and for salinity intrusion prevention.

The same as the other projects in Mekong delta region, the common constraints on water use is inadequate fresh water for irrigation in dry season caused by high salinity (more than 2 g/l observed).

3) Management

In terms of water management, the project authority (Irrigation Management Company-IMC of Go Cong) is responsible for planning water supply, operation of head works (sluices), monitoring gate operation, checking water quality and informing farmers of the gate operation schedule. Water users are in charge of maintenance of on-farm canals. Water is taken to the field individually with their own pumps. Water users pay water fees to IMC via a local tax collector based on contracts between IMC and farmers. The rate is set as unit area per year with different cropping condition as follows.

- US$12 /ha/year for 2 or 3 rice-crops
- US$6 /ha/year for 1 rice crop
- US$6 /ha/year for fruit trees

47% of total water fee collected is allocated to IMC for system maintenance, 45% goes to the Districts, and 8% for tax collectors' salaries. Water fees were collected for around 90% of total command areas in 2005.

The organisation chart of Go Cong project is shown in Figure 9 as follows.

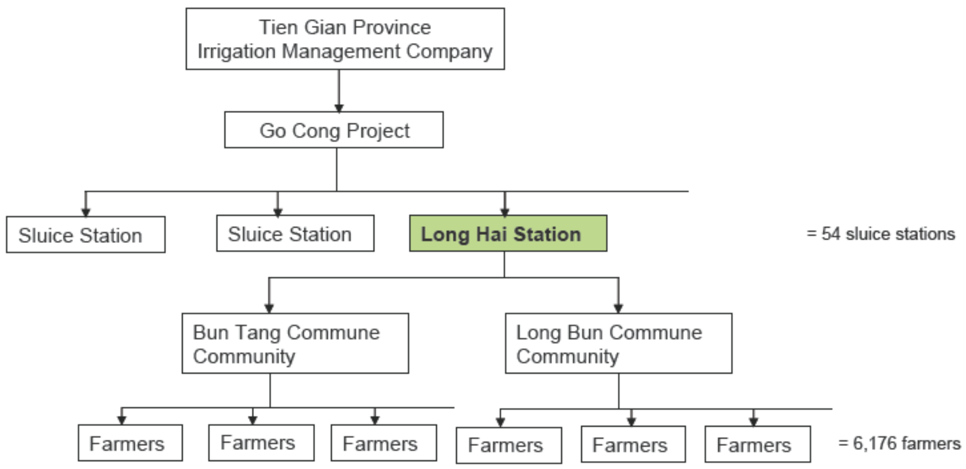


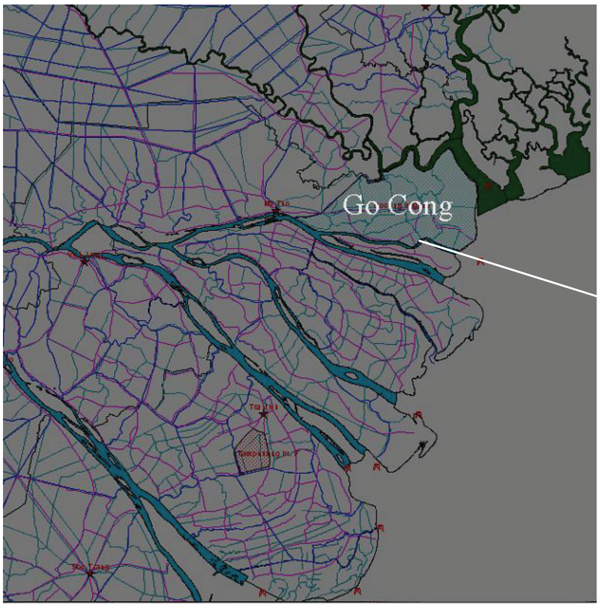
Figure 9: Organisation Chart of Go Cong Irrigation Project

(2) Longhai Irrigation Station

Considering the limitation of IIEPF framework, it is difficult to fully cover 54,000 ha of the command areas of Go Cong project. Therefore as a subcommand area, Longhai irrigation station area was selected as representative to conduct field observation activities.

1) Outline

The Longhai irrigation station is a sub-command area within the Go Cong project as shown in Figure 10. The total area is 924 ha, covering two communes of Long Binh and Binh Tan in Go Cong Tay district. The elevation ranges from 0.85 to 1.2 m above MSL. The total agricultural area is about 667 ha, of which there are 604 ha of rice field and 63 ha of upland crops and perennial plant. There are 1,225 families in the project area with a total of 6,176 people, who mostly rely on agriculture.



Long Hai sluice

Long Hai sluice in side command area

Figure 10: Longhai Irrigation Station at Go Cong Irrigation Project

2) Irrigation Practices

The Longhai station is managed by the Go Cong IMC, which is responsible for sluice gate operation. There are two main sources of irrigation water supply to the area, one from the main canal number 14 via HL 6 sluice under road No. 6 throughout the year and the other from the Tien River through Longhai sluice. The Longhai sluice not only functions for irrigation purposes, but also for drainage and salinity intrusion prevention as do other tidal irrigation projects in the Mekong delta. From August to November in general water is diverted in through this sluice as the primary irrigation water supply for the area. During this operation period, irrigation practice is set for a 5-days cycle: one day to intake water into system, three days for keeping water in the system and one day for to release water to drain salinity out from the system. During the dry period of December to July, the gate is opened once a week to flush salinity. Gravity irrigation is applicable for about 400 ha during this period.

3) Field Level

All the junctions between the tertiary, secondary and main canals are open without any control structures as shown in Photo 1. This is a characteristic of the canal system in the delta areas. The agricultural area partially uses gravity irrigation driven by tidal variation. The remaining area is irrigated by pumps. Each farmer has their own pumps and therefore they can use water when they need it (Photo 2). Since farmers manage water distribution individually on their fields by themselves, there is no water user group established in the area.

Photo 1: Junction between irrigation canals

Photo 2: Farmers bring water into their fields using portable pumps

4.3.5 Summary of the pilot sites

Table 2 summarises the general information of the four pilot sites and Figure 11 indicates the typical cropping pattern at those pilot sites based on information obtained from the projects' staff.

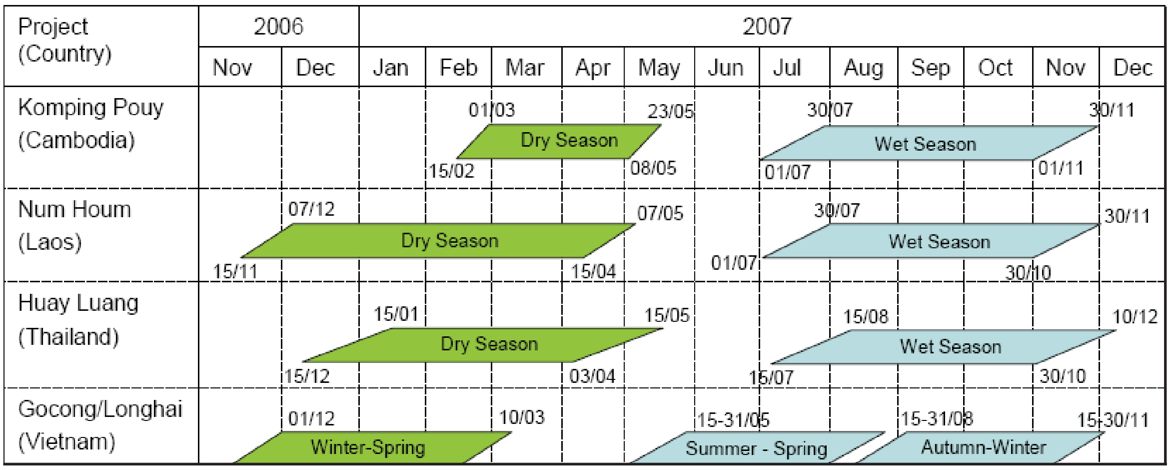


Figure 11: Typical Cropping Patterns of 4 Pilot Schemes

Table 2: Summary of 4 schemes

Figure Items	Komping Pouy Project	Num Houm Project	Huay Luang Project	Go Cong/ Longhai Project
Location	Battambang Province, Cambodia	Vientiane Capital, Lao PDR	Udonthani Province, Thailand	Tien Giang Province, Vietnam
Construction Period	1975	1978 phase 1 1990 phase 2 2000 phase 3	1940 phase 1 1970-84 phase 2	1980 - 1990
Rehabilitation Year	2002	None	2001	None
Irrigation Type	Gravity	Gravity	Gravity	Tidal
Current Command Areas	2,850 ha	2,400 ha - 93% paddy - 5% fishpond - 2% cash crops	16,095 ha (total) 7,975 ha (LMC)	54,000ha (Go Cong) 667 ha (Longhai) - 604 ha paddy - 63 ha cash crops
Number of WUAs	1 FWUC	3 WUAs	2 WUAs	2 Communities (for Longhai station)
Number of WUGs	16 WUGs	55 WUGs	490 WUGs	N.A.
Beneficiaries	1,200 families	19,879 farmers 17 Villages	6,600 farmers	Longhai: 1,225 families 6,176 farmers
Canal Type	Earth	Earth	Lining	Earth
Capacity of Main Canal Intake	16 m^3/s	7 m^3/s	$6.1m^3/s$ (RMC) $6.3m^3/s$ (LMC)	25 m^3/s (Go Cong) 2 m^3/s (Longhai)
Canal Length	Total: 38.020 Km	Total: 60.727 km 9.3 km (MC) 30.014km (SC) 16.827km (TC) 4.5 km (QC)	Total: 217.1 km 28.5km (RMC) 52.6 km (LMC) 136 km (total laterals)	N.A.
Reservoir Capacity	Max: 110 MCM Active: 90 MCM Dead: 20 MCM	Max. 60 MCM Min. 6 MCM	Max. 118.36 MCM Min. 5.250 MCM	N.A.
Average Yield	3 T/ha (wet season) 4 T/ha (dry season)	3.5 T/ha (wet season) 4.5 T/ha (dry season)	3.4 T/h (wet season) 3.7 T/ha (dry season)	5.55 T/ha (Winter-Autumn) 4.35 T/ha (Summer Autumn) 4.5 T/ha (Autumn-Winter)
Average Annual Rainfall	1,100 mm	1,700mm	1,300 mm	1200 mm
Water Fee Rate	10 US$/ha/season	15 US$/ha/season	N.A.	- 12 US$/ha/year for 3-rice crops - 6 US$/ha/year for 1- rice crop and fruit tree
% Water Fee Collected	50 % in 2005	46% in 2005	N.A.	90% in 2005
General Constraints	- Water shortage - Poor water distribution - Low Productivity - Inefficient water control measurement -Weak of WUAs	- Poor irrigation Infrastructures - Low skills of O&M - Low % of water fee collection - Low productivity - Weakness of farmers' participation	- Water shortage in dry season - Efficient water control at on-farm level - Lack of farmer's participation	- Shortage of fresh water in dry season due to high salinity -

4.4 Results by RAP initial assessment

The results obtained from the RAP initial assessment are analysed and summarised into 3 parts: external indicators, internal indicators, and IPTRID indictors. The accuracy largely depends on the reliability of input data and understanding of questions by surveyors. However as some input data was based on assumption, results shown here may not be highly reliable.

4.4.1 External Indicators

The external indicators are the product from irrigation scheme physical data, which is mainly composed of hydrological data including effective rainfall, project areas, crop type and crop evapo-transpiration, water supply, and production etc. Three-year data was required unless climate conditions were quite similar over 3 years or a longer period. The average values are used for computing external indicators. External indicators are ratios or percentages comparing scheme inputs and outputs and describe its performance, and are various expressions of efficiency related to economic productions, water distribution and crop productions. They do not provide any insight into what must be done to improve performance or efficiency, but will give an indication to conserve water and enhance the environment through improved water management.

The external indicators in 4 pilot projects are shown in Table 3 as follows.

Num Houm and Huay Luang projects use data of 2003-2005, but Komping Pouy project uses only 1-year data of 2005 due to unavailability. Longhai station of Go Cong project also uses 1-year data of 2005 only, because the climate condition was very different during 2003-2005.

Interpretations of some important key values of external indicators shown in the Table 3 are.

(1) Areas

The total command area is estimated as 10,050 ha in Komping Pouy project; 2,397 ha in Num Houm project; 13,918 ha in Huay Luang project; and 680 ha in Longhai station of Go Cong project. The irrigated crop area in command areas (including multiple cropping a year) were 3,282 ha, 5,199 ha, 15,229 ha, and 2,040 ha in Num Houm, Komping Pouy, Huay Luang, and Longhai of Go Cong project respectively. The irrigated crop area in Komping Pouy project is relatively small compared with the command area. This is because the project is still under rehabilitation. Only 3,282ha was rehabilitated in 1999 and is now ready to be cultivated. Water cannot reach the end of the other remaining area due to deterioration of the irrigation infrastructures.

Table 3: External Indicators

Item Description	Units	Komping Pouy	Num Houm	Huay Luang	Go Cong/ Longhai
Stated Efficiency					
Stated conveyance efficiency (seepage and spills)	%	65	65	57	60
Weighted field irrigation efficiency from stated efficiencies	%	60	58	68	60
Areas					
Physical area of cropland in the command areas (not including double cropping)	Ha	10,050	2,397	13,918	680
Irrigated crop area in the command area	Ha	3,282	5,199	15,299	2,040
Cropping intensity in the command area including double cropping	None	0.33	2.17	1.09	3.00
External sources of water for the command area					
Surface irrigation water inflow from outside the command area (gross at diversion and entry points)	MCM	18	47	65	41
Gross precipitation in the command area	MCM	92	38	172	8
Effective precipitation to irrigated fields (not including salinity removal)	MCM	6	37	93	3
Net aquifer withdrawal due to irrigation in the command area	MCM	0	0	0	0
Total external water supply-including gross ppt.and net aquifer withdrawal, but excluding internal recirculation	MCM	110	85	237	49
Water sources inside the command area					
Internal surface water recirculation/pumping by farmer or project in command area	MCM	0	0	0	0
Gross groundwater pumped by farmers within command area	MCM	0.07	0	0	0
Gross groundwater pumped by Project Authorities within command area	MCM	0	0	0	0
Estimated total internal source water	MCM	0.07	0	0	0
Irrigation water delivered to users					
Internal water sources are assumed to have a conveyance efficiency of:	%	88	88	86	87
Delivery of external surface irrigation water to users-using sated conveyance efficiency	MCM	11.83	30	37	24.61
Delivery of internal source water to users (surface recirculation plus pumping, with assumed conveyance efficiency)	MCM	0	0	0	0
Total irrigation water deliveries to users (external surface irrigation water + internal diversions and pumping water sources), reduced for conveyance efficiencies	MCM	12	30	37	25
Net Field Irrigation requirements					
ET of irrigated crops in the command area	MCM	18	41	90	6
ET of irrigation water in the command area (ET-effective precipitation)	MCM	12	4	-8	2
Irrigation water needed for salinity control (net)	MCM	0	7	0	0
Irrigation water needed for special practices	MCM	0	11	28	1
Total NET irrigation water requirement (ET-eff ppt+ salt control + special practice)	MCM	12	19	26	3
Other key Values					
Flow rate capacity of main canal (s) at diversion points (s) this year	cms	16	7	12	25
Actual peak flow rate of main canal (s) at diversion point (s) this year	cms	5.6	4	8	25
Peak NET irrigation requirement for field, including any special requirements	cms	1.9	5	9	0.3
Peak GROSS irrigation requirement, including all inefficiencies	cms	4.7	12	23	4.0
ANNUAL or One- Time External INDICATORS for the Command Area					
Peak litres/sec/ha of surface irrigation inflows to canal (s) this year	LPS/Ha	0.56	1.16	0.54	36.76
RWS Relative Water Supply for the irrigated part of the command area (To external water supply)/(Field ET during growing seasons + water for salt control-Effective precipitation)	none	9.76	4.52	9.92	15.06
Annual **Command Area Irrigation Efficiency** [100 x (Crop ET + Leaching needs-Effective ppt)/(Surface irrigation diversions + Net groundwater)]	%	40	41	38	8
Field Irrigation Efficiency (computed)= [Crop ET-Effective ppt + LR water]/[Total Water Delivered to Users] x 100	%	61	63	67	13
RGCC- Relative Gross Canal Capacity – (Peak Monthly Net Irrigation Requirement)/(Main Canal Flow Rate)	none	0.12	0.70	0.72	0.01
RACF – Relative Actual Canal Flow – (Peak Monthly Net Irrigation Requirement)/(Peak Main Canal Flow Rate)	none	0.33	1.15	1.18	0.01
Gross annual tonnage of agricultural production by crop type	m Tons				
Total annual value of agricultural production	$ US	1,208,375	1,963,258	10,412,142	1,933,920

(2) External sources of water for the command area

The total external water supply coming into the command area is higher in the Huay Luang project, totalling 237 MCM per year, compared with 110 MCM in Komping Pouy project, 85 MCM in Num Houm project, and 49 MCM in Longhai of Go Cong project. These values include gross precipitation and diverted water from the main canal, but do not include internal recirculation into command areas. Due to lack of available information, the circulated use of water resources inside the command area by pumping or other methods is not estimated in this assessment.

It is noted that effective precipitation in Komping Pouy project is relatively low (6MCM), but very high in Num Houm project (37 MCM) compared with gross precipitation in the command area. This is caused by different estimations on effectiveness of rainfall among the projects. Of the gross precipitation 80% in dry season and 40% in wet season are estimated as effective rainfall for Komping Pouy project, but 90% in dry season and 80% in wet season for Num Houm project. While 90% in dry season and 70% in wet season are applied for Huay Luang project, and 70%, 30% and 90% are used for Go Cong project. This estimation of the effective rainfall will be reviewed again for the final RAP assessment.

(3) Irrigation water delivered to users

The total irrigation water delivered to users comprises external surface irrigation water, internal diversions from main canal and pumped water, but this is reduced by assumed conveyance efficiency. The results are 12 MCM, 30 MCM, 37 MCM, and 25 MCM in the Komping Pouy, Num Houm, Huay Luang, and Longhai of Go Cong projects respectively.

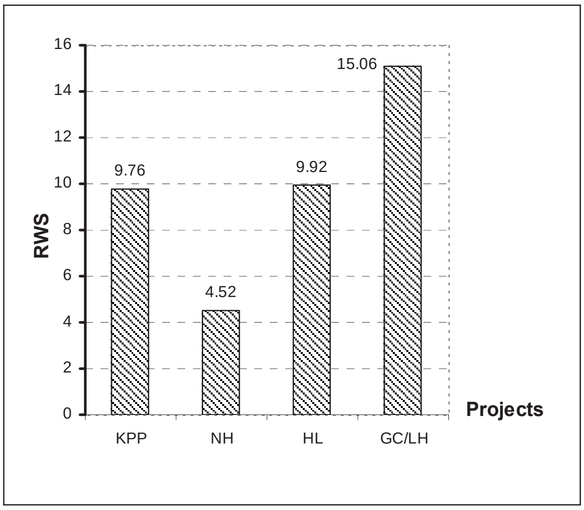
The lowest value is observed in Komping Pouy project. When conducting RAP initial assessment, a huge loss through spillways at the end of canals was observed. This fact can be interpreted that the main canal with an original design capacity for more than 10,000 ha needs excessive water diversions from the reservoir for the current cultivated area of 3,282 ha in order to keep water level high enough to deliver water to secondary and lower level canals. And this leads to the low value of this indicator although a large amount of water seems to be diverted into the command area.

(4) Relative Water Supply- RWS

RWS is defined as the ratio of total external water supply (including gross precipitation and net aquifer withdrawal to the scheme, but excluding internal recirculation) to water required by crops in the command area. Required water is composed of field evapo-transpiration plus water for salinity control minus effective precipitation. Based on the information from each project staff member there are no wells being used for irrigation in the system. Therefore, aquifer withdrawal from shallow wells is not examined at this assessment and water for salinity control is considered for Go Cong project only.

The RWS are 9.76 in the Komping Pouy Project, 4.52 in the Num Houm, 9.92 in the Huay Luang project and 15.06 in the Longhai of Go Cong project as given in Figure 12. Most schemes show high value of RWS, which indicates excessive water supply to its demand, is caused by poor water management in general.

However in case of Go Cong project, much water is diverted to the system to keep water level high not only for irrigation but also for navigation, salinity control and so on. That is why the RWS value is high compared with the water requirement. The real amount for irrigation is the amount removed by farmers but is not estimated in this assessment. It will be considered for the final assessment.



Note: KPP: Komping Pouy scheme; NH: Num Houm scheme;
HL: Huay Luang scheme; GC/LH: Go Cong/Longhai scheme;

Figure 12: Relative Water Supply

(5) Efficiencies

1) Command Area Efficiency:

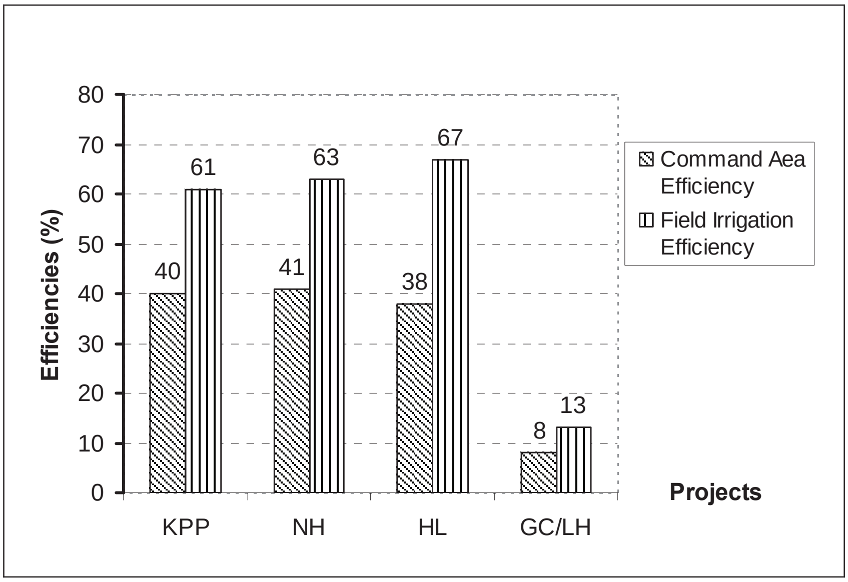
The command area irrigation efficiency is the ratio of system water requirement (crop evapo-transpiration plus leaching needs minus effective precipitation) to total irrigation water diverted into the system, which included surface irrigation and net ground water irrigation, but excluded gross precipitation. Leaching water needs are not counted at most schemes except Go Cong project and ground water supply is not examined for whole schemes.

The command area efficiency is shown in Table 3 and also in Figure 13. The value (around 40%) is not largely different among Komping Pouy, Num Houm and Huay Luang projects, but the value obtained from Go Cong project is very low (8%) compared with the other three schemes. This is caused because recycled use of irrigation water is not properly estimated, only diverted water into the system was considered as explained above.

2) Field Irrigation Efficiency:

This is the ratio of water required (by crops) to delivered (to users). Water delivery to the field obtained from diverted water to the system through main canal intake multiplied by conveyance efficiency. The assumed conveyance efficiency ranges from 86-88%.

The field irrigation efficiency is given in Table 3 and Figure 13. Over 60% is obtained in three projects, Komping Pouy, Num Houm and Huay Luang, but 13% only in Go Cong project because of the reason above mentioned.



Note: KPP: Komping Pouy scheme; NH: Num Houm scheme; HL: Huay Luang scheme; GC/LH: Go Cong/Longhai scheme;

Figure 13: Efficiencies

4.4.2 Internal Indicators

The internal indicators identify key factors related to water control throughout a project. They describe the level of water delivery service provided to users and examine specific hardware, management techniques and processes used for the control and distribution of water, and then give a detailed perspective of how the system is actually operated, and the water delivery service that is provided at all the levels. The identification of what actions must be taken to improve external indicators (i.e. scheme performance) comes from an examination of internal indicators

The internal indictors are estimated by information from project staff, water user group, and farmers from project level down to canal system and on- farm level. As Annex 11, the results are given by score at each service level. The score ranges from 1-4 (poor-excellent performance). The criteria of judgement and scoring depend on surveyors. Since each pilot scheme is evaluated by different team, some obtained results may not be consistent for comparison among four schemes.

(1) Representing values of internal indicators

Some major internal indicators values are selected from Annex 11 and summarised as Table. 4. Based on Table 4, internal indicators are interpreted as Table 5 below.

Judging from scores obtained from the field investigation in Annex 11, Table 4 and Table 5, the major observations are described as following sections project by project.

Table 4: Representing values of internal indicators

Level of Services	Indicator Name	Score 1- 4 (1: poor; 4 excellent)				
		Komping Pouy	**Num Houm**	**Huay Luang**		**Go Cong/ Longhai**
				RMC	**LMC**	
Service and social order	**Actual:** Water delivery to Individual Ownership Units (e.g., field or farm)	1.5	0.9	1.3	1.8	2.7
	Stated: Water delivery to Individual Ownership Units (e.g., field or farm)	1.2	2.0	2.5	2.5	2.7
	Actual: Water delivery service at the most downstream point in the system operated by a paid employee	0.7	0.9	1.4	1.4	2.6
	Stated: Water delivery service at the most downstream point in the system operated by a paid employee	1.7	1.4	0.8	0.8	1.4
	Actual: Water delivery service by main canals to second level canals	1.8	2.2	1.2	1.4	0.0
	Stated: Water delivery service by main canals to second level canals	2.8	1.6	3.3	3.3	1.8
Main Canal	Cross regulator hardware in main canal	1.7	1.9	3.3	1.9	N.A.
	Turnouts from main canal	2.7	1.7	2.8	2.3	N.A.
	Regulating reservoir in the main canal	0.0	0.0	0.0	0.0	N.A.
	Communications for the main canal	1.9	1.9	2.9	2.5	N.A.
	General conditions for the main canal	1.8	2.0	2.6	1.8	N.A.
	Operation of the main canal	2.1	2.1	2.3	2.1	N.A.
2nd Level Canals	Cross regulator hardware (2nd canal level)	1.0	1.3	1.6	1.4	N.A
	Turnouts from 2nd level canals	3.0	2.3	2.8	3.0	2.7
	Regulating reservoir in the 2nd level canals	0.0	0.0	0.0	0.0	3.7
	Communications for the 2nd level canals	1.6	2.1	2.5	2.7	2.8
	General conditions for the 2nd level canals	1.2	2.0	2.0	2.3	2.4
	Operation of the 2nd level canals	2.4	2.1	2.5	2.3	1.3
3rd Level Canals	Cross regulator hardware (3rd level canals)	1.0	1.0	1.9	1.4	N.A
	Turnouts from 3rd level canals	2.3	2.0	2.8	2.7	2.7
	Regulating reservoir in the 3rd level canals	0.0	0.0	0.0	0.0	3.3
	Communications for the 3rd level canals	1.2	1.5	2.4	3.1	2.0
	General conditions for the 3rd level canals	2.8	2.0	2.3	1.3	2.0
	Operation of the 3rd level canals	1.8	2.4	2.3	1.3	1.9
Budgets, Employees, WUAs	Budget	0.0	1.2	0.8	0.8	2.0
	Employees	2.0	2.4	2.1	2.1	2.9
	Water User Associations	1.5	1.8	2.0	0.6	0.6
	Mobility and Size of Operations Staff	0.0	3.0	0.0	0.0	0.0
	Computers for billing record management	0.0	0.0	1.0	1.0	1.0
	Computer for canal control	0.0	0.0	0.0	0.0	0.0
Ability of present water delivery service to individual field to support pressurized irrigation method		2.5	2.2	0.0	0.0	3.3
Special indicator that do not have a 0- 4 rating scale						
Turnout density	No. of water users down stream of employee-operated turnout	20	15	12	11	1
Turnout/Operator	(No. of turnouts operated by paid employees)/(paid employees)	1.8	40.6	4.7	4.7	1.5
Main canal chaos	(Actual/Stated) overall service by the main canal	0.64	1.38	0.37	0.43	N.A.
2nd level chaos	(Actual/Stated) overall service at the most downstream point operated by a paid employee	0.41	0.67	1.71	1.17	1.88
Field level chaos	(Actual/Stated) overall service to the individual ownership units	1.23	0.45	0.50	0.71	1.00

Table 5: Interpretation of internal indicators

Service Level	Komping Pouy Project	Num Houm Project	Huay Luang Project	Go Cong Project/ Longhai Station
Service and social order	• Poor of water delivery service at on-farm level • Fair water distribution from main to 2nd canal level • Good in social order in the canal system operated by employees	• Very poor water delivery at on-farm level • Good water distribution from main to 2nd canal level • Poor in social order in the canal operated by employees	• Poor of water delivery service at on-farm level • Poor water delivery service from main to 2nd canal level • Very good in social order in the canal by operated employees	• Good water delivery service at on-farm level • Very poor water deliver service to 2nd canal level • Good in social order in the canal by operated employees
Main Canal	• Poor operation and condition of cross regulators • Good condition and operation of turnouts • No regulating pond • Fair communication system • Fair general condition and operation of canal	• Fair operation and condition of cross regulators • Poor condition and operation of turnouts • No regulating pond • Fair communication system • Fair general condition and operation of canal	• Good condition and operation of cross regulators • Good condition and operation of turnouts • No regulating pond • Very good communication system • Good condition and operation of the canal	• Not conducted
2nd Level Canals	• Very poor condition and operation of cross regulators • Good condition and operation of turnouts • No regulating pond • Poor of communication system • Poor general condition of canal • Good operation of canal	• Poor condition and operation of cross regulators • Good condition and operation of turnouts • No regulating pond • Fair communication system • Fair general condition and operation of canal	• Poor condition and operation of cross regulators • Very good condition and operation of turnouts • No regulating pond • Good communication system • Good general condition and operation of canal •	• No cross regulators along the canal • Good condition of turnouts • Very good regulating pond • Very good communication system • Good general condition of canal • Poor operation of canal
3rd Level Canals	• Very poor condition and operation of cross regulators • Good condition and operation of turnouts • No regulating pond • Poor communication system • Good general condition of canal • Poor operation of canal	• Very poor condition and operation of cross regulators • Fair condition and operation of turnouts • No regulating pond • Poor communication system • Fair general condition of canal • Good operation of canal	• Poor condition and operation of cross regulators • Very good condition of turnouts • No regulating pond • Good communication system • Fair general condition of canal • Good operation of LMC, but poor of RMC	• No cross regulators along canal • Good condition of turnouts • Good regulating pond • Fair communication system • Fair condition and operation of canal
Budgets, Employees, WUAs	• Very weak of budget status • Fair status of employee • Weak of WUA performance	• Weak of budget status • Good status of employees • Weak of WUA performance	• Weak of budget status • Fair status of employees • Fair performance of WUAs in LMC, but poor in RMC	• Fair status of budget • Very good status of employee • Weak of WUA performance
Mobility and size of operations staff	• Poor mobilisation of staff	• Good mobilisation of staff	• Poor mobilisation of staff	• Poor mobilisation of staff
Computer used in the project	• No computer used in the project	• No computer used in the project	Computers used in the project	• Computer used in the project
Support pressurize irrigation	• Good to support pressurised irrigation method	• Good to support pressurised irrigation method	• Poor to support pressurised irrigation method	• Very good to support pressurised irrigation method

(2) Komping Pouy Project

1) Service and social order:

The project has poor water delivery service at on-farm level. The detailed score in Annex 11 indicates that the poor performances are mainly caused by limitation of flexibility and reliability.

The actual operating services which are the responsibility of the paid employee at the most downstream, or tertiary canal in this project, are also relatively poor, particularly compared with what project staff state. Annex 11 shows that the water volume is not controlled and measured properly.

The water delivery service between main and secondary canal levels is almost fair, but lacking equity and that makes the performance lower than average.

2) Ratio of observed and started conditions:

The special indicators shown at the end of Table 4 indicate the gap in the observed and stated conditions as ratios.

In Komping Pouy scheme, the team overestimates performance of the main and the secondary canal levels, but underestimates it at field level. In other words, the scheme functions better than the project managers believe at the main and secondary canal levels, but worse at the field level.

3) Cross regulators:

Poor operations of cross regulators are found in the main canals, especially in the second and the third canal levels. They are still in good physical and operational conditions, because they are newly constructed, however they are not operated and controlled properly. Inappropriate operation of cross regulators has resulted in water fluctuation and inconsistent travel time of flow rate change throughout the canals.

4) Turnouts:

Observation reveals good performances of the turnouts in each canal level. They are operated according to the designed schedule. As the turnouts are regularly maintained, they are still in good condition and function well. The flow rates through turnouts are estimated by operators with existing H-Q curves. The high performance of turnouts is especially found at the second canal level.

The turnout density, which means the ratio of water users by turnouts or outlets, is high in the Komping Pouy scheme with 20 water users per one turnout. However one operator is responsible for approximately 2 outlets only. This means water operators seem sufficient in this scheme.

5) Regulating reservoir:

There is no regulating reservoir in the scheme. Thus the scores Table 4 and Annex 11 shows “0”, but it does not mean poor performance.

6) Communication:

The communication performance is poor throughout all levels and particularly in the secondary and lower levels. Lack of communications with higher levels is one reason. The other is poor reliability of voice communications by phone or radio. Furthermore there is no remote monitoring at key spill points such as spills along the canal or canal end. Mobile phones are not used in the field level except by project officers. Communication is usually made by meeting. Road accessibility along the canals is also poor.

7) Canal conditions:

The score of the general conditions of each canal is at average level. Canals show good cross section shape with little erosion on the bank. The maintenance level is also excellent because regular maintenance has been conducted before every cultivation season, although the project is still lacking proper equipment and staff to adequately maintain the canals.

8) Canal operation:

The operation of the main canal is evaluated as slightly better than the average level. The reasons are effective water ordering/delivering procedures to adequately meet water demand, appropriate instructions to operators and frequent canal inspections and its reporting system to the offices. However weakness is also found in terms of real time feedback of monitored water distribution between operators of the main regulator and of each gate along the canal.

The operation of secondary canal level is quite good with the same reasons described as before. However one observed weakness is the lack of clear instructions to operators.

The third level canal operation is poor compared with other higher levels. Real time feedback of water distribution is poor, water ordering/delivering procedure to meet actual demand is ineffective, and instructions to operators is not clear enough, even though the problems are often checked and reported to the office.

9) Budgets, employees and WUAs:

The project has no budget available for system operation and maintenance (O&M). The water fee or any other in kind services to support O& M and modernisation activities has not regularly been collected from water users or allocated by the government. However the project collected water fees from farmers in the 2005 dry season and another budget from ADB and other international sources supporting modernisation is made available at present. Therefore in terms of budget the result may not be reliable and needs further clarification at the final RAP assessment.

The status of the project employees is also at average level. Training concerning system management and water distribution is provided regularly to the staff by foreign technical assistance. Rewards are also provided to the staff when showing excellent performance, although the project does not have documented rules for evaluating project staff performances.

The performance of WUAs is poor. The limited participation of water users contributing to water distribution is the main reason and weak financial status is the other.

10) Ability to support pressurized irrigation system:

The score on the ability to support pressurised irrigation to individual fields under the current water delivery service is relatively high in Komping Pouy project compared with Huay Luang project, although the Huay Luang project has better conditions and facilities and is more intensive in terms of water control and management. The differences seem to be caused by inconsistent judgments given by the different evaluators , i.e. RAPs in these two projects were facilitated by different resource persons of FAO. This issue will be discussed with FAO and clarified and adjusted if necessary at final RAP conducting.

(3) Num Houm Project

1) Service and social order:

The water delivery service at on-farm level is relatively poor, although project staff stated it at average level. Volume is not measured through the gates, and water delivery is weak on its flexibility.

Water delivery service at the most downstream points in the system operated by a paid employee (outlet of secondary canal level) is lower than the average level, although the score given by the project staff is higher than the average. Lack of water volume control, its flexibility, reliability and equity is the reason.

The water delivery service from the main to the secondary canals, however, performs higher than the average and higher than stated condition. The equity of water delivery at the inlet of secondary canal is quite high.

The social order in the canal system operated by the paid employees such as “degree to which water delivery are not taken when not allowed,” “lack of vandalism of structure” and “noticeable non-existence of unauthorised turnouts from canal” etc is recognised as low, since scores given in these items are zero (0) as shown in Annex 11.

2) Ratio of observed and started condition:

In contrast with the Komping Pouy scheme, the comparison of the scores between actual and stated conditions in Table 4 shows that the condition is underestimated at the main canal and overestimated at the secondary and lower canal levels.

3) Cross regulators:

The physical and operational conditions of cross regulators are evaluated as slightly lower than average level along the main canal. Cross regulators can be easily operated by the staff, but water fluctuation is high due to inappropriate operation. At the secondary and third canal levels, the cross regulators show very poor performance. This has been caused by the high water fluctuation along the canals and long travel time of flow rate change resulting from fluctuation throughout these canal levels.

4) Turnouts:

Turnout facilities of the main canal are not in good condition. This makes it difficult to run a good operation and to control volume of water. However at the secondary and the third canal levels, they function quite well. They provide for easy operation and controlling flow rate through the gates, but are still lacking in maintenance, especially at the third canal level.

One outlet supplies water for 15 water users which ranks as the second highest among the four schemes and one employed staff covers 40 turnouts each, which could indicate that additional staff are required for appropriate system operation.

5) Regulating reservoir:

There is no regulating reservoir in the Num Houm scheme. Thus the score appeared in Table 4 and Annex 11 is “0”, but it does not mean the poor performance.

6) Communication:

The communication is evaluated as slightly lower than the average level. Farmers and all the project staff can communicate each other by cell phone. Good dependability of telephone communications and frequent visits by upper level supervisors to the fields are observed, but there is lack of communication between gate operators and both farmers and reservoir operators.

At the secondary canal level, communication is evaluated as slightly higher than the average level. There is frequent communication with the higher level or project staff and dependability thorough cell phone useage, but still miscommunication occurs between operators and their farmers.

The communication at the third canal level is relatively poor due to the weakness of communication among project staff, operators and farmers.

7) Canal conditions:

The physical conditions of the main, the secondary and the third level canals are average. Seepage observed from the canals was not at a critical level. Access by the material suppliers for maintenance is also easy. However the availability of proper equipment and staff to adequately maintain the canal system is still insufficient.

8) Canal operation:

The canal operation is evaluated as better than the average level at the entire canal system and especially at the third canal level. Real time feedback from water receivers to suppliers at whole canal levels is secured. Effective water ordering/delivering procedures to meet actual demands in main canal and correct instructions to operators at the secondary and the third level canals are also secured. However water ordering/delivering procedures together with procedure to check and report problems to the office are ineffective or weak at the secondary and the third level canals.

9) Budgets, employees and WUAs:

The project budget status is weak. A limited a budget is available which is mostly collected as water fees and mainly spent for operation and maintenance. No budget is available for scheme modernisation and rehabilitation.

The performance of employees is evaluated higher than the average level. Employees have power to make decision by themselves for water allocation based on documented performance rules in the management activity. Operators are provided a higher salary than day labourers.

The function of WUAs is, however, evaluated lower than the average level. Although there is legal basis for the WUAs, participation of water users and project staff in water allocation as well as financial status is weak.

10) Ability to support pressurized irrigation system:

This project has shown potential and ability to support pressurised irrigation systems through its present conditions of water distribution practice judged from obtained scores. However, observation has revealed that physical conditions of the project facility is less suitable and water management of the project is less intensive than the Huay Luang scheme, although the project scored higher points than Huay Luang scheme. The same interpretation could be applied as for the Komping Pouy project.

(4) Huay Luang Project

In case of the Huay Luang project, investigation for internal indicators was conducted by two teams, one on the RMC and the other on the LMC. Therefore the obtained scores vary depending on the judgment of each team. Major findings are described as follows.

1) Service and social order:

The water delivery services at on-farm level or to individual ownership unit are poor and worse than the stated conditions, especially at the LMC. The reasons are no volume measurement through the gates, weakness of flexibility in the LMC and lack of water availability in the RMC.

The water delivery services observed at the most down stream point operated by employees seem to perform better than the stated conditions. In particularly there is good flexibility, reliability and apparent equity.

The water delivery services by the main canal to the second canal level were evaluated as poor, and worse than the stated conditions. Water control is weak in particular, while the stated conditions gave the full score on this point.

The score representing the social order in the canal system operated by employees is relatively high compared with other schemes, especially in terms of "the noticeable non-existence of unauthorised turnouts from canals" and "lack of vandalism of structures."

2) Ratios of observed and started conditions:

The comparison of the scores between the actual and the stated conditions of the Huay Luang scheme has shown that project managers underestimated at the second canal level, and overestimated at the main and field levels.

3) Cross regulators:

The cross regulators are still in good condition and well operated at the main canal level. Although there is some water fluctuation at the RMC, maintenance level is high and travelling of flow rate change is good.

The operation of cross regulators at the secondary and tertiary canals is, however, relatively poor. This is caused by high water fluctuation along these canal levels.

4) Turnouts:

Evaluation has given high scores for turnouts for the whole canal levels in general. They are well maintained and in good condition and easy for operators to manipulate. While the observation has found that many Canal Head Orifice (CHO) gates are installed as turnouts of the main and the secondary canal levels, they are not appropriately operated in terms of its theory. CHO gates are composed of two gates as a pair and are supposed to operate together for supplying water smoothly without high water fluctuation. However only one of those two gates was actually operated and the other was permanently closed. The project staff gave the reason as the fact they have difficulty and limited experience to control them properly.

Special indicators at the end of Table 4 show that one outlet supplies water for 12 water users and one employed staff is responsible for operation of 5 turnouts each, which could be understood that additional staff is not necessarily required for system operation.

5) Regulating reservoir:

There is no regulating reservoir in the Num Houm scheme. Thus the scores appearing in the Table 4 and Annex 11 are "0", but it does not mean the poor performance.
An old reservoir, because it serves to the RMC as external source, is not considered as regulating reservoir.

6) Communication:

The communication level is good for all the canal levels because of frequent communication with higher levels and supervisors or project staff being maintained. Mobile phones and radios are used for communicating within the project. The project is also equipped with good roads, which allow easy access to each canal level. However, the spill points from the secondary and the third canal levels are not monitored well.

7) Canal conditions:

General physical and operational conditions of the canals are evaluated as better than the average at whole canal levels. Seepage along the canals is controlled well. One of the reasons is concrete lining. The scheme location, not far from the town, allows the project easy access to material suppliers when maintenance work is needed and this helps maintain the canals in good conditions.
However the condition of the RMC seems to be poor concerning maintenance level. Availability of proper equipment and staff to adequately maintain the canals also seems to be insufficient.

8) Canal operation:

The main and the secondary canals are operated better than the average level. The reasons are that 1) instructions to operators are clear and 2) problems are checked/reported to the office frequently.
The third canal level for the RMC is, however, poor in its operation, as the feedback is not quick enough when water supply does not match with demand.

9) Budgets, employees and WUAs:

The project stated that some budget was available for scheme modernisation and rehabilitation purposes coming mostly from government subsidy, but no budget was available for scheme operation and maintenance purpose, nor was it collected from water users. However the observation has found that the project receives a budget every year from the government for scheme operation and maintenance activities. This contradiction will be reviewed at the final RAP.
The performance of employed staff is evaluated slightly better than the average. The documented rules for evaluating staff performance on a yearly basis are available, and a relatively good salary (compared to day labourers) is paid to operators. But the project is still lacking procedure both to dismiss employees when there is cause and to reward them for their exemplary services.
The performances of WUAs are evaluated as average in LMC, but significantly weak in the RMC. The weakness of the WUAs in the RMC is due to less participation to water distribution practice and weakness of financial status of the groups.

10) Ability to support pressurised irrigation system:

The observation has revealed that the present situation of the scheme is not good to support pressurised irrigation because of limited flexibility and reliability to control flow rate properly.

As described in Komping Pouy and Num Houm projects, the observation found that although the Huay Luang project was equipped with better physical facilities such as the gates and the canals in good condition, the score of Huay Luang project for pressurised irrigation is lower than those of Komping Pouy and Num Houm projects. This contradiction is caused by the judgement of different evaluators between these three schemes. The final RAP will carefully review this point.

(5) Go Cong Project

As mentioned earlier in this report, the characteristic of this Mekong delta irrigation system is unique among the pilot sites and some RAP indicators may not be effective or appropriate to explain this uniqueness of the project. However an attempt was made to interpret internal indicators and the result is as follows.

1) Service and social order:

Due to limitation of the project framework, the RAP assessment was conducted not on the whole Go Cong project area but the Longhai station area only. HL6 (Houng Lo 6) sluice is considered as the inlet of the secondary canal. The water delivery service from main to secondary canal level has been evaluated relatively poor, because the sluice operation with its fixed schedule shows lack of flexibility and reliability. The volume of water through the sluice was also not measured.

However good performance of water delivery to individual fields was observed in spite of no volume measurement. Farmers individually bring water to the fields by their own pumps at any time as they wish. This practice is considered to guarantee high flexibility and apparent equity.

The social order in the canal system operated by paid employees has been evaluated as the highest score since there is high score on “degree to which deliveries are not taken when not allowed,” “noticeable non-existence of unauthorised turnouts from canals” and “lacking of vandalism of structures.”

2) Ratio of observed and stated conditions:

In case of Go Cong project, the project managers have underestimated the performances in the second canal level but at field canal level their evaluation is same as that observed. The main canal was not evaluated at this first RAP assessment.

3) Cross regulators:

As described earlier, there are no cross regulators along canals. Water level control within the canal system is made by intake gate operation at the secondary canal level only.

4) Turnouts:

Assessment was not conducted at the main canal level, thus no result is shown in Annex 11 and Table 4. HL6 (Houng Lo 6) sluices can be considered as turnouts of the main canal, but the result (or score) is not representing whole turnouts along the main canal of the Go Cong scheme.

At the secondary and the third canal levels, pumps of individual farmers have been considered as the turnouts and shown high performance. The pump is usually easy to operate and can be repaired by farmers themselves when a problem occurs. The volume of water supply can also be definitely identified. Therefore the score giving to the turnouts (i.e. pumps) is relatively high.

5) Regulating reservoir:

Although the system has no regulating reservoirs in its design, the canals have a regulating function. Since farmers can take water from the canals when they want to irrigate their own fields, the canals in each level are therefore functioning as regulating ponds and they have shown high performance, especially in terms of operation as well as storage and buffer capacity.

6) Communication:

The level of communication is quite high since there is intensive communication between lower and higher levels (sluice operators and the project staff), and the project staff regularly monitor the sluice gate operation.

7) Canal conditions:

The general conditions of the secondary and the third canal levels have been evaluated as average since there is not much seepage loss. The observation has found that the canal condition is difficult to judge because the canal characteristic is similar to natural rivers. As mentioned in earlier, the canal functions not only for irrigation but also for drainage, navigation, and salinity control purposes. The access to the third canal level is difficult or sometimes impossible by road but easy by boat.

8) Canal operation:

The operation is not required at the secondary canal level because of no control structure, but pump operation is considered as tertiary canal level operation. The performance at tertiary canal level (i.e. pumps) is higher than the average.

9) Budgets, employees and WUAs:

The project has fairly good budget status. Their budget is from water fee collection and from the government support for regular structure maintenance.
The status of employees is also good because of frequent training opportunities for staff, documented operation rules, rewards for employee service and relatively good salary for operators compared to day labourers. Computers are used in the project for billing and recording management data.
The communities are considered as WUAs in this project. Their performance seems to be poor since there is little participation for water distribution and limited ability to influence real-time water deliveries.

10) Ability to support pressurized irrigation system:

The project has high potential and ability to support pressurised irrigation system because pumps are applied in the project and allow for supplying water with pressure. However management procedures and hardware systems will have to change if pressurised irrigation is to be applied.

4.4.3 IPTRID Indicators

IPTRID (International Programme for Technology Research for Irrigation and Drainage) also defines and provides external indicators. However some indicators are the same as (or duplicated with) the RAP external indicators shown in Table 3. Therefore, Table 6 shows some (but not all) IPTRID external indicators, which are not shown in Table 3.

The explanation does not cover all the indicators, but points out some selected important indicators (marked by **<u>bold and underline</u>** in the following table) as follows.

Table 6: IPTRID Indicators

Value				Description
Komping Pouy	Num Houm	Huay Luang	Go Cong	
7,317	638	36,928	11,807	Gross revenue collected from water users, including in-kind services, $US
489,463	**857**	**1,075,000**	**8,231**	**Total management, operation and maintenance cost of project, $US**
390	311	50,000	2,870	Total annual (Project + WUA) expenditure on system maintenance, $US
341	612	576,488	3,486	Total cost of personal in the project and WUAs, $US
75	14	127	6	Total number of personal employed by the Project and WUAs
1,208,375	1,963,258	10,412,142	1,933,920	Total annual value of agricultural production at the farm gate, $US
18	41	90	6	Total annual volume of water consumed by the crops (ET)-MCM
1,811	19,523	4,704	n.a.	Annual irrigation water delivery per unit consumed area (m^3/ha)
5,545	9,001	4,299	n.a.	Annual irrigation water delivery per unit irrigated area (m^3/ha)
65	65	57	60	Main system water delivery efficiency, %
6.2	2.1	2.6	n.a.	Annual relative water supply *** does not include rice deep perc.***
1.0	1.1	0.7	n.a.	Annual relative irrigation supply***does not include rice deep perc.***
3.41	0.58	0.54	n.a.	Water delivery capacity
90	100	36	80	Security of entitlement supply, % received
0.01	**0.7**	**0.0**	**1.4**	**Cost recovery**
0.05	0.49	1.35	0.24	Maintenance cost to revenue ratio
49	0	77	12	Total MOM cost per unit area (US$/ha)
5	44	4,539	581	Total cost per person employed on water delivery (US$/ha)
0.78	0.32	n.a.	0.59	Revenue collection performance
0.0075	0.0058	0.0091	0.0088	Staffing numbers per unit area (Persons/ha)
0.00062	0.00002	0.00099	n.a.	Average revenue per cubic meter of irrigation water supplied (US$/$m^3$)
1,208,375	258	10,412,142	1,933,920	Total annual value of agricultural production (US$)
120	819	748	2,844	Output per unit serviced area (US$/ha)
368	**378**	**684**	**948**	**Output per unit irrigated area (US$/ha)**
0.0664	0.0420	0.1151	n.a.	Output per unit irrigation supply (US$/$m^3$)
0.0679	**0.0480**	**0.1151**	**0.3414**	**Output per unit water consumed (US$/$m^3$)**

*The following are data items that have been defined by the IPTRID Secretariat in the publication.
"Guidelines for Benchmarking Performance in the Irrigation and Drainage Sector", December 2000.

(1) O&M cost

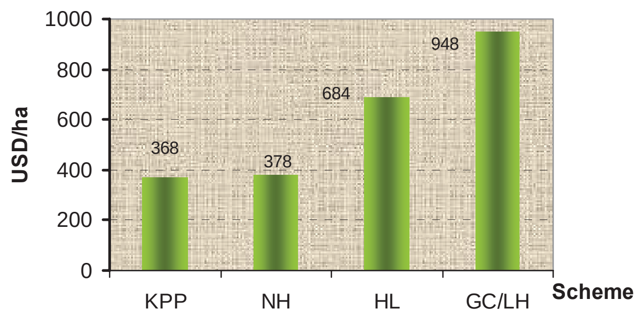
The highest budget is allocated for operation and maintenance cost of the scheme in the Huay Luang project. This project regularly receives running budget for daily O&M. The available O&M budget is lowest in the Num Houm project. This project does not receive budget support for scheme O&M from any sources and other purposes. Although the project is owned by government, the government does not allocate budget. The collected water fee only can be used for all the activities of the scheme management including O&M and staff employment.

(2) Cost Recovery

The cost recovery rate is the highest in Go Cong project. This might be because the high percentage of water fees (higher than 80%) could be collected every cultivation season in the project. Huay Luang and Komping Pouy projects show low cost recovery rate. Field investigation has revealed that the water fee has not been systematically collected yet and only small amounts needed for canal maintenance are collected from time to time. Although the water fee is collected in Komping Pouy project, it just started in 2006 dry-season cultivation and the collected percentage is still low (around 30%). The rate of water fee is also low (around 0.5 US$/ha) compared with Num Houm Project in Lao PDR (around 1.2 US$/ha).

(3) Output per unit irrigated area, US$/ha

The highest value is observed in Go Cong project of US$ 948/ha. The second highest is in Huay Luang project of US$684/ha. The low values, around half of that in Huay Luang project, are shown in Komping Pouy and Num Houm projects. One of the reasons of high value in Go Cong project is that an intensive cropping system (3 crops a year) is applied. The project has higher production compared with the same area in other projects. The other reason is the higher price of rice in Mekong Delta. In Huay Luang project, although 2 crops a year are produced, as in the other 2 projects, crop diversification is largely practised in the dry season with crops such as soybean, sugarcane etc. These crops are usually sold at higher prices than rice. The price of rice in Thailand is also higher than in Lao PDR and Cambodia. This contributes to the high output from Huay Luang project. The value of output per unit-irrigated areas is presented in the Figure 14 as follows

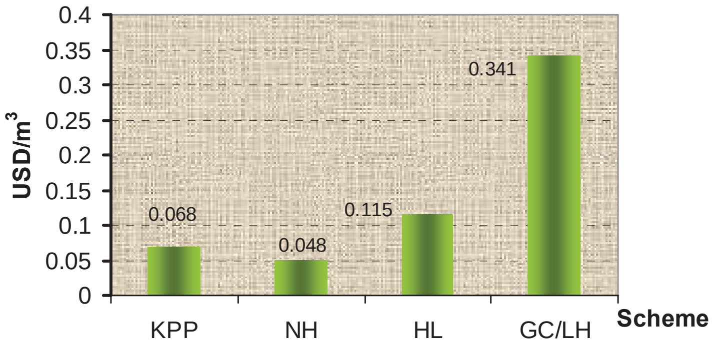


Note: KPP: Komping Pouy scheme; NH: Num Houm scheme;
HL: Huay Luang scheme; GC/LH: Go Cong/Longhai scheme;

Figure 14: Output per unit-irrigated areas, USD/ha

(4) Output per unit water consumed, US\$/m^3

The result shows that the highest value of US\$0.34/m^3 is recorded in Go Cong project. The reasons would be the highly intensive cropping system with combination of rice and others. The water productivity of Num Houm project is slightly lower than that of Komping Pouy project. Based on field investigation, there is a lot of fish breeding activity practised in Num Houm project, however in this RAP assessment, fish production was not counted due to lack of information. The values of water productivity are shown in Figure 15 as follows.



Note: KPP: Komping Pouy scheme; NH: Num Houm scheme; HL: Huay Luang scheme; GC/LH: Go Cong/Longhai scheme;

Figure 15: Output per unit water consumed, US\$/m3

4.5 Modernisation Plan

Following data collection, input and analysis, the fieldwork teams have prepared short presentations regarding system modernisation plans based on the results obtained from the RAP assessment. The idea of this work is to measure how team members understand the system situation based on interpretation of the RAP results, to brainstorm a modernisation plan and to learn how to propose that plan for implementation.

The guideline to prepare presentations provided to the teams is attached as Annex 12. The vision and objectives of modernising systems, the main problems identified from the RAP results, the strategy and options to improve and modernise systems and estimated costs are the items which were required for inclusion in the presentation.

Table 7 summarises the content of the presentations of three schemes. PowerPoint presentations prepared by the teams are made available in Annex 13. Go Cong scheme did not conduct a presentation, instead focus was put on oral discussion and brainstorming among participants regarding current problems and counter-measures needed to improve and modernise the scheme.

Table 7: Summary of the presentation contents for Modernisation plan

Contents	Komping Pouy Scheme	Num Houm Scheme	Huay Luang Scheme
Vision	• To ensure enough water for irrigation schemes, reduce water fee to increase income for all the farmers and sustainable management	• To be model irrigation system with complete infrastructure, effective management, and empowered WUAs	
Objectives	• To improve existing irrigation areas • To rehabilitate irrigation areas • To empower farmers water users' groups	• To increase water use efficiency and productivity • To increase farmers' income • To achieve sustainable system operation	• To improve irrigation water efficiency in each canal level • To avoid insufficient water in dry season • To strengthen project staff & WUGs • To increase productivity
Major constraints	• Incomplete infrastructure system • Low field irrigation efficiency • Low agricultural production • Irrigation water drained out of the command area • No regulating reservoirs in the command area • Lack of communication facilities and procedure • Poor physical conditions of on-farm level • Inefficient water control and measurement		• Farmers do not know the quantity water supplied & received • Lacking of flow monitoring equipment • Lacking of budget support for system management • Supplied water does not meet water demand in some areas • Too many structures, difficult to cover whole operation appropriately • Some farmers are not active in PIM because they are earning from other sources, not agriculture • Some farmers renting land for cultivation make it difficult to manage water fee collection, and make plans for water supply
Strategies proposed	• To rehabilitate existing irrigation structures • To extend irrigation areas • To strengthen capacity of FWUC & WUGs • To strengthen O&M	***<u>Hardware:</u>*** • Rehabilitation & improvement of existing irrigation infrastructures including roads, drainage system and on-farm canals • Providing water measurement devices for monitoring flow, runoff & spills • Improve IT system to improve water distribution • Strengthen irrigation facility protection • Providing heavy machines for scheme O&M activity ***<u>Software:</u>*** • Improve project management plan • Add 3 more project staff • Strengthen WUAs • Increase collecting rate from 32% to more than 90% • Improve system operation and service toward more flexible and user oriented model	• Capacity building of project staff & WUGs • Providing instrument for water allocation monitoring • Allocating budget, bonus for working overtime, gasoline, phone card, etc. • Making plans for reserving water (regulating reservoir, fishpond, etc)during the shortage period • Training to farmers how to estimate water quantity • Allocating budget to support activities of agriculture extension, land development, etc, to promote and improve crop yield.
Cost estimation	US$ 7,417,500	US$ 2,249,500	

According to Table 7, Annex 13 and oral discussion of Go Cong scheme, it can be summarised as follows.

4.5.1 Komping Pouy scheme

The team has set the modernisation vision as a five year plan which would ensure sufficient water, reduce water fees and increase household incomes. In order to achieve this vision, the team has set objectives to improve existing irrigation infrastructure and irrigated areas and to empower WUGs.

The major constraints of the scheme pointed out are incomplete irrigation infrastructure including drainage systems, low field irrigation efficiency and productivity and lack of water allocation monitoring and communication.

In order to solve these problems, the team has set its main strategy as rehabilitation of existing infrastructures, expansion of irrigated areas and strengthening of project staff, FWUG and O&M activities.

To realise these, the necessary budget is estimated as US$ 7,417,500. In other words unit cost of approximately US$2,600/ha for current total irrigated areas of 2,850 ha.

4.5.2 Num Houm scheme

The team has shown the vision to step forward to be a model irrigation scheme with complete infrastructure, effective water use and empowered WUAs. To reach this vision, three main objectives have been set: To increase water use efficiency and productivity, to raise farmers' income and to ensure long term sustainability for operation.

The constraints of the project have not been identified. However to achieve the objectives, the strategies have been set and categorised into hardware and software aspects as shown in Table 7. The main strategy focuses on improving infrastructures, IT and communication system as well as monitoring flow as the hardware improvement. For the software improvement strategy, the focus is placed on improvement of the management plan, strengthening WUAs and improving service systems to increase the water fee collection rate.

The necessary budget has been estimated as US$ 2,249,500 to cover whole strategies proposed, considering total present areas of 2,400 ha and unit cost of approximately US$ 937/ha, which is less than half of that for Komping Pouy project.

4.5.3 Huay Luang scheme

The objectives of modernisation in this project have been set as improving irrigation water efficiency, guaranteeing solving water shortage problems; strengthening WUAs and increasing water productivity.

The major problems of the project have been summarised as Table 7, and concern water allocation, insufficient instrumentation and budget support as well as PIM.

To achieve the objectives, the strategy has also been set as shown in Table 7 with the focus mainly on improvement of water allocation, capacity building and encouraging PIM activity.

The necessary budget has not been estimated for this project.

4.5.4 Go Cong scheme

As mentioned earlier, a slide show presentation has not been prepared for this project, however the oral discussion was made for brainstorming ideas among the team regarding current problems and counter-measures to improve and modernize the scheme.

The directors of Go Cong project have pointed out that the current important issues and needs for the project improvement are:

- The saline density in the project area. To prevent and control salinity institution is one of the highest priority issues of the region.
- The characteristic of water level changes in the canal system because this is essential information to set up irrigation schedules for farmers for their cultivation needs. Currently farmers have no idea about how water levels change daily in the canal system. If the water level can be predicted, farmers can choose by pumping or gravity. As pumping cost is very expensive, farmers prefer to control water by gravity to get higher profit.
- In order to improve the project, installation of more gates is proposed in order to control water level more delicately and precisely. This will allow farmers to apply gravity irrigation for longer periods The operating schedule of the main intakes and other gates within command area also needs careful study in order to produce good coordination in operation for gravity irrigation and also drainage.

5. Conclusions

5.1 Achievement

Although this first RAP assessment needs more improvement in terms of accuracy of input data and quality of analysis, this assessment is considered as a good step to assess irrigation scheme performance and one of the valuable achievements of the IIEPF project. At least the actual situations of pilot schemes have been evaluated and the involved team members have learnt how to evaluate the irrigation scheme performance through this activity. This becomes a good capacity building activity for line agencies. The achievements could be summarised as follows.

- A primary data set of four pilot sites concerning water use and scheme management has been established in a uniform format. This data set can be used as reference for the next assessment and to propose guidelines for more efficient water use.
- The team members have gained deeper understanding of the situation of their own irrigation schemes.
- Involved team members have developed their capacities in terms of up-to-date concepts of irrigation efficiencies and water balance through the training workshop and field level on-the-job training.
- Team members have also developed their capacities in terms of modern tools and procedures to evaluate the system performances by systematic diagnostic procedure that includes both visits to the office to interview the project staff and field evaluation on control structures, operational strategies, communications and water delivery service.

5.2 Lessons Learnt and Recommendations

5.2.1 Lessons Learnt

The RAP is an effective system to evaluate irrigation system performance over a short period of time. It covers all aspect of performance in both software and hardware of the system. However since the RAP is designed to evaluate large gravity systems, some indicators are unfortunately not suitable to or applicable with a tidal irrigation system like the one in the Mekong Delta. For example conveyance efficiency cannot be correctly evaluated as the canal system in the Mekong Delta is linked without gate control between each canal level. This point requires further future improvement.

The fieldwork was, in general, planned and organised well by the team. The appointments with farmers and the project staff were made in advance to the fieldwork. During the fieldwork the teams were actively working and keen to learn from the resource persons. However some problems and difficulties were observed during the conducting of the fieldwork as follows.

- The teams had not prepared enough nor read the questionnaire in advance before conducting interviews at the field. It made them confused and wasted time during the fieldwork.
- The teams had not really understood that conducting fieldwork was the teams' responsibility. They did not usually take initiative but followed the resource persons to start each activity.
- If the resource persons could have shown examples how to conduct the RAP, such as how to raise the questions and then suggest to the teams that they do it by themselves, it would have made the fieldwork go more smoothly.
- As the time was limited, the facilitator should make it clear that external information should be analysed advance to fieldwork. Only the problems and unclear points should be checked during the fieldwork.

5.2.2 Recommendations

In order to conduct the final RAP more effectively, some recommendations are made as follows.

- The team should prepare in advance so they have clear understanding of the questionnaire before fieldwork.
- The team should recognise that fieldwork is the responsibility of the team, not others.
- Data input for external indicators should be completed before fieldwork. During the fieldwork, more time should be spent for interviews, data input for internal indicators and its analysis.
- It would be more effective to spend more time in the field in order to obtain more detailed information of the situation and characteristics of the system.
- The different canals should be observed in order to identify and understand more about the system.

5.3 Follow-up

Apart from its purpose as on-the-job training following the training workshop, this initial RAP assessment can also be recognised as a trial assessment with limited, but currently available, data only. After one year (covering one dry and one rainy season crop) data collection for the final RAP is expected to fill in the missing data, to complete all the necessary steps of data input and analysis and to provide full information, interpretation and analysis of the selected pilot schemes. In particular the assumed data such as efficiency, percolation and so on is expected to be replaced for contributing more reliable result.

As some questions and indicators of the RAP are not suitable to evaluate characteristics of the Mekong Delta tidal irrigation system, improvement of the RAP to include some additional indicators to fit with tidal irrigation characteristics is proposed to and recognised by the FAO. The improved version of RAP data sheets is expected to be available for the final RAP.

At the final RAP, whole process of the assessment will be reviewed and revised, if necessary, once again in order to improve it and make it more reliable and applicable. In particular for the assumed data and some unclear points (which have been temporarily filled in this time) need to be replaced by more reliable information. The specific points need to be reviewed for the final RAP assessment is listed as below.

5.3.1 Komping Pouy

- 3 years (2005, 2006, and 2007) worth of data is required. Only the data of 2005 was filled in this time.
- Actual command area needs to be confirmed. The total command area is considered as 10,050 ha this time, however this value is for whole existing command area, which was operating more than 10 years ago with both right and left main canals. Today only the right main canal is in operation and the total command area of this canal is only 2,859 ha. The issue needs to be clarified next time.
- The data of conveyance and field efficiencies as well as seepage should be replaced by the result of fieldwork analysis.
- Data of EC_e of irrigation water should be confirmed.
- Kc data should be checked if correct.
- The irrigation water from outside into the command area through irrigation canals and other external sources should be revised because the data filled this time is assumed.
- Water re-circulated within the command area such as water pumping inside of the command area for irrigation should be examined.
- The cropping pattern data should be replaced next time once the IIEPF field observation collects it.
- The calculation of effective rainfall was not reliable yet since a lot of estimation was made. The detail methodology should be identified by external resources such as the FAO.
- Specific water requirements such as water use for land preparation should be checked if correct.
- The result of Relative Water Supply (RWS) of the system seems extremely higher than usual cases. The information should be reviewed.
- All the answers from the project office down to on-farm level should be reviewed through the next interview in order to confirm if the responses are reliable enough.
- The accuracy of flow control and measurement (plus or minus in percentage) should be reviewed since method to estimate this value was not clear enough this time.

- The score given for the ability of present water delivery of scheme to support pressurised irrigation method is higher when compared with the score given to Huay Luang scheme. This score should be reviewed.
- Annual irrigation water delivery per unit consumed area of IPTRID indicators seems too low (1,811 m^3/ha). This should also be reviewed.

5.3.2 Num Houm

- Input data need to be reviewed, whether to stay using 3-year data or if 4-year data is needed.
- The data of conveyance and field efficiencies as well as seepage should be replaced by the results of the field observation under the IIEPF project.
- Data of ECe of irrigation water should be checked.
- Kc data should be checked if correct.
- The irrigation water coming from outside into the command area through irrigation canals and other external sources should be revised. The water from external sources was not estimated this time.
- Water re-circulated inside command area such water taken from drainage canals through weirs and pumping should be taken into account.
- The cropping pattern needs to be reviewed. The cropping pattern of vegetables should be added.
- The calculation of effective rainfall should be reviewed.
- Some water requirements such as water use for land preparation, water supply for fishpond and vegetable gardens should be considered next time.
- All the answers from the project office down to on-farm level should be reviewed through the next interviews to improve the quality.
- The project budget data should be revised, as it was assumed this time.
- The accuracy of flow control and measurement (plus or minus in percentage) should be reviewed.
- The score to support pressurised irrigation method is higher compared with Huay Luang scheme. This score should be reviewed.
- The estimation of the production should include not only rice, but also fish and other livestock production. There are many fishponds as well as rearing of livestock in the command area using irrigation water, however these kinds of practices have not been taken into account this time.

5.3.3 Huay Luang

- Input data need to be reviewed, whether to stay using 3-year data or if 4-year data is needed.
- The data of conveyance and field efficiencies as well as seepage should be replaced by the result of field observation work under the IIEPF project.
- Data of EC_e of irrigation water should be checked. The data this time does not seem reliable.
- The irrigation water coming from outside into command area through irrigation canals as external sources at RMC should be taken into account, as it was not estimated this time. The water taken for domestic use at RMC should also be considered for water balance calculation.

- Water re-circulated inside command area such as from drainage canals by farmers' pumps should be examined, as it was not considered.
- Estimation of effective rainfall needs to be reviewed, especially for different crops such as soybean, sugarcane, lotus etc.
- The answers for internal indicators should be reviewed in order to improve accuracy and reliability.
- The result of gross revenue of IPTRID indicators should be revised because the current result is affected by inaccurate data of the WUA budget.

5.3.4 Go Cong

- It is recommended that the final RAP assessment cover whole scheme, i.e. it should cover the main canals of Go Cong project, not only the secondary and lower level. The issue should be further discussed with the team.
- Data covering 3 years is requested next time.
- Capacity of the main canal and actual peak of the flow should be reviewed. The data should be replaced by the data recorded by the field observation under the IIEPF project.
- The special water requirements (except for crops) such as water for salinity control and for local navigation should be reviewed and discussed as well as methods to estimate these water uses.
- Ground water use data should be examined.
- External indicators should be reviewed.
- The estimation of actual water diverted and used for crops through the project field observation should be used to evaluate field irrigation efficiency, command area efficiency, relative water supply etc. However the conveyance efficiency cannot be calculated since there is no check structure along canal.
- As suggested by the resource persons from the FAO, additional indicators counting water level in the irrigation canal are important factors affecting the performance of the scheme. These indicators and others to improve the reliability of the scheme assessment should be further developed (through consultation with FAO.)