IRRIGATION SYSTEM PERFORMANCE APPRAISAL AND DEVELOPMENT OF ROADMAP FOR MODERNIZATION WITH MASSCOTE APPROACH CASE STUDY: YEN LAP RESERVOIR'S IRRIGATION SYSTEM, QUANG NINH PROVINCE

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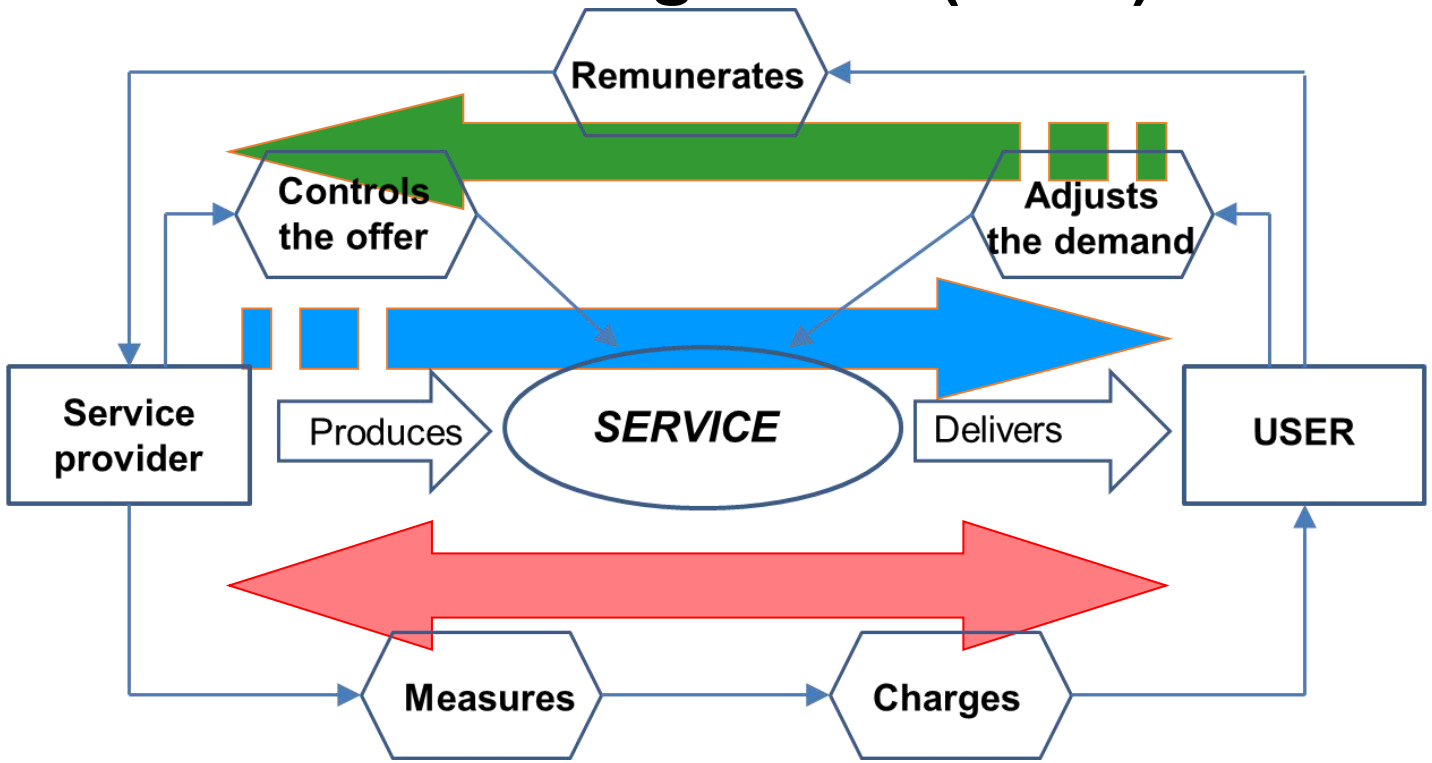
1. Introduction of MASSCOTE & RAP

Service-oriented management (SOM):



(SOM = Water – Information – Money)

1. Introduction of MASSCOTE & RAP

Modernization of irrigation system:

«Modernization is a process of technical and managerial upgrading **(as opposed to mere rehabilitation)** of irrigation schemes combined with institutional reforms, the objective to improve resource utilization (labor, water, economics, environmental) and water delivery to farms**»** (FAO – Bangkok, 1996)

Rapid Appraisal Process RAP:

- ***Objective:***
  - Providing a basis for making specific recommendations for modernization and improvement of water delivery service.
  - Providing a baseline of information for comparison against future performance after modernization
  - Benchmarking for comparison against other irrigation projects

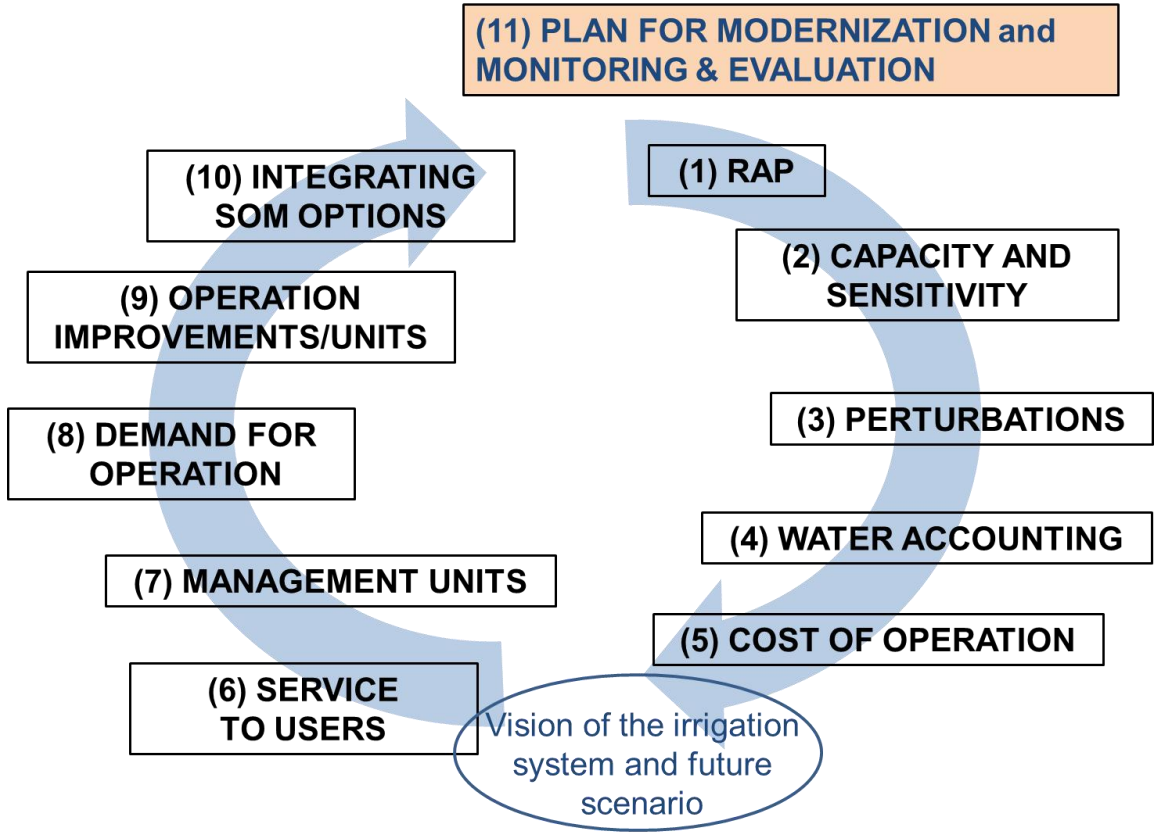
1. Introduction of MASSCOTE & RAP

Rapid Appraisal Process RAP:

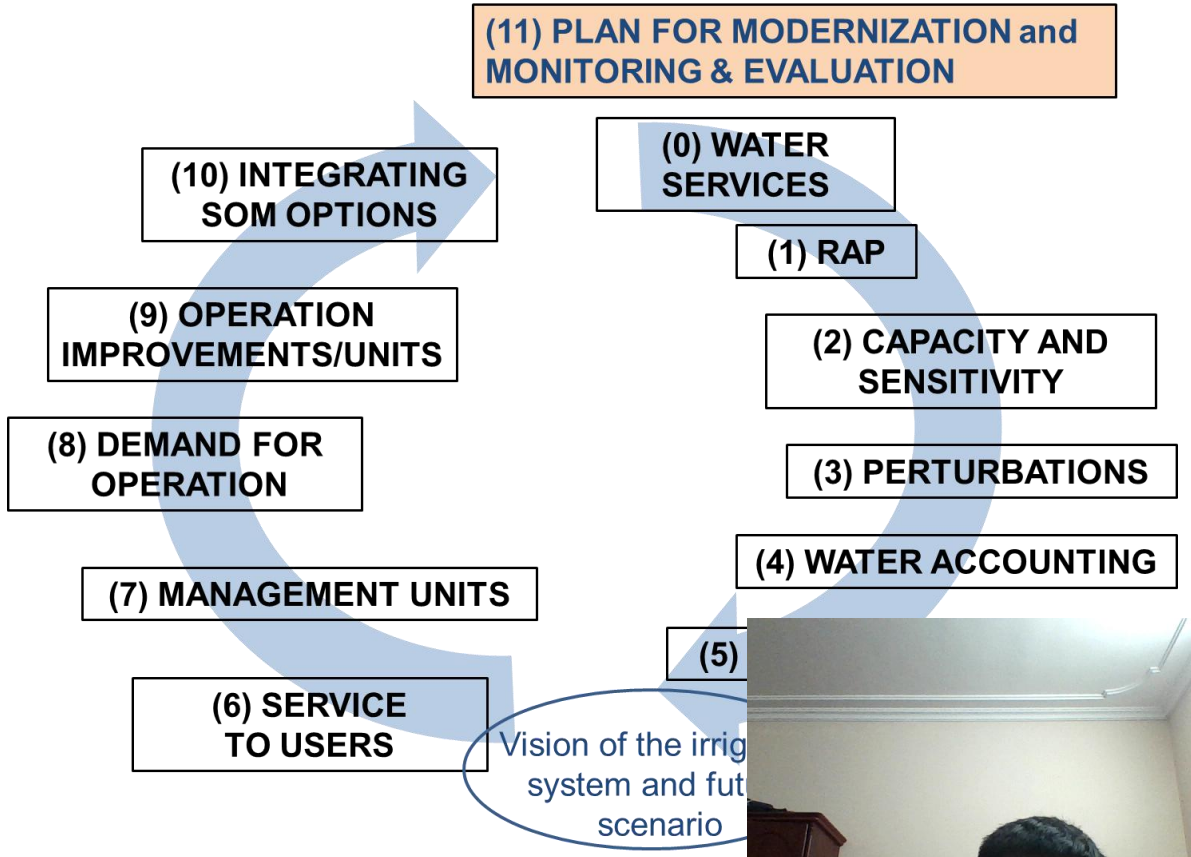
- ***Results:***
  - External indicators:
    - Examining external inputs and outputs of the system
  - Internal indicators:
    - Identifying key issues of regulating in the system
    - Identifying services provided to users in all levels in the system
    - Examining the hardware, management technique and processes used to regulate and distribute water

1. Introduction of MASSCOTE & RAP

MASSCOTE:



Mapping systems and services for multiple uses (MASSMUS):



2. PERFORMANCE ASSESSMENT

Assessment

Results from step 0-5 in MASSCOTE process

- Step 0: Multiple uses of water
- Step 1: RAP
- Step 2: Capacity and Sensitivity
- Step 3: Pertubation
- Step 4: Water accounting
- Step 5: Cost of operation

2. PERFORMANCE ASSESSMENT

- ❖ Main purposes: Irrigation, flood prevention, water supply for domestic, industrial and aquaculture activities, and saltwater prevention.
- ❖ Reservoir capacity: 127.6 mil m3
- ❖ Main dam:
- Maximum dam height: 38m high earthfill dam
- Crest length: 276m
- ❖ Secondary dam 1:
- Maximum dam height: 18m
- Crest length: 500m
- ❖ Secondary dam 2:
- Maximum dam height: 6m
- Crest length: 54m
- ❖ Canal system
- Main canal: 14 km
- Tertiary canal: > 300 km
- ❖ Irrigated area: 10,000 ha
- ❖ Domestic water supply: 2.0 mil m3/year.

2. PERFORMANCE ASSESSMENT

Step 0: Services

There are 7 services in actual operation of Yen Lap reservoir‘s irrigation system

Design	At present
▪ Irrigation and Drainage ▪ Domestic water supply	▪ Irrigation and Drainage: about 10,000 ha ▪ Domestic water supply: 2.0 mil m3/year ▪ Water supply for industry ▪ Fisheries ▪ Environment (Prevention on salinity intrusion) ▪ Flood prevention

2. PERFORMANCE ASSESSMENT

Services in Yen Lap reservoir‘s irrigation system

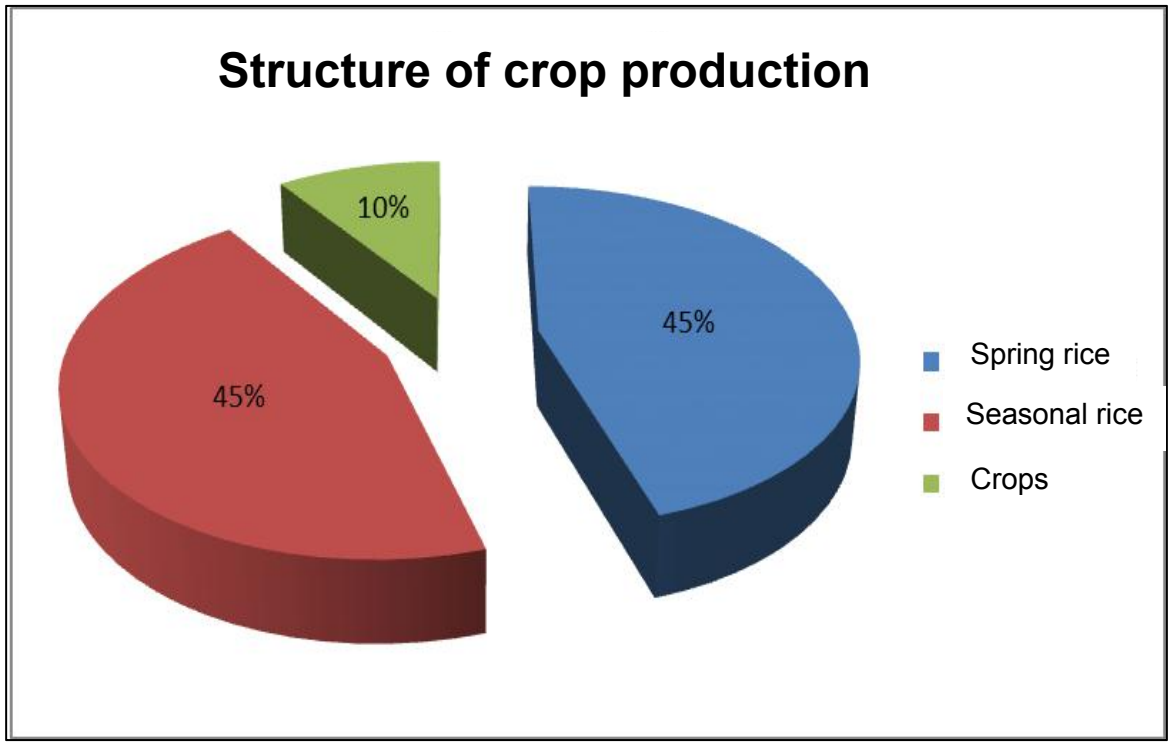


Figure. Paddy and crop fields in Yen Lap irrigation system

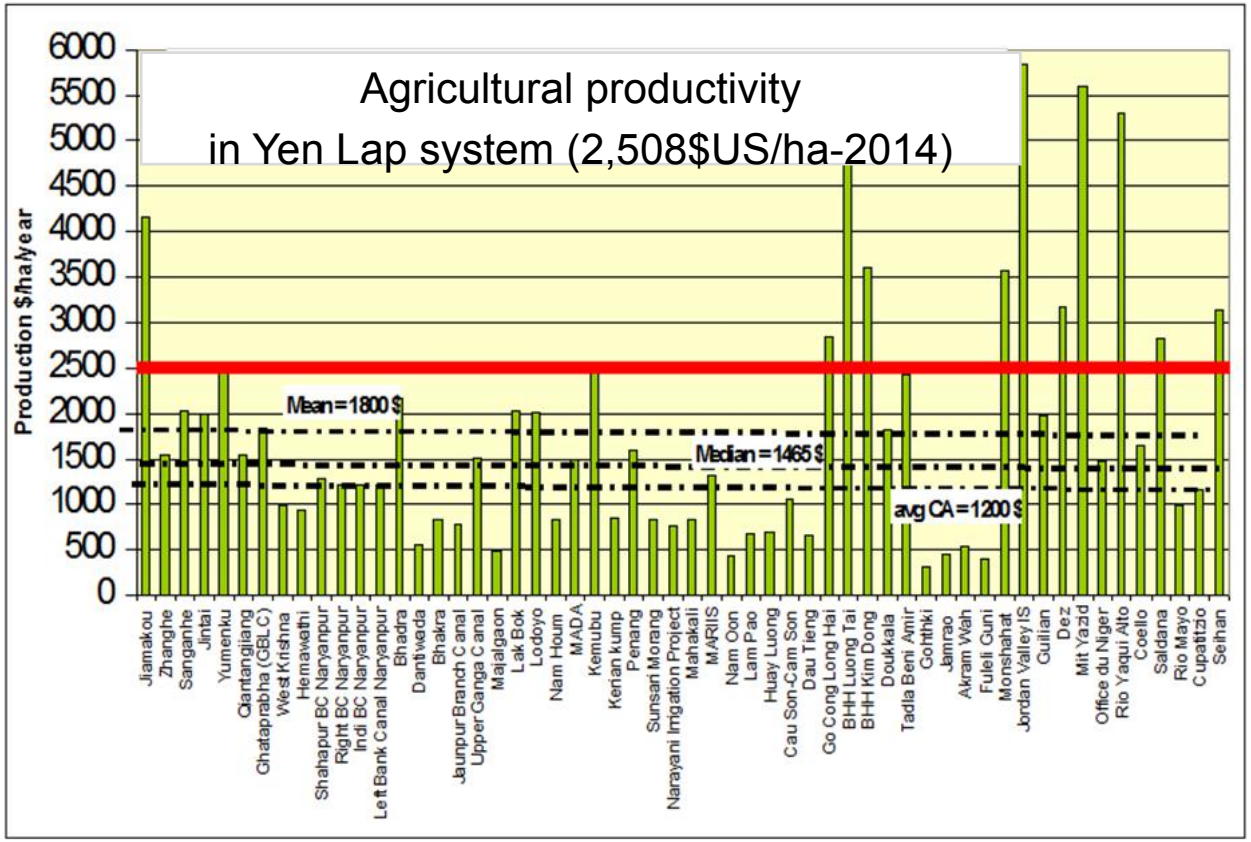
2. PERFORMANCE ASSESSMENT

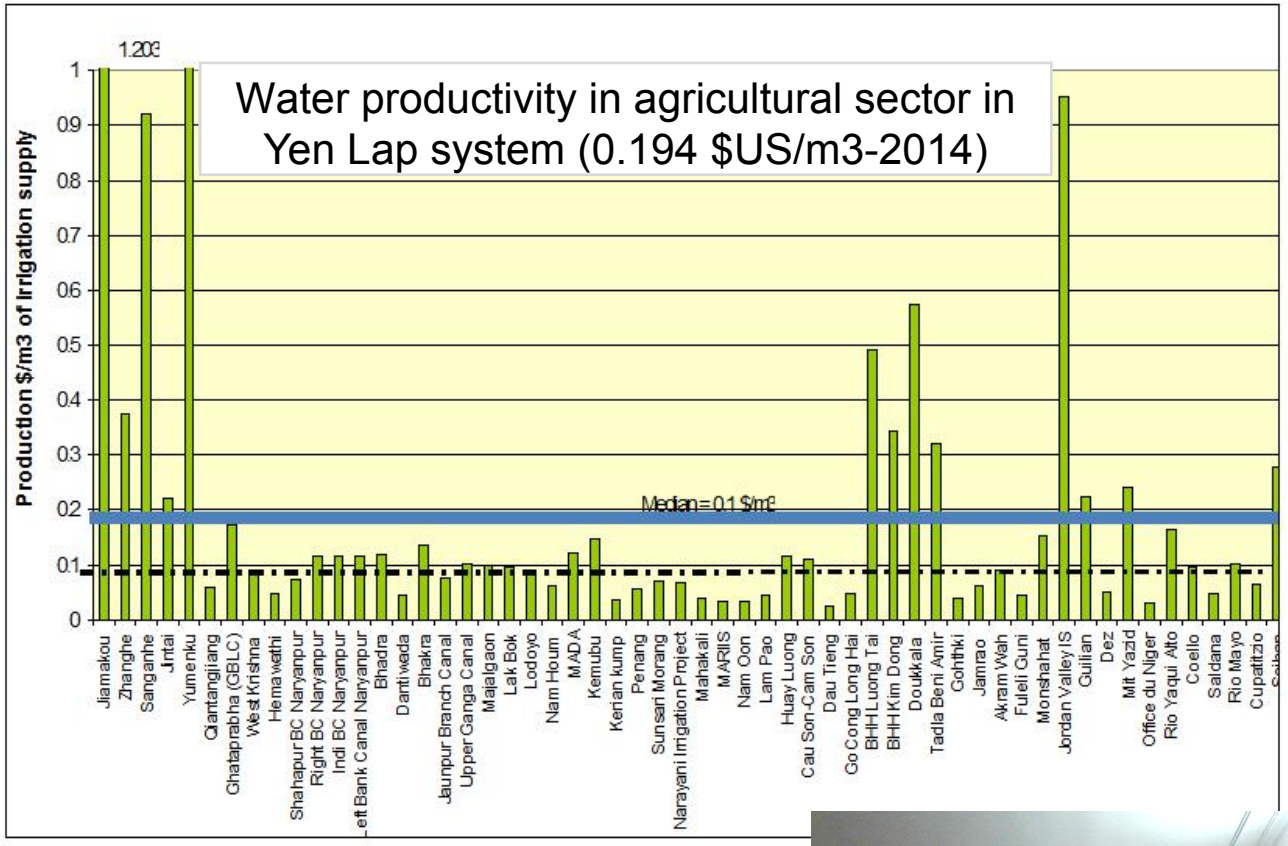
Step 1: RAP indicators

1. External indicators

External indicators	Unit	Value
Area		
Physical area of irrigated cropland in the command area	Ha	8,320
Integrated crop area in the command area, including mutiple cropping	Ha	11,811
Cropping intensity in the command area	-	1.98
Water supply		
Total external irrigation supply for the project	MCM	210.48
Gross precipitation in the irrigated fields in the command area	MCM	102.90
Effective precipitation to irrigated fields	MCM	19.8
Delivery of external surface irrigation water to users	MCM	64.5
Total NET irrigation water requirements	MCM	38.1
Field irrigation Efficiency	%	36
Economic indicators		
Agriculture productivity	USD/ha	2,508
Water productivity	USD/m3	0.194

2. PERFORMANCE ASSESSMENT





2. PERFORMANCE ASSESSMENT

Step 1: RAP's results

1. External indicators – Key findings

1. The amount of water supplied to the irrigation area is relatively large (107.58 million m3), while the demand for crops in the system is 47.2 million m3 (ET crop). In fact, after taking into account the effective rainfall, the irrigation need is only 38.1 million m3 with the efficiency of field irrigation of 60%. This shows that the amount of water loss is still very large.
2. That the coefficient for land using is not relatively high (1.42) is the opportunity for the project team to increase this in the future.
3. That the ratio between water supply and actual demand is relatively high (5.52 times) is the opportunity to expand irrigation area or other services of water supply.
4. The effectiveness of on-farm irrigation is relatively low (only 60%), so on-farm water distribution may be improved in the future.
5. The agriculture productivity as well as water productivity are still low compare with other systems around the world.

2. PERFORMANCE ASSESSMENT

Step 1: RAP‘s results

2. Internal indicators: Operation indicators

Indicators	Giá trị
Service	
Actual water delivery service to individual ownership units (e.g., field or farm)	**1.7**
Stated water delivery service to individual ownership units (e.g., field or farm)	**2.0**
Actual water delivery service at the most downstream point in the system operated by the employees	**1.5**
Stated water delivery service at the most downstream point in the system operated by the employees	**1.4**
Actual water delivery service by the main canals to the second level canals	**3.3**
Stated water delivery service by the main canals to the second level canals	**2.3**
Model of canal system operated by paid employees	**3.0**

2. PERFORMANCE ASSESSMENT

Step 1: RAP's results

2. Internal indicators: Yen Lap reservoir and Main canal indicators

Indicators	Value
Yen Lap reservoir	
General conditions of the reservoir	**2.8**
Operation of the reservoir	**2.8**
Communication on the reservoir	**3.0**
Assessment on the water intake's capacity	**3.0**
Main canal	
Assessment on regulators of the main canal	**2.0**
Assessment on intakes of the main canal	**3.0**
Supplying or regulating reservoirs, ponds on the main canal	**0.0**
Communication on the main canal	**2.4**
General conditions of the main canal	**3.2**
Operation of the main canal	**3.1**

Reinforced canal section (Hai Nam island's segment)

Weir No. 1 (K2+930)

Upstream of Yen Lap reservoir

2. PERFORMANCE ASSESSMENT

Step 1: RAP‘s results

2. Internal indicators: Second-level canal indicators

Indicators	Value
Second level canal	
Assessment on regulators (second level canal)	**2.0**
Assessment on intakes of the second level canal (at the beginning of the third level canals)	**2.5**
Regulating reservoirs, ponds on second level canal	**0.0**
Communication on second level canal	**1.7**
General conditions of second level canal	**3.1**
Operation of second level canal	**2.3**

Second level canal

Road along 2nd level canal (

2. PERFORMANCE ASSESSMENT

Step 1: RAP‘s results

2. Internal indicators: Tertiary level canal indicators

Indicators	Value
Third level canal	
Assessment on regulators (third level canal)	**1.6**
Assessment on intakes of the third level canal (at the beginning of the forth level/ on-farm canals)	**2.3**
Regulating reservoirs, ponds on third level canal	**0.0**
Communication on third level canal	**2.5**
General conditions of third level canal	**2.4**
Operation of third level canal	**2.2**

Operation road along 3rd level canal

Intake at the begining of 3rd level canal

2. PERFORMANCE ASSESSMENT

Step 1: RAP‘s results

2. Internal indicators: Indicators of Budget, Emplyees and WUAs

Indicators	Value
Budget, Employees và Water User Associations	
Budgets (including WUAs)	**1.5**
Staff’s capacity	**3.3**
Water User Associations (WUA)	**2.3**
Computer for billing and record management	**2.0**
Computer for canal control	**1.0**

2. PERFORMANCE ASSESSMENT

Step 1: RAP's results

2. Internal indicators – Key findings

1. Actual findings during the field trip are consistent with managers' understanding of current operation.
2. Frequency of contact, information exchange and operation desicions during operation period in water management level is relatively good.
3. Irrigation plan is expected and adjusted to the actual situation despite low level of modernization.
4. Measuring the water in the main canal is implemented relatively well despite unspecialized structures. Data i updated and stored well.

2. PERFORMANCE ASSESSMENT

Step 1: RAP's results

2. Internal indicators– Key findings

5. Roads along the main canal are relatively good, but thoses in the lower level canals are still restricted.
6. Most of the main canal is concreted leading to improved water transmission.
7. Quality of intakes in the main canal is relatively good due to recent renovation and repair.
8. Operation in the main canal is still based on experience.
9. Quality of lower level canals is not good, most of them are not reinforced with concrete.
10. Operation of WUAs is relatively poor because on-farm water f not collected successfully.

2. PERFORMANCE ASSESSMENT

Step 2: Capacity and Sensitivity

1. Objectives

- Assessing the capacity of structures in the system regarding their functions such as: water tranmission, regulating, water measurement... To identify problems needing to be improved.

- Assessing the sensitivity of structures in irrigation system (regulators and intakes) to identify operation requirements and sensitivity of the system.

2. PERFORMANCE ASSESSMENT

Step 2: Capacity and Sensitivity

2. Capacity

- **Water conveyance:** The effectiveness is not high, some second-level canals are not lined yet.
- **Regulating:** The quality of regulators on the main canal is quite good due to recent renovation. On the other hand the quality of regulators in lower-level canals is low.
- **Water distribution:** Many intakes in the main canal and lower level canals are good, they can work with the design capacity.
- **Water measurement:** is relatively adequate at the head work reservoir with modern equipment; howeve it is still limited on the canal system.

2. PERFORMANCE ASSESSMENT

Step 2: Capacity and Sensitivity

2. Capacity

- **Canal safety :** Adequate and Effective at the head work reservoir
- **Information:** Telephone, mobile phone and email.
- **Transportation:** Roads along the main canal meet requirements regarding canal management, operation and maintenance, but there are still some limitations in lower level canals.
- **Water management:** based on experience, but there is still limitation in application of information technology
- **WUAs:** There are some limitations in water management and operation.

3. Sensitivity

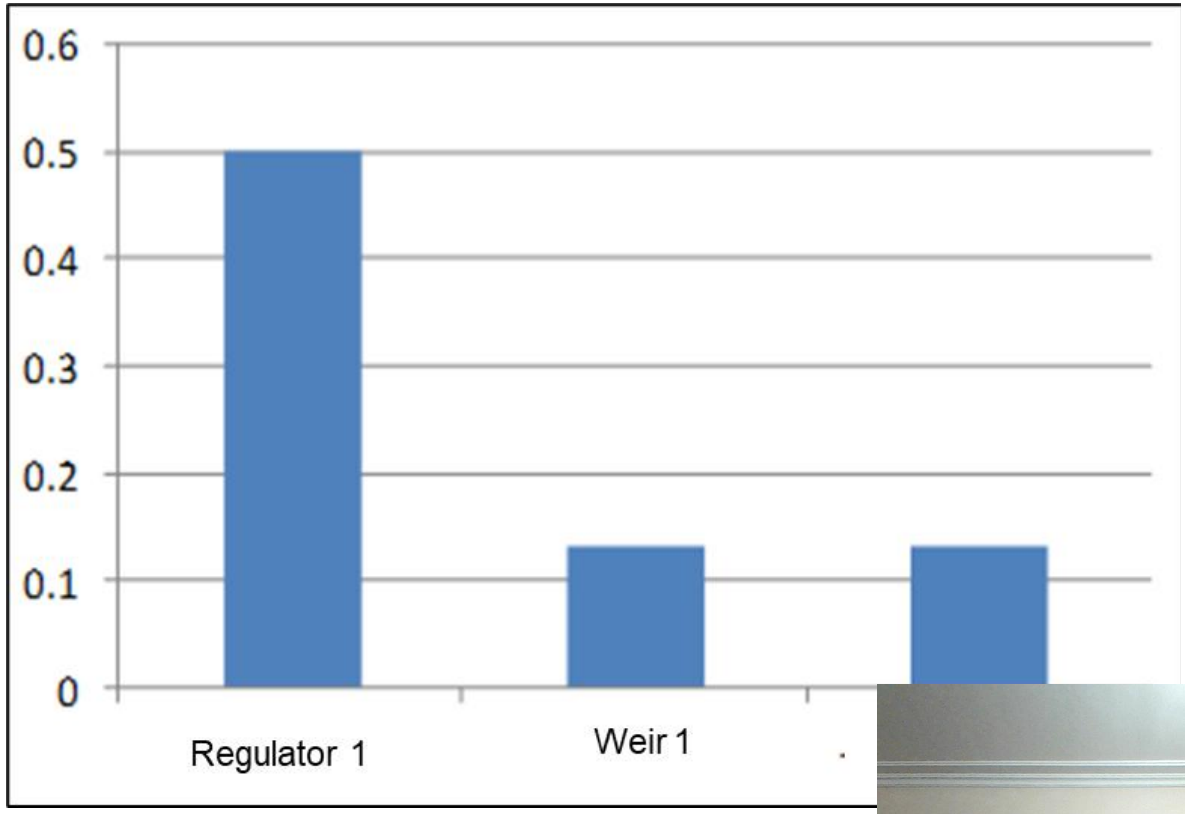
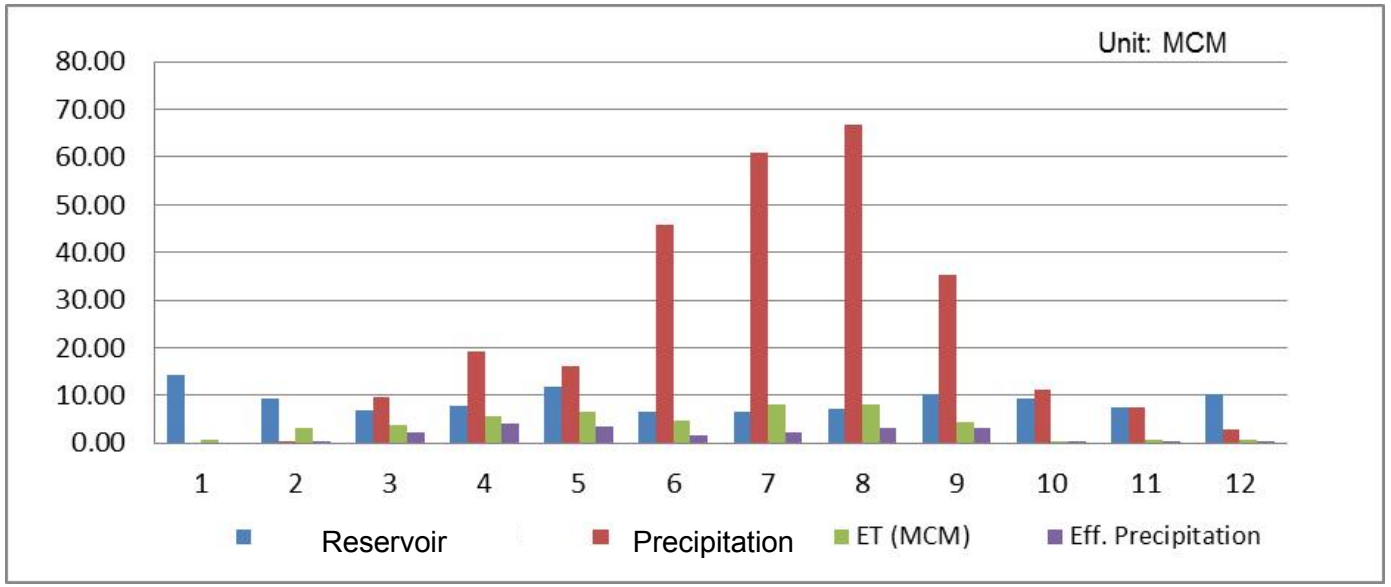


Figure. Regulator sensivity along the main canal – Yen Lap rese

2. PERFORMANCE ASSESSMENT

Step 3: Pertubation

Causes	Degree	Location	Frequency
Rainfall	High	Entire catchment and irrigation area	Sometimes
Construction	Medium	Entire irrigation area	Sometimes
Crop pattern and schedule	Medium	Entire irrigation area	Sometimes
Climate change	High	Entire catchment and irrigation area	Regularly



2. PERFORMANCE ASSESSMENT

Step 4: Water Accouting

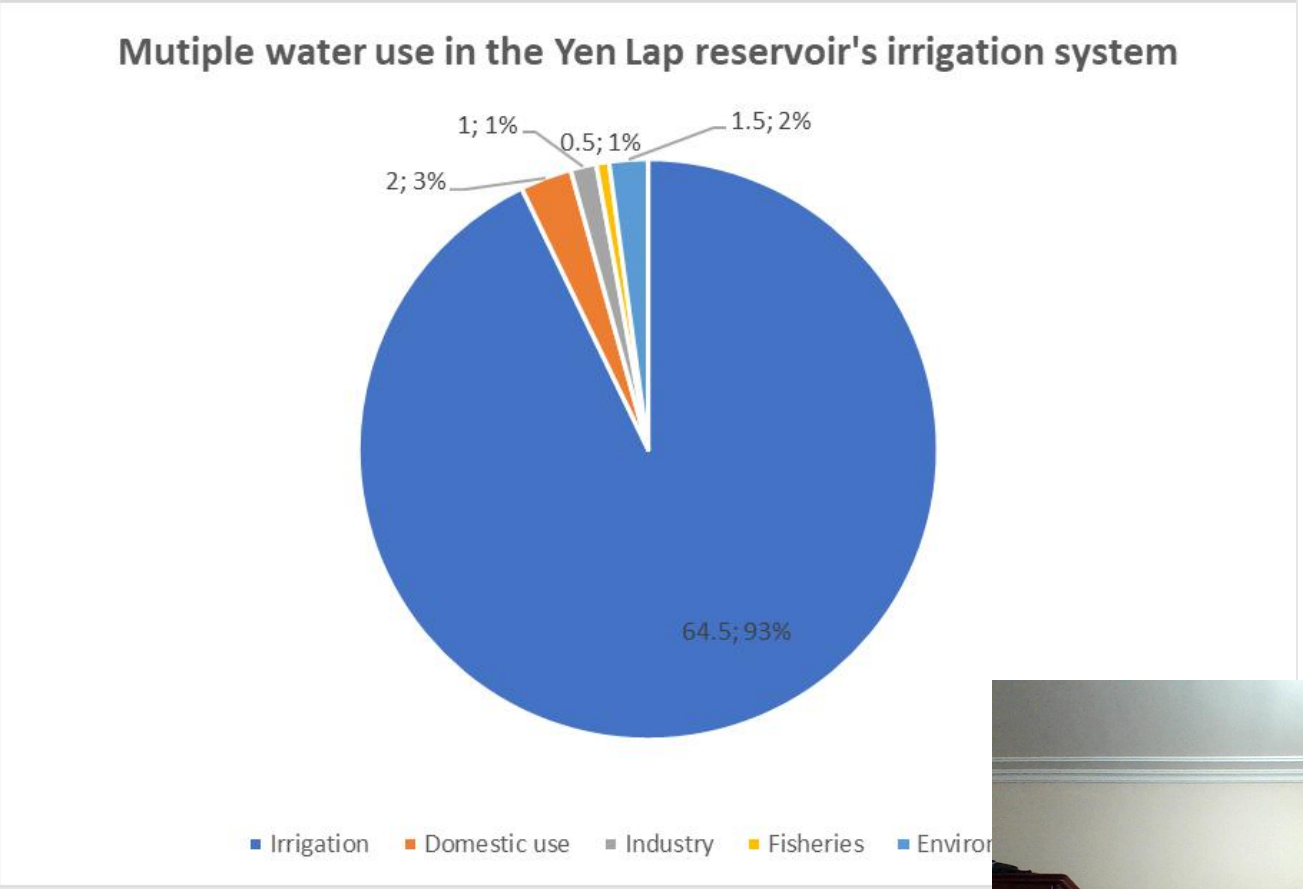
1. Water supply

- From Yen Lap reservoir: 107.6 (million m3)
- Precipitation: 102.9 (million m3) *(Effective Precipitation = 9.1 million m3)*

2. Water use

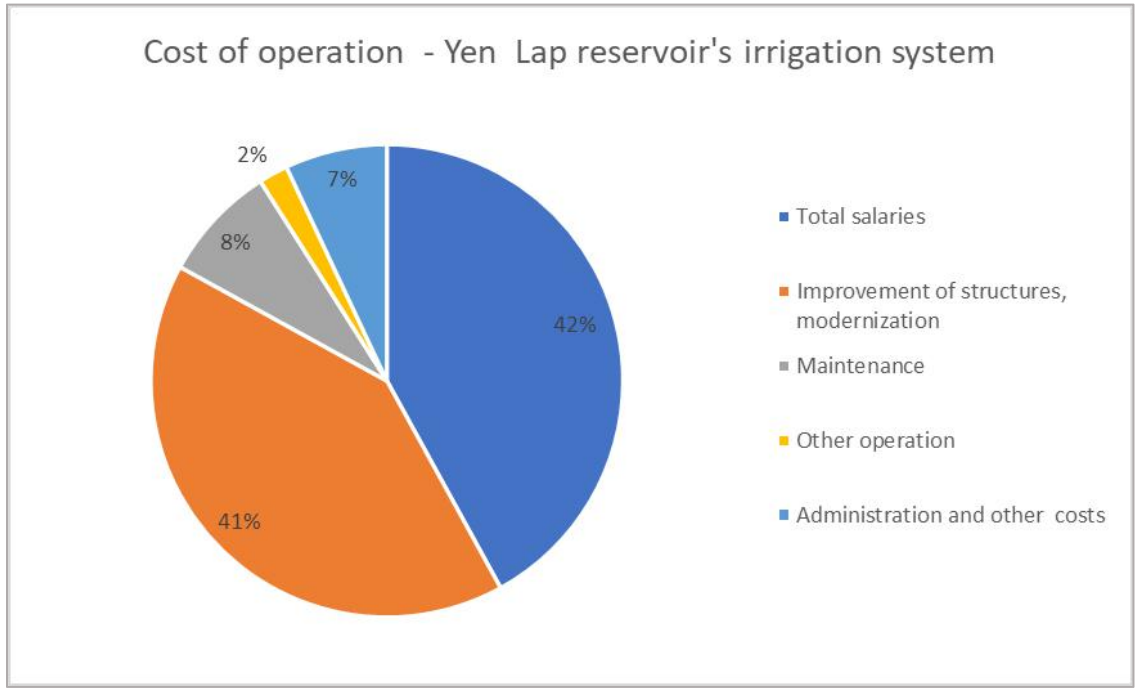
- ET (Crop Evapotranspiration): 47.2 (million m3)
- Other uses: 2.0 (million m3)

  Actual need for plant = 38.1 (million m3)

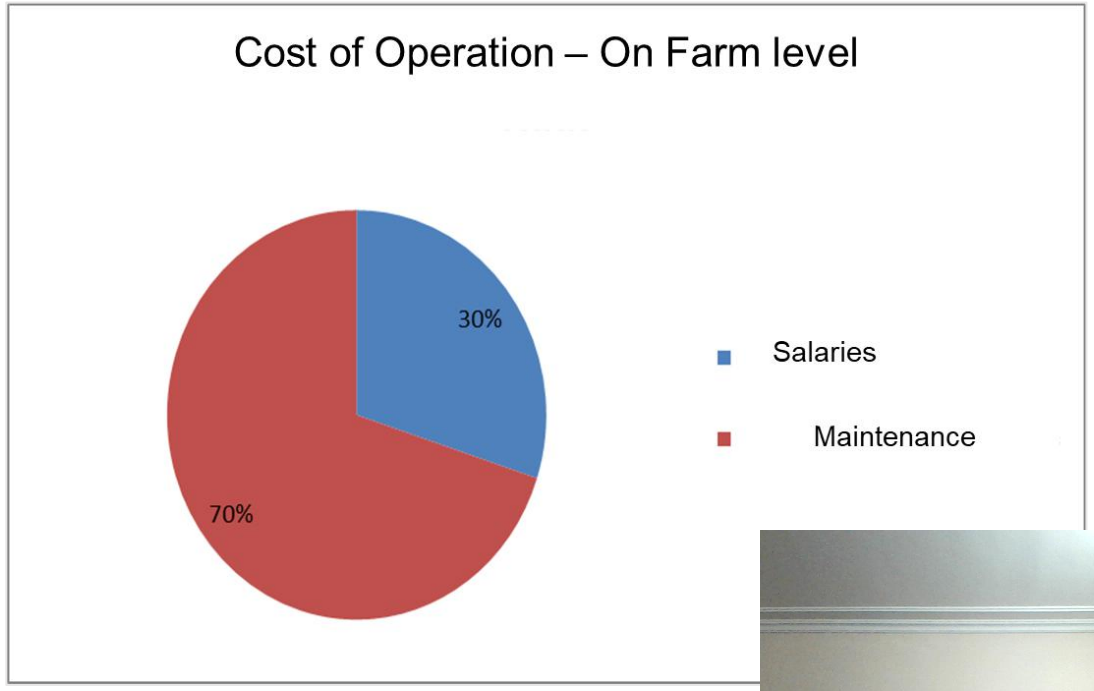


2. PERFORMANCE ASSESSMENT

- **Step 5: Cost of Operation**



Cost of operation – Yen Lap company



Cost of operation – Water use

3. System‘s vision

Vision

Enhancing the living standard of the community in a multiple water uses of water by optimizing productivity of water and land based on appropriate, sustainable and eco-friendly water management practices.

Objectives

- Increasing command area by 10%.
- Increasing irrigation intensity by 5%.
- Increasing income of farmers by 15%.

4. Improvement Requirements

Step 6: Service to User

Basic services

- Irrigation and Drainage
- Domestic water use

Other uses of water

- Environment
- Industry
- Fisheries
- Husbandry

4. Improvement Requirements

Step 7: Management Units

Water management strategy consists of following factors and their objectives:

- Reservoir management:
  - Optimizing water use
  - Minimizing water loss (seepage, evaporation...)
- Command area management:
  - Improving living standards of the community.
- On-farm management:
  - Increasing productivity
  - Decreasing water consumption reasonably

4. Improvement Requirements

Step 8: Demand for Operation

Objective

Improving management of the head work reservoir and canal system and water delivery service.

Targets

- Increasing water conveyance efficiency of the system to 70%.
- Increasing Field Irrigation Efficiency to 65%
- Reducing cost operation by 10%

4. Improvement Requirements

Step 8: Operation requirements

Solutions

- Upgrading canal system.
- Applying suitable regulator structures, water distribution structures...
- Developing operation procedure of the system reliably and effectively.
- Strengthening operation capacity of the system.
- Sensitive structures should be more concerned.
- Strengthening relationship with WUAs.

4. Improvement Requirements

Step 9: Operation improvement

Factors need to be improved:

- Reservoir management.
- Irrigated area management.
- On-farm management.
- Canal operation.

Step 10: Integrating SOM options

This is not an issue due to the small system where other uses of water is less important than irrigation service.

5. Modernization strategic plan

Step 11: Modernization and recommendations

Recommendations for system modernization are corresponding to 4 factors in step 9, in different terms:

- Reservoir management.
- Irrigated area management.
- On-farm management.
- Canal operation.

Terms:

- Plan to 2020.
- Strategy to 2030

5. Modernization strategic plan

1. Reservoir management

Objective

Maintaining the water storage capacity of the reservoir to meet the demands of multiple use with strategy in a long term effectively.

Targets

- Increasing command area are by 10%.
- Increasing land use intensity by 5%.

5. Modernization strategic plan

1. Reservoir management

Plan to 2020

1. Establishing the relationship between evaporation and water level.
2. Measuring seepage effectively.
3. Establishing dam safety manual
4. Applying GIS
5. Training reservoir management and operation
6. Emergency response

Vision to 2030

1. Reforesting to protect the whole catchment.
2. Promoting tourism, fisheries, domestic water supply...
3. Water quality management.
4. Collecting, storing and processing data.
5. Developing and applying smart and effective algorithms in reservoir operati

5. Modernization strategic plan

2. Command area management

Objective

Improving living standards of the community.

Target

- Increasing income of farmers by 15%.

5. Modernization strategic plan

2. Command area management

Plan to 2020

1. Applying geographic information system (GIS) with different layers of information regarding command area: road, field, canal, elevation...
2. Establishing and developing database: soil, land use and reclamation and other social aspects.
3. Installing weather stations to measure rainfall and climate specifications.
4. Agricultural extension program consists of Post-harvest techonology, value added, marketing...

Vision to 2030

1. Measuring factors of drainage.
2. Improving drainage system appropriately.
3. Diversifying plants by investigation and analysis.
4. Developing smart agriculture adapting to climate change.
5. Developing husbandry
6. Maintaining environment flow

5. Modernization strategic plan

3. On-farm management

Objective

Improving productivity and reducing on-farm water consumption reasonably.

Targets

- Increasing agricultural production value by 8%.
- Reducing on-farm water consumption by 10 %

5. Modernization strategic plan

3. On-farm management

Plan to 2020

1. Land reclamation, land consolidation.
2. Raising awareness and encouraging farmers to participate in irrigation management; consolidating and developing water user associations (WUAs).
3. On-farm drainage.
4. Strengthen on-farm water management capacity.
5. Diversifying plants.
6. Building pilot site; study tour program to gain experience.

Vision to 2030

1. Improving of plot size to facilitate water distribution and effective farm mechanization.
2. Promoting use of organic fertilizers.
3. Developing on-farm water drainage effectively.
4. Managing WUAs effectively.

5. Modernization strategic plan

4. Canal operation

Objective

Improving effectiveness of water conveyance in the system and saving the operation cost by improving and modernizing the canal system sustainably to delivery water reliably, adequately and timely.

Targets

- Increasing the effectiveness of water conveyance in the system to 70%.
- Increasing the Field Irrigation Efficiency to 65%
- Reducing operation cost by 10%

5. Modernization strategic plan

4. Canal operation

Main canal:

1. Completing the main canal
2. Improving, upgrading and completing regulator structures.
3. Improving, upgrading and completing intake structures.
4. Collecting, storing and processing operation data effectively.
5. Establishing canal operation procedure.
6. Exploiting SCADA system effectively and upgrading with smart algorithms.

Distribution canal system (Second-level and tertiary canals):

1. Completing distribution canal system
2. Building water measurement structures at the head of the canal (long crested weir, constant discharge division structure...)
3. Completing regulator structures and intake structures
4. Improving operation management roads along the canals.

5. Modernization strategic plan

4. Canal operation

On-farm canal:

1. Completing and consolidating intake gates into the field (quantity and type)
2. Considering and applying regulator structure effectively (temporary blockage, weir, long crested weir...)
3. Canals lining
4. Improving operation management roads along the canal.

Water drainage:

1. Completing and consolidating lateral spill (overflow into the canal)
2. Improving and upgrading drainage sluices (under the canal)
3. Improving and upgrading outfall structures.
4. Measuring factors of drainage.

Thank you very much!

Mapping System & Services for Canal Operation Techniques - MASSCOTE