Experiences of Irrigation Rehabilitation and Modernisation in Viet Nam
Viet Nam – Overview of Irrigation Infrastructure and Rice Production

Salient Facts and Figures (2012)

- Gross Area of Viet Nam: 331,210 km²
- Population: 88.8 M
- **Arable area:** ~7.0 Mha (21.1% of land) of which:
  - Irrigation infrastructure (80%) 5.6 Mha
  - Irrigation functioning well: 2.8 Mha
  - Poor / partial / no irrigation: 4.2 Mha
- Area of rice land: 3.8 Mha
- Cropped rice area: 7.8 Mha
- **Average cropping intensity:** 205%
- Average rice yield: 5.6 t/ha
- **Rice production:** 43.4 Mt
- **Rice exports:** 8.1 Mt
- Agricultural sector: 21.5% GDP
In its Strategy of Socio-Economic Development 2001-2010, the GOVN made agricultural modernisation a top priority to increase growth and reduce poverty.

VWRAP was a WB-funded US$ 176 M programme (2005-2012) of irrigation rehabilitation and modernisation on six irrigation schemes, designed to pilot the GOVN’s strategy of agricultural modernisation and improved water resources management.

VWRAP’s objective was “Fostering agricultural diversification and gains in productivity through irrigation system modernisation, and thereby raising farm household incomes and reducing rural poverty”.

Priority was major improvement of water delivery service.
VWRAP – IRRIGATION SCHEME LOCATIONS

Dau Tieng  57,600 ha
Da Ban        7,300 ha
Cau Son    21,800 ha
Yen Lap   6,800 ha
Ke Go       19,000 ha
Phu Ninh   17,400 ha
Total area: 130,000 ha
Modernisation of Irrigation Infrastructure
VWRAP - Scope of Civil Works

• Generally, **scheme capacities were not significantly increased** from original 1980s design.

• **Excavation / filling** carried out to restore / modify original canal cross-sections, as required.

• **Canals lined in selected areas** (permeable soils, perched reaches, weak eroded banks).

• **Canal structures** rehabilitated, modified or replaced.

• **New long-crested weirs and measurement flumes** constructed at strategic locations.

• **SCADA systems installed** in 5/6 schemes (excl. Da Ban).
Rehabilitation and Modernisation Design Process

• Design carried out by 3 sets of consultants, but with limited international staff time, used up too early.

• There was a 1½ year delay in appointing design consultants, thus delaying the start of construction.

• In general, the original feasibility study proposals were adopted.

• Original schemes had been designed in 1980s on u/s control basis, which was mostly retained as too costly to change to d/s control.

• Only East main canal of Dau Tieng scheme was converted to d/s control, with SCADA actuators connected to 6 cross-regulators.
Canal lining - Construction

- **Majority of canal systems were built during the 1980s**, following the American war, and were unlined due to budget constraints; the **most vulnerable reaches were lined in subsequent years**.

- Under **VWRAP**, significant lengths of the main, primary, secondary and tertiary systems **were lined**.

- **Choice of lining type** was influenced by the length of construction ‘windows’ and type of embankment material, and included; a) **insitu concrete panels**, b) **precast slabs**, c) **small precast units**, d) **dry stone pitching in rc frames**

- **Geomembrane was laid in some reaches** (Yen Lap and Ke Go) where canals were perched on permeable soils.
Canal lining added under VWRAP

<table>
<thead>
<tr>
<th>Type of Canal</th>
<th>Length</th>
<th>Lined before VWRAP</th>
<th>Lined after VWRAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km</td>
<td>km / %</td>
<td>km / %</td>
</tr>
<tr>
<td>Main canals</td>
<td>196</td>
<td>4.8 2.5%</td>
<td>116 59.1%</td>
</tr>
<tr>
<td>Primary canals</td>
<td>647</td>
<td>52 8.0%</td>
<td>384 59.4%</td>
</tr>
<tr>
<td>Secondary and tertiary canals</td>
<td>2,004</td>
<td>39 2.0%</td>
<td>688 34.4%</td>
</tr>
</tbody>
</table>

Approximately 40% of civil works costs were on canal lining.
Canal Lining Types

- **Dau Tieng** – insitu concrete panels
- **Yen Lap** – precast slabs with geomembrane
- **Phu Ninh** – rectangular flume
- **Phu Ninh** – dry stone pitching in rc frames
## Improvements in Canal Conveyance Efficiency

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Increase in Flow Parameters</th>
<th>Reduction in Water Delivery Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cau Son</td>
<td>No data provided by PMU/IMC</td>
<td>Middle Canal: 48 hrs &gt;&gt; 30 hrs, East Main Canal: 72 hrs &gt;&gt; 50 hrs, <strong>West Canal:</strong> 24 hrs &gt;&gt; 16 hrs, Phan Dam Canal: 12 hrs &gt;&gt; 9 hrs, Secondary Canals: Reduced by 50%, Fill canal system: 4 days &gt;&gt; 2 days</td>
</tr>
<tr>
<td>Yen Lap</td>
<td><strong>Main canal flow:</strong> 5.5 &gt;&gt; 8.0 m³/s</td>
<td>Main Canal: Reduced by 4 hrs</td>
</tr>
<tr>
<td>Ke Go</td>
<td><strong>Main canal water level</strong> at tail: 4.80 &gt;&gt; 5.47 m, 67 cm increase</td>
<td>Main Canal: 3 days &gt;&gt; 1 day</td>
</tr>
<tr>
<td>Phu Ninh</td>
<td>No data provided by PMU/IMC</td>
<td><strong>North Main Canal:</strong> 40 hrs &gt;&gt; 19 hrs, Secondary Canals: Reduced by 50%</td>
</tr>
<tr>
<td>Da Ban</td>
<td>No data provided by PMU/IMC</td>
<td>West Main Canal: 40 hrs &gt;&gt; 6 hrs, East Main Canal: 36 hrs &gt;&gt; 5 hrs, Branches N3, N4: 5 hrs &gt;&gt; 4 hrs</td>
</tr>
<tr>
<td>Dau Tieng</td>
<td>No data provided by PMU/IMC</td>
<td><strong>Main canal to field:</strong> 2 days &gt;&gt; 1 day</td>
</tr>
</tbody>
</table>
New Structures - Long-crested weirs and Measurement Flumes

- Yen Lap – Ha Bach main canal
- Yen Lap – Ha Bach main canal head
- Phu Ninh – Primary canal N18
- Ke Go – Primary canal head N2
Need for **Supervisory Control and Data Acquisition (SCADA)** to modernise system operation

**Typical SCADA Layout**

- **Reservoir or river intake**
- **Irrigation HQ** (Control centre)
- **Main canal**
- **Secondary canal**
- **Minor canal**
- **Branch canal**

**Symbols**
- X-regulator gates
- Offtake gates
- Local station. Supports data transmission from sensors monitoring water levels u/s and d/s of gates, flow measurement d/s of gates, gate openings, and water quality (if required).
- Data transmission
SCADA Installation on Dau Tieng Scheme

- K34 Cross-regulator - East main canal
- Gate Actuator (Electric motor)
- Acoustic water level monitor
- Display monitor in Control Centre
Was Infrastructure Modernisation Achieved?

- Whilst additional lining has much improved canal conveyance efficiency, this is not ‘irrigation modernisation’ per se.

- **Insufficient water control and measuring structures** were built, in particular long-crested weirs to maintain water levels at strategic offtakes - their **unit cost was comparatively small**, and many could have been constructed by reducing small lengths of **more expensive canal lining**.

- Only in Phu Ninh & Yen Lap have reasonable numbers been built, and their benefits are now appreciated by IMC staff and farmers.

- It is understood that **long-crested weirs were not listed in GOVN’s irrigation structures design manual**, despite many recommendations. Maybe some local IMC managers didn’t have the confidence to approve the designer’s proposals.

- **SCADA installation in Dau Tieng was successful** but is **not being used properly**. In the other 4 schemes, **installation was so late** that the project had finished before the systems were completed, so **no feedback so far**.
Lessons Learned – Design/Construction

Inappropriate designs caused additional costs and delays

• Designers must spend more time consulting local people to avoid wasting cost and time on abortive design and bidding.

Canal closure periods

• For canal rehabilitation, contractors have limited construction windows due to canal closure periods. Appropriate design and construction planning is vital.

Dry / Rainy seasons

• Canal earthworks must be done in dry season so contract award timing is important – but difficult to achieve as period for tendering, bid evaluation, approval and contract award is unpredictable so first dry season may be lost.
Cau Son Contractors were delayed due to insufficient details on how to deal with minor problems, such as small pumping stations, protecting bridge abutments, or modifications to drainage culverts.

Contract drawings need the full details.

Cau Son Yen Lai canal bed width was reduced from 10 to 8 m in one short reach.

Bank-filling of eroded canal profiles to achieve straight sections, added more cost and delay, especially with limited construction windows, and added little significant benefit to the canal’s hydraulic performance.
Lessons Learned – Design/Construction

**Cau Son**  Completion of contracts 18 & 19 were delayed due to poor design decisions.

Trapezoidal design encroached on householders land so *design was changed, mid-contract*, to a flume section, with a *large cost increase* needing a rebid and thus *even further delay*.

**Phu Ninh**  Some soils on North main canal, *known to be weak at design stage*, caused several bank failures.

*Alternative lining methods could have been provided on the drawings* for these weak sections.

*Dry stone pitching in an rc grid frame proved successful.*
Modernisation compromised

Dau Tieng, Primary Canal N18, K7+600
Construction of gated long-crested weir.
Two orifices had been made through weir walls, at IMC’s request who said gate width was not sufficient to pass flow.
Thus, some IMC staff didn’t understand the main function of long-crested weirs.

Cau Son, Guia canal
Existing bridge with debris caught on central pier, causing large head losses.
Problem made worse because new canal profile is now wider than bridge, which was not scheduled to be replaced.
Modernisation objective compromised.
Missed Opportunities

**Ke Go – main canal aqueduct, K3+329**
- A long-crested weir could have been built u/s of aqueduct inlet to regulate water levels for u/s offtakes.
- Existing central gate could have been used for fine tuning of water levels.

**Cau Son – Need for long-crested weirs**
- IMC staff were asked about the usefulness of long-crested weirs in canal operation.
- Agreed were useful - the designers had wanted to put in more, but PMU said existing system was functioning ok and did not agree to more than two weirs.
Missed Opportunity

Ke Go - main canal tail, K16+900

- At Ke Go main canal tail are two gated regulators, feeding N8 & N9 sec. canals.

- PMU staff said a long-crested weir had been constructed at end of main canal.

- However, a new side-spill escape weir had been built into the left bank instead.

- The designer said a long-crested weir had been designed, but was rejected by PMU and a side-spill escape weir built instead.

- An opportunity to improve operational control was lost – a long-crested weir could have been built in front of N8, using its existing gate to fine tune water levels.
Ke Go – N6-7 tertiary canal

- This photo is 1 of 20 new ‘long-crested weirs’ on the tertiary network.

- A side spill weir had been formed in left side wall, just u/s of gate; water should flow around gate and rejoin canal d/s.

- Gate was not fully closed so water flowed under the gate and not over the side spill weir.

- A cheaper solution would put simple long-crested weirs diagonally across flume, to maintain water levels.
Incorrect Operation

Dau Tieng - N8 primary canal, K2+506

• A ‘W’ long-crested weir operated with the gate open, rather than shut, with water passing over the crests.

• Gate operators didn’t understand the reasons for introducing long-crested weirs, and need training.

• Senior IMC staff explained when periods of least irrigation demand the operators like to keep canal water levels low, so canal banks are not stressed.

• With canal lining this argument is no longer valid.
Wrong design?  Construction error?

New long-crested weir **submerged and ineffective**.

At the time, it was not established whether wrong design or construction error.

**Crests could easily be raised** to make weir functional.

Phu Ninh – North main canal K12+590
Civil Works Costs

- Average cost ~US$ 970/ha (2009-10 prices), say ~US$ 1,180/ha (2013-14 prices @ 5% pa).
- Add 5% for design consultants.
- Costs shown do not include land compensation and resettlement costs which are often significant.

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Area ha</th>
<th>Cost US$/ha</th>
</tr>
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<tbody>
<tr>
<td>Cau Son</td>
<td>21,800</td>
<td>970</td>
</tr>
<tr>
<td>Yen Lap</td>
<td>6,800</td>
<td>1,500</td>
</tr>
<tr>
<td>Ke Go</td>
<td>19,000</td>
<td>1,040</td>
</tr>
<tr>
<td>Phu Ninh</td>
<td>17,400</td>
<td>1,310</td>
</tr>
<tr>
<td>Da Ban</td>
<td>7,300</td>
<td>730</td>
</tr>
<tr>
<td>Dau Tieng</td>
<td>57,600</td>
<td>810</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Average</th>
<th>2009-10</th>
<th>$ 970/ha</th>
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<tr>
<td></td>
<td>2013-14</td>
<td>$ 1,180/ha</td>
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Modernisation of Irrigation Operations and Institutional Reform
Institutional modernisation and reform is equally as important as rehabilitating and modernising civil works.

However, it usually takes second place in donor-funded projects, with need to finish design and construction works to keep up with the loan disbursement schedule.

For 5-7 years of a typical project life, insufficient time is available to reform institutions – needs maybe >10 years.

For a successful outcome it’s essential that the leaders (eg. IMC directors) are enthusiastic about reform – if not, then little will be achieved.
Participatory Irrigation Management (PIM)

- A 3-year PIM programme was funded by a Japanese grant - **66 WUOs were set-up in 13 pilot areas in the 6 schemes** and were running well when VWRAP ended.

- However, **lack of continuity in funding when the project finished** meant that several WUOs stopped operating, due to lack of financial resources, even though the members wanted to continue,

- **Continuity budget should be applied for** and be in place when the donor-funded project finishes.

- This would **demonstrate that the authorities were serious** about institutional reform.
Irrigation Management Transfer (IMT)

- **IMT aims to transfer responsibility** for O&M of secondary canal networks to WUOs.

- IMT programme was **not introduced into VWRAP until its last year** so not enough time for any significant progress.

- **Some WUOs don’t have the legal status** to have irrigation infrastructure transferred to them.

- One **major problem** is that current WUOs are based on **either administrative or hydraulic boundaries**, which are incompatible.
Irrigation Benchmarking

- Benchmarking programme not introduced into VWRAP until its last year.

- Initial findings highlighted many institutional obstacles to starting benchmarking, such as ……

- IMCs are not obliged, under their charter, to measure and monitor water use but function only as a water service provider.

- GOVN legislation on M&E of irrigation infrastructure exists but is not specific enough.
Lessons Learned - Acceptance of Irrigation Modernisation

There was reluctance from some IMCs to accept modernisation in the way that canals would be operated and controlled.

- **East main canal of Dau Tieng** now designed for d/s control - SCADA can set levels at cross-regulators to match flows taken off into primary canals. Thus, operational staff have no need to adjust cross-regulator gates but they continue to do so as ‘it’s what we’ve always done’.

- **Cau Son**: the reluctance to build long-crested weirs may be because IMC continue to operate canals on an ‘on/off’ basis, not necessary but ‘it’s what we’re used to doing’. Unless senior IMC management wish to modernise, little will happen in practice, despite training programmes.
VWRAP.....
How Successful Was It?
The overall lesson learned from VWRAP is that principles of modernisation were not fully understood by the main stakeholders - consultants, PMU and IMC managers ..... 

1) Although infrastructure has been improved it has not yet met all operational requirements – e.g. damaged gates of some cross regulators were replaced but are still operated manually rather than electrically, so difficult and time-consuming for operators.

2) Local managers have not yet properly put new infrastructure into use due to their poor understanding of the principles of modernisation to meet operational requirements.

3) Implementation was not fully in accordance with project objectives due to wrong design in some places, some unnecessary long-crested weirs built (Yen Lap), no institutional changes, and keeping the traditional modes of operation – thus the expected benefits have not yet been fully achieved.
Conclusions in WB Completion Report

• Final WB rating was ‘Moderately Satisfactory’.

• Modernisation is a **continuous process** - initial phase was completed but more years needed to fully achieve the **objective** envisaged at appraisal.

• Future projects could **concentrate on fewer changes** with enhanced sustainability.

• Delays in design process delayed start of construction, so **IMC reform was neglected**.

• Much staff training provided on improved system operation but **not generally implemented** in the field by IMC staff.

• Project **lacked an agricultural component** in its preparation.
THE END

Da Ban Dam