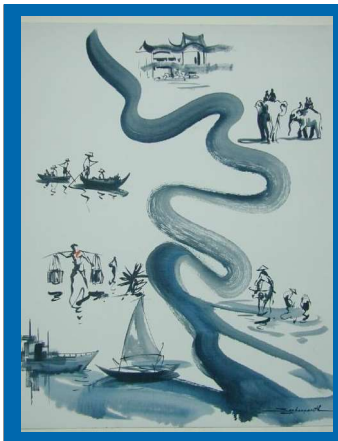
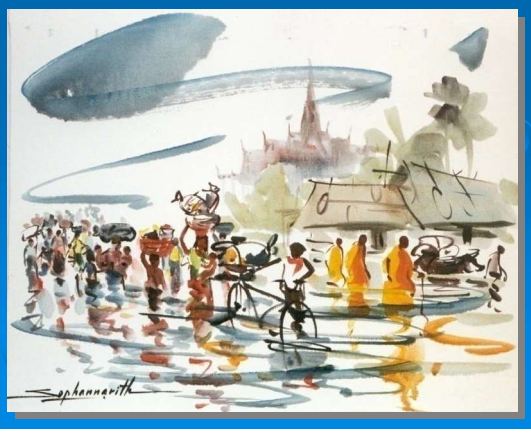


Participatory Approach in Adaptive Water Management and Rural Disaster Planning by Irrigation Gate Operation

Takao MASUMOTO

Akita Prefectural University
JAPAN

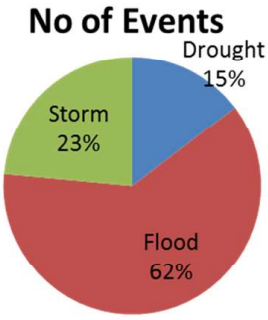


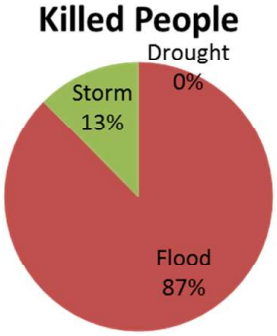
Outline

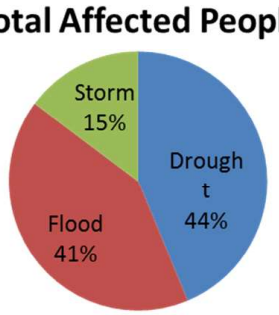
- Development of a method to work out a rural disaster management plan

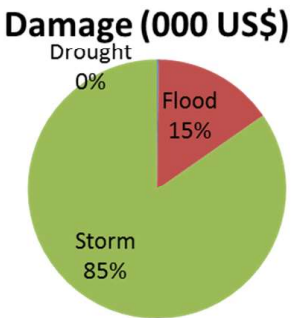
- A typical watershed with frequent floods in rainy seasons
  - Nam Cheng River Basin in the LAO PRD
- Relation between irrigation gates management for water supply during dry seasons and floods
  - Modeling runoff, inundation and gates operation by utilizing DWCM-AgWU (model)
  - products of adaptive water management and rural disaster planning evoking local managers and relevant farmers

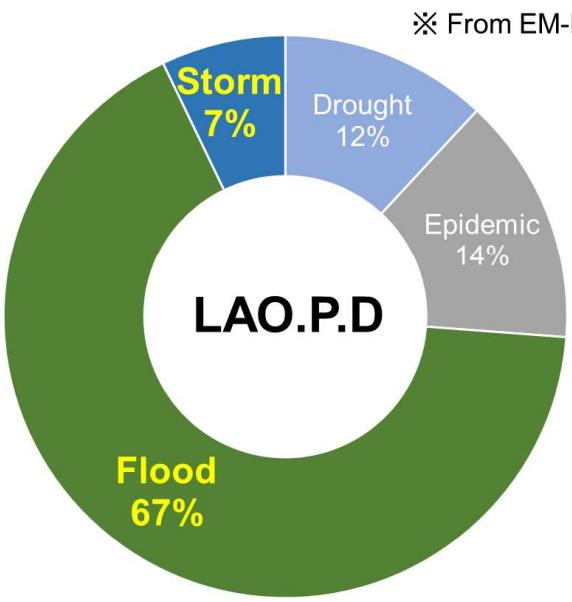
Background: Severity of flood damage in the Lao PDR (1900～2017)











Source: "EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net – Université Catholique de Louvain – Brussels – Belgium"

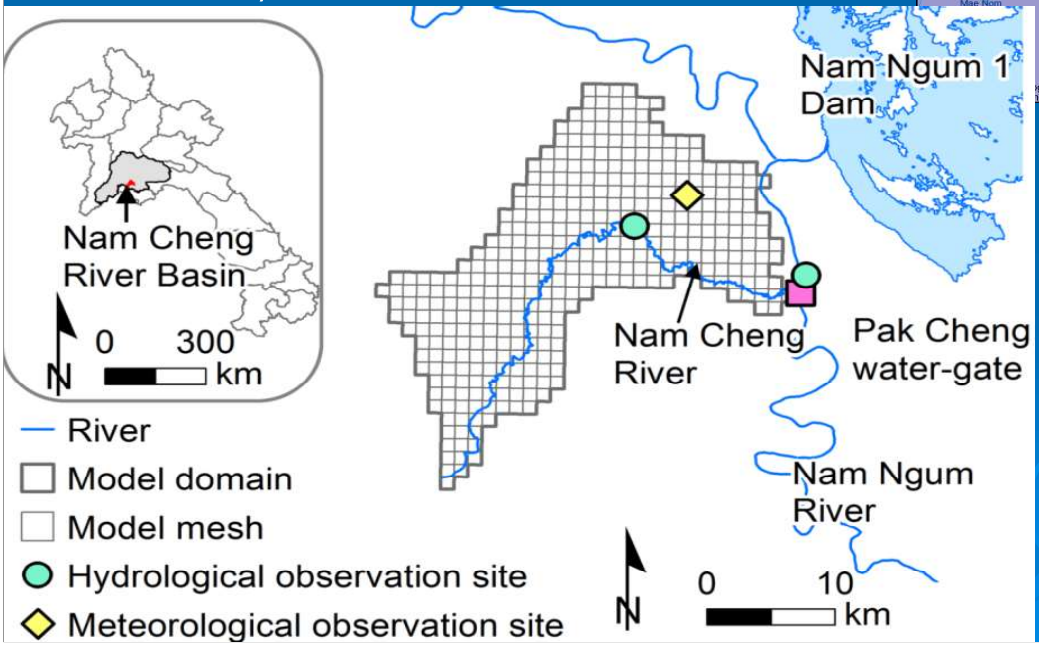
Floods and storms account for the majority of natural disasters in Laos.

3

Target Area

A basin controlled by irrigation gates

Nam Cheng River Basin: Nam Ngum River Basin
(One of the tributaries of the River Basin with 6 hydro-generation dams and with their big influences)



- Watersheds: 435 km²
- Downstream end: 14 gates for irrigation

4

Identification of Causes for Floods and Additional Problems

- Inquires for causes of inundations of paddies in the basin by operations of irrigation gates (Skepticism from local people)

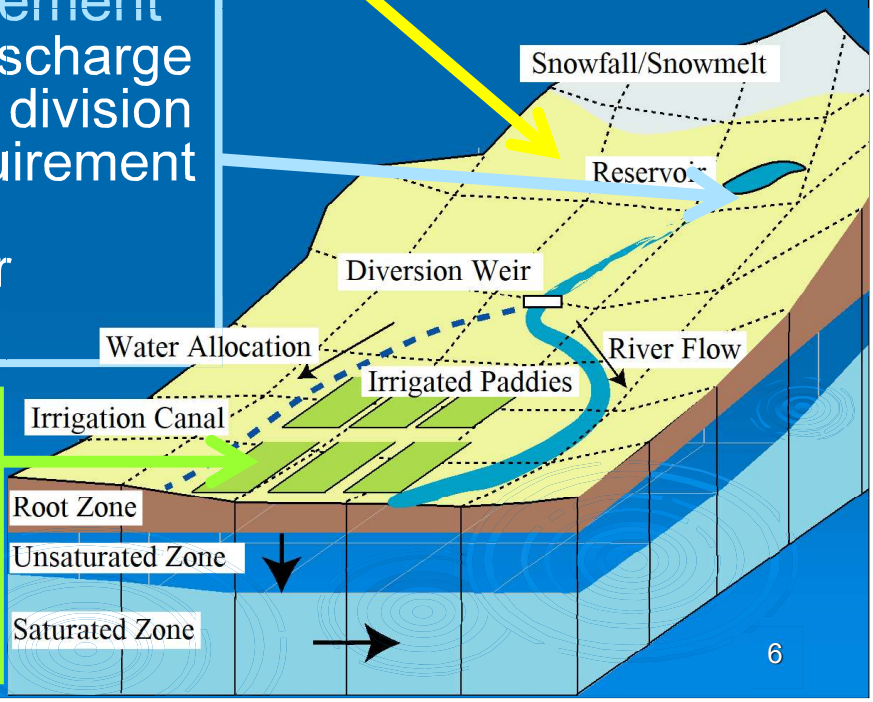
- Lack of fundamental hydrology data (water level, discharge, rainfall etc.)
- Operations of irrigation gates fully depend on experience of managers.

1) Stage of Model Development (Improvement of the DWCM-AgW)

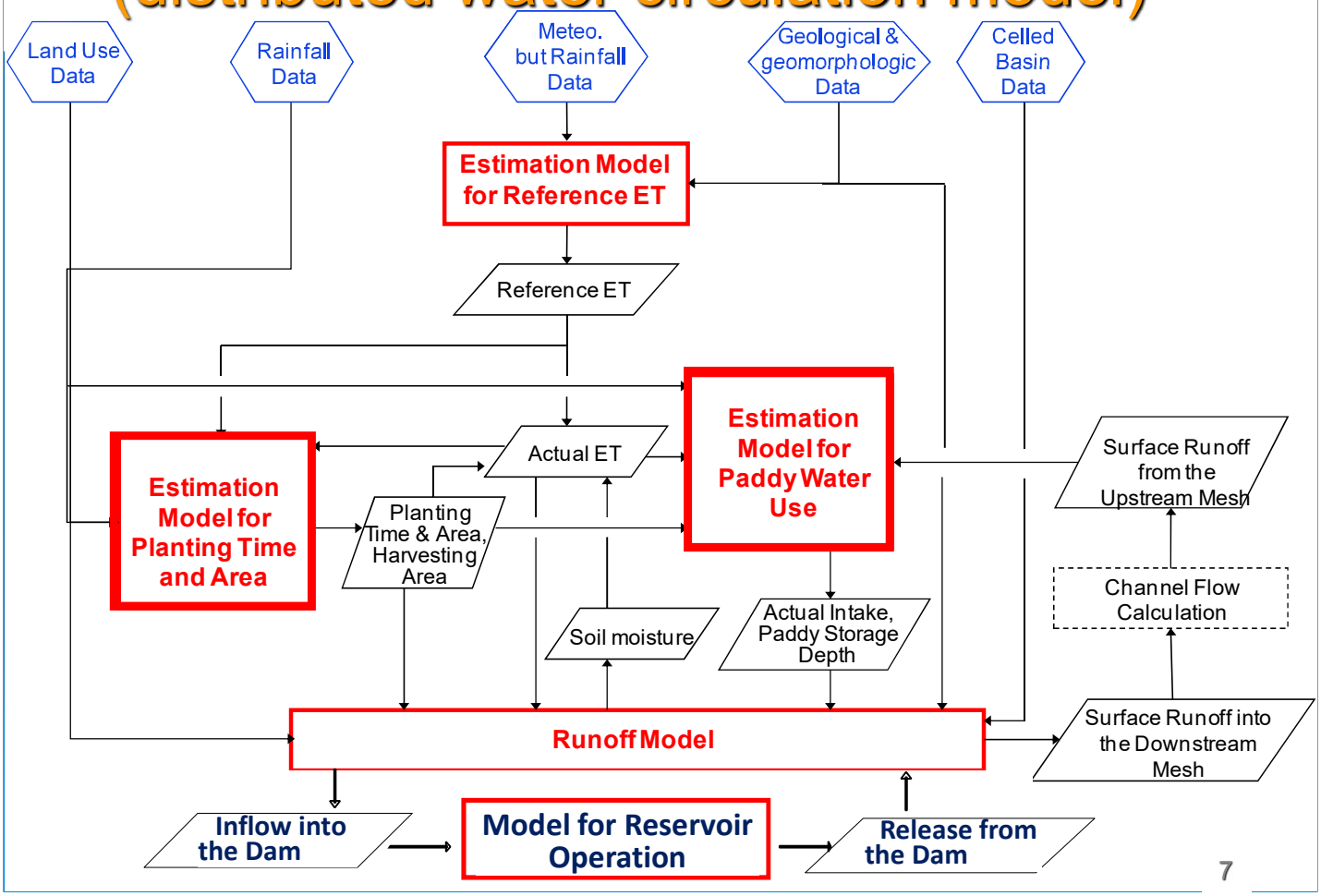
i) Basin-wide Runoff
- DWCM-AgWU Model

ii) Reservoir Management
- To compare river discharge (available water) at division weir and water requirement in irrigated paddies
- To release water for irrigation

iii)Water Delivery in Irrigated Paddies
- To decide intake, water allocation, infiltration, drainage

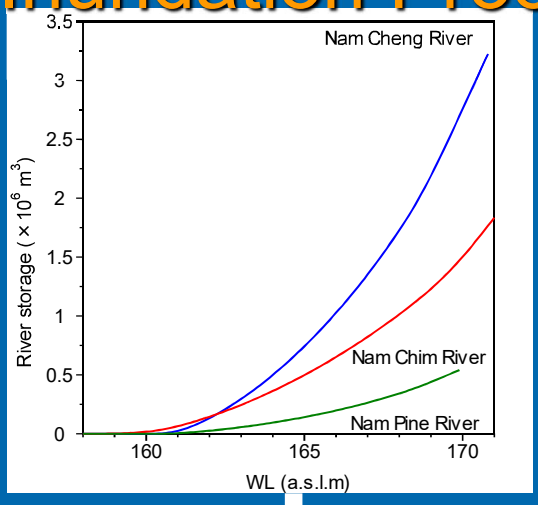


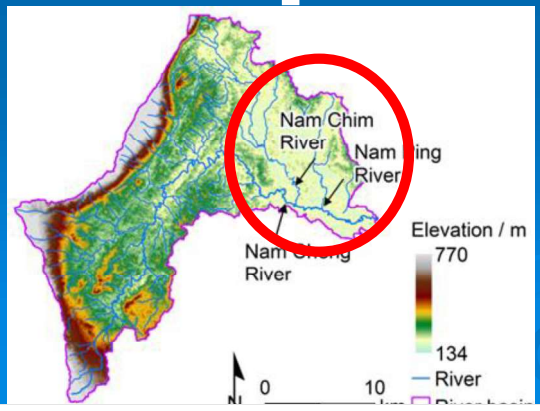
Calculation algorism of DWCM-AgWU (distributed water circulation model)

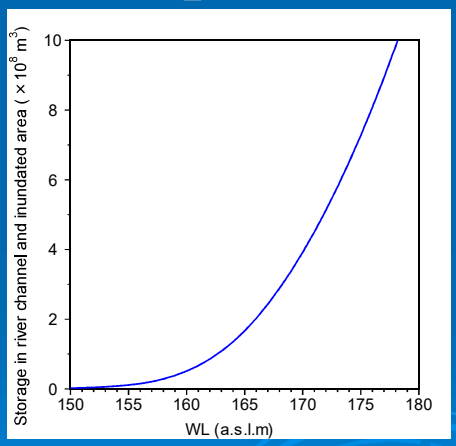


7

Modeling of Flooding and Inundation Processes







Flooding processes were reproduced by using *H* (WL)--*V* (Flood Vol.) curves.[8]

Modeling of Gate Operation

Rainy Season

Inner W.L. [m]	Outer W.L. [m]	Gate Open Height [m]	No of Open Gate
Outer W.L. 1m > Inner W.L.		0	0
<3.9	Lower than inner W.L.	0	0
3.9-4.1		1.0	2
4.1-4.3		2.0	3
4.3-4.7		2.5	5
4.7-5.0		2.5	6
5.0-5.5		2.5	8
≧5.5		2.5	10

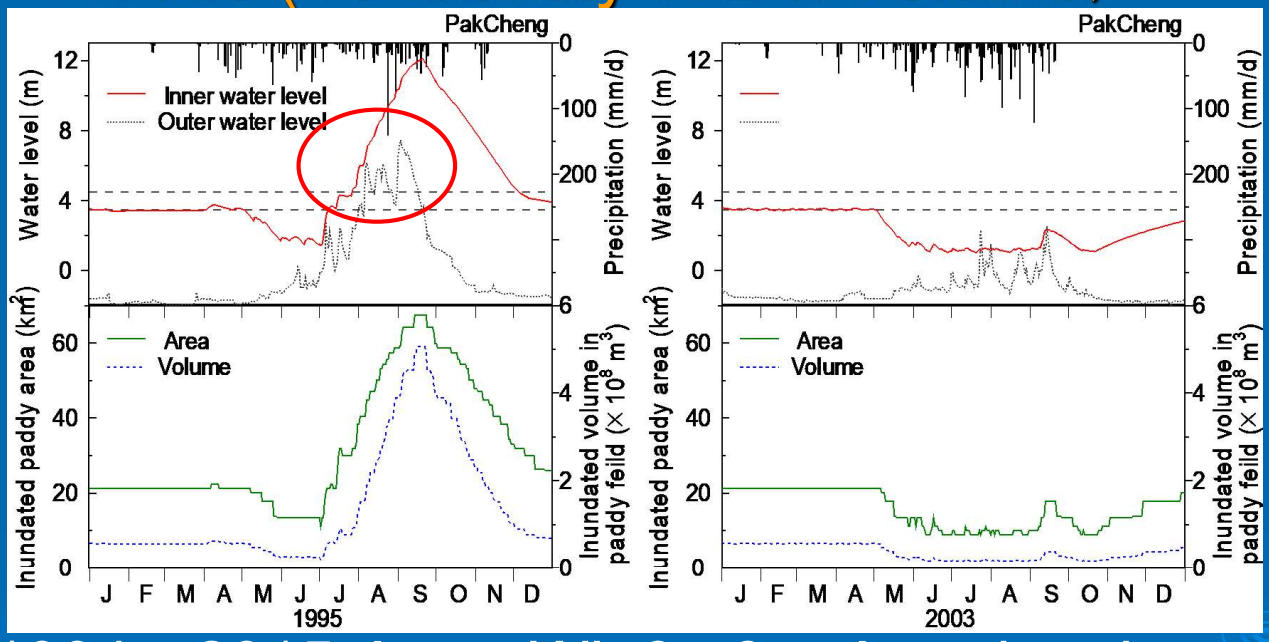
Dry Season

Inner W.L. [m]	Outer W.L. [m]	Gate Open Height [m]	No of Open Gate
<3.4	Lower than inner W.L.	0	0
3.4-3.6		0.5	2
3.6-3.8		1.0	2
3.8-4.0		2.0	3
≧4.0		2.5	5

- When outer WL > Inner WL by more than 1m, gates closed
- Target WL: 4.0m (rainy seasons), 3.5m (dry seasons)

9

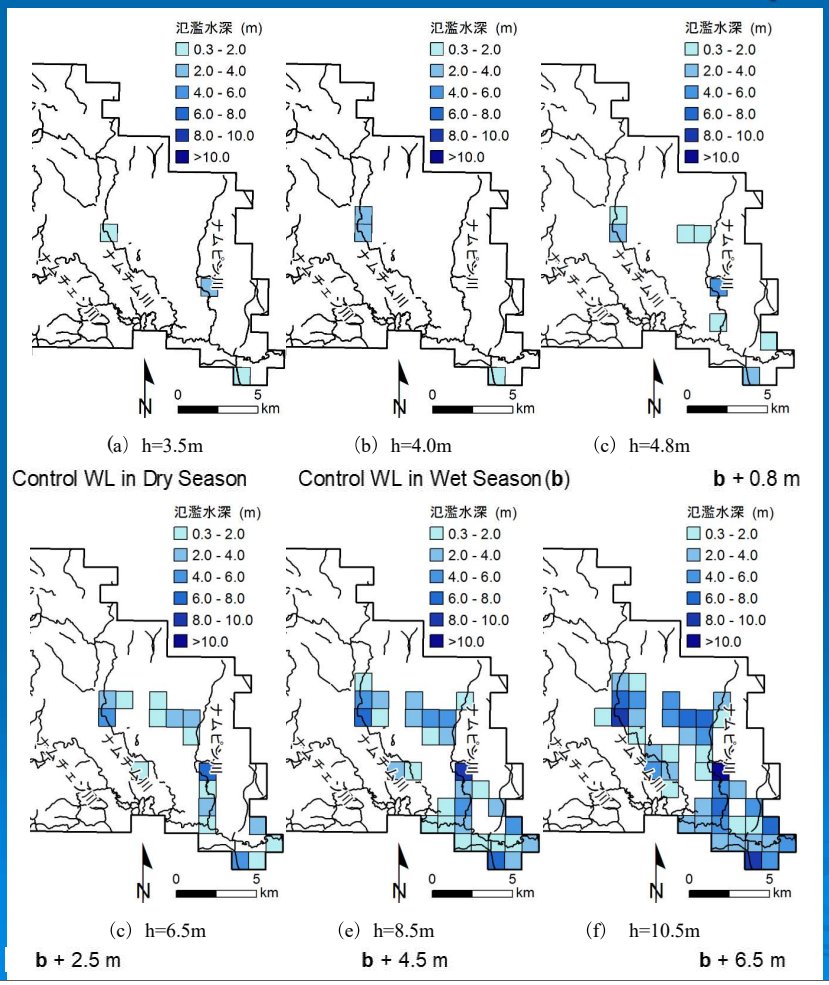
2) Specification Stage of Causes for Floods (To Identify WL & Volume)



- 1994～2015: Inner WL 6 - 8m, Inundated paddy area 16～30km²
- Flood year 1995 (10-year RP): Proved that paddy inundation caused by gate operation.

10

Estimation of Inundated Area (simulated)



- Corresponds to inner WL at the Pak Chen Gates

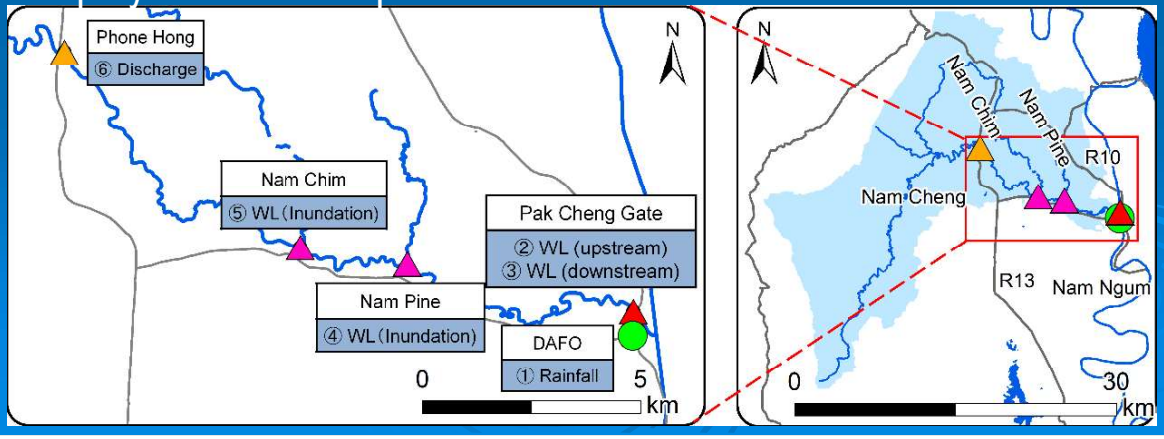
3) Proposal of Hydrological Observ.

Original proposal:

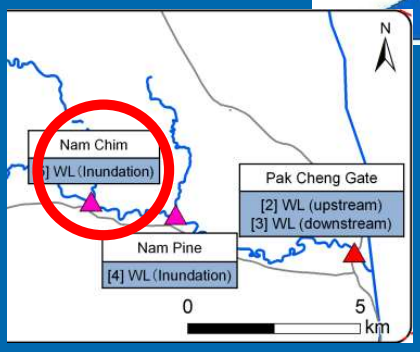
1) Tipping Bucket-type Rainfall Gage, 2) Staff gages (Inner & outer) at Pak Chen Gates, 3) Staff gage in flooded prone areas (1 site), 4) Automatic WL recorder for Q (Discharge) at Phone Hong site, 5) Panel Display at the Operation Office, 6) Interval Recorders (Instant Cameras)

Final decision:

- Rainfall: One at the Gate Operation Office
- WL: 4 Staff Gages (Near the Gates 2 sites, 2 sites at the Confluences, Q observation 1 site)
- Display Panel: the Operation Office



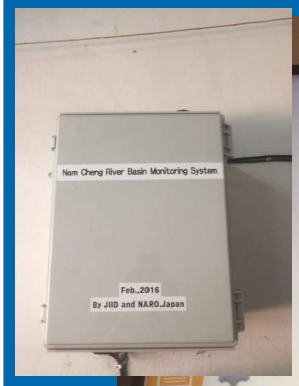
Water Level Observation by Instant Cameras

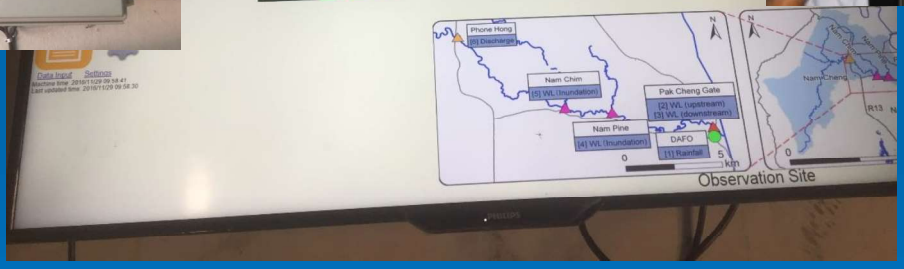


Functionalized as simplified (temporal) WL observation equipment.

13

Display of Observation Results (DAFO site)

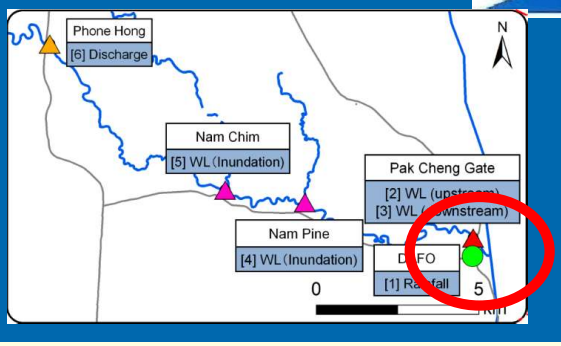


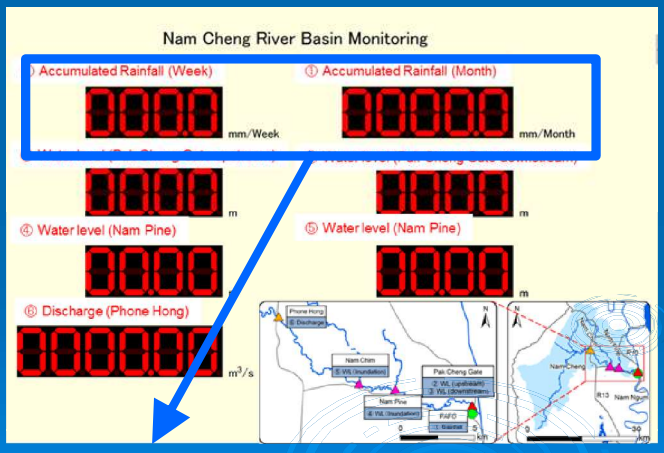


- WLs observed by staff gages are input <u>by a keyboard for Display Panel manually</u>.
  - → In the future, observed information will be transmitted by cable wires and/or wireless radio automatically and displayed in the panel.

14

Rainfall Observation





Displayed at the panel as accumulated weekly and monthly rainfall amounts.

15

4) Design of Flood Prevention through the improvement of gate management

- Gate operation methods: Present, Designs (Nos.1 – 3), Final proposal
- Improvement indicators: Difference of inner and outer WLs, Operated gate nos./hights, Nos. of gate operation in a week, Inner WL targets in wet/dry seasons, Allowance of reverse flows etc.

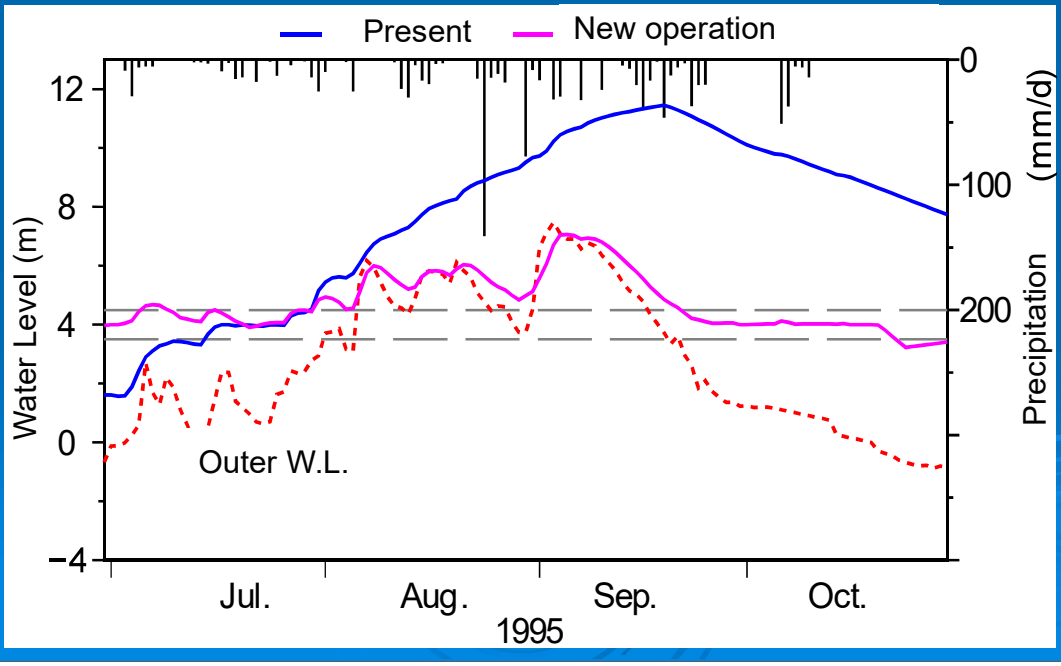
16

Table 1 Estimation of flood damage and remedy effects of gate operation (1995-2015)

	Present rule	Desig n 2	Design 3	Final proposal
Maximum inner WL [m]	14.94	8.36	8.08	8.09
Inundated paddy area [km^2]	62.1	35.8	33.9	33.9
Flooded volume [x10^{8}km^3]	3.99	0.94	0.84	0.87
Maximum drainage [m^3/s]	164.7	286.3	316.4	318.1
Maximum inverse flow [m^3/s]	71.5	254.5	254.5	255.6

Effects of Renewed Gate Operations --Simulated Results by the Model--

- Inundated days (depth > 30cm: 201 → 112 days
- Days for Inner WLs > 7.5m: 68 → 0 days



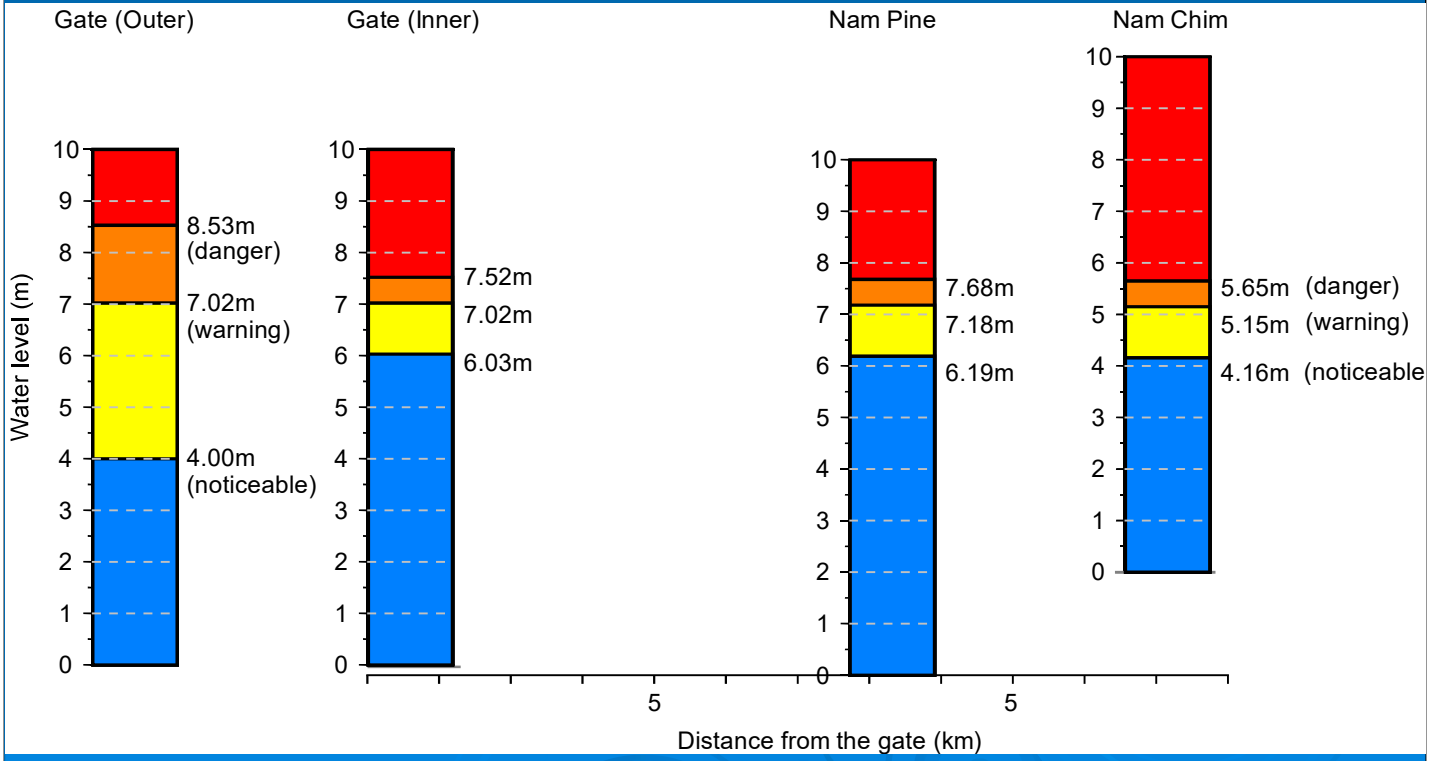
5) Development Stage for a Guide-line of Rural Disaster Planning

- Usage of modeling: Effective tools for analyzing the areas with the scarce of basic data
- To utilize the estimates for river flows and water levels as quasi-observed data (Series of the methods: an effective way to obtain various data at arbitral points)

↓

- Watershed Management for the next stage
  - -- Gate operation using the difference between inner and outer WLs at the gate site
  - -- Setup of "Warning WL" for outer WL and for inundated WL and coloring of staff gages
    → WL Warning System
  - -- Gate operation using observed and/or predicted Q in the upper basin

Examples for a "WL Warning System"



Conclusion

1. Modeling: It is used as a tool to generate quasi-observed data. At the same time, it can be used to evaluate the effectiveness of counter-measures and policies.
2. Experimental demonstrations (2 years) are not the execution of our proposals, but the exchange among the proposers (research institutes, univ., etc.) and irrigation facilities' operators (managers, engineers) and inhabitants, through local visits (7 times) and seminars (4 times). → Adaptive Water Manag. and Rural Disaster Prevention Plan

➔ *To improve gate operations by local engineers === Participatory approach by operators as well as locals*

The End

Thank you for your attention.