Ministry of Agriculture and Cooperatives

THE PROJECT FOR FLOOD COUNTERMEASURES FOR THAILAND AGRICULTURAL SECTOR

IN

THE KINGDOM OF THAILAND

FINAL REPORT

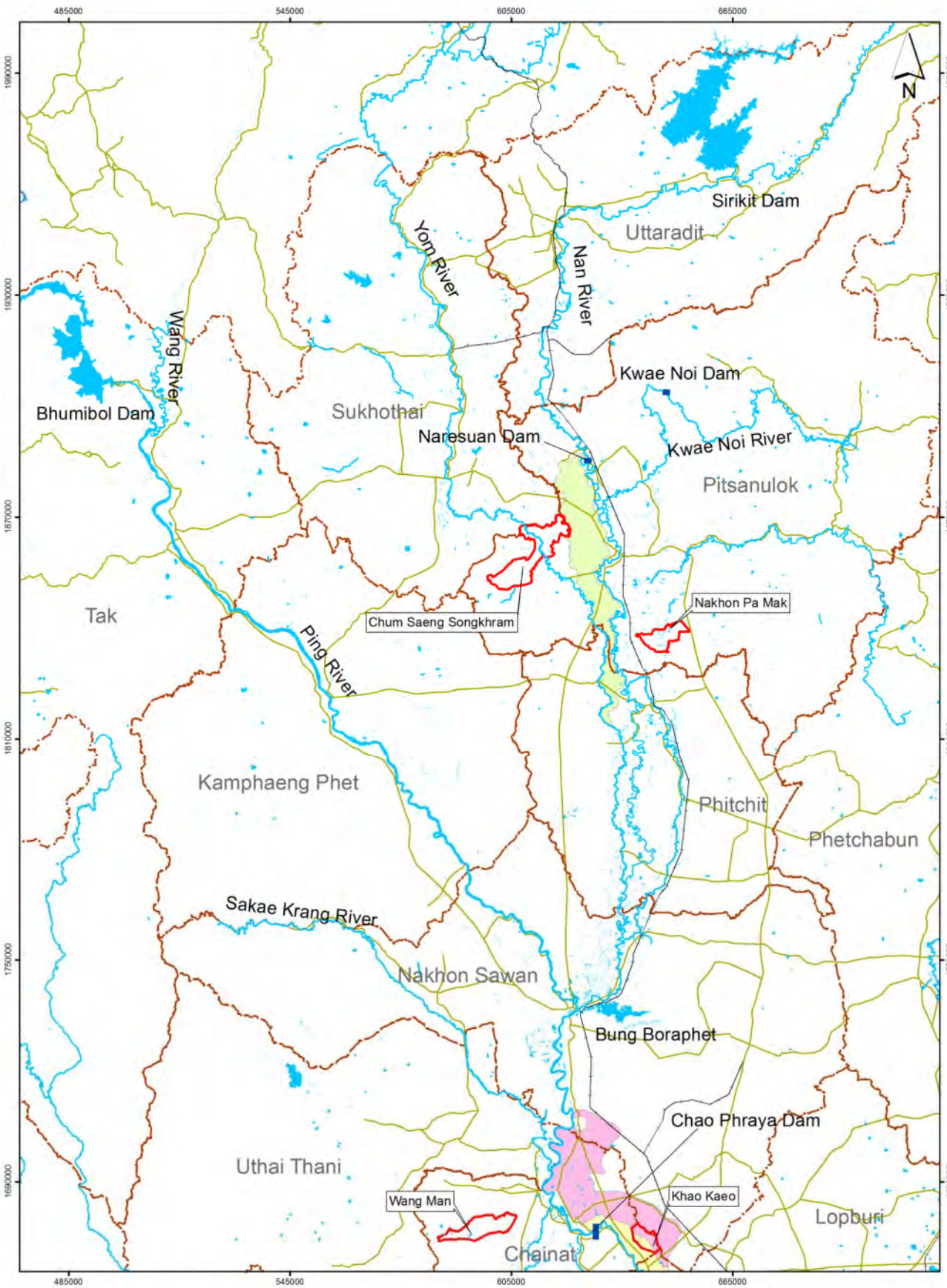
JULY 2013

Japan International Cooperation Agency

SANYU CONSULTANTS INC.

NIPPON KOEI CO., LTD.


Location Map of the Study Area
N
W
E
S
Chiang Mai
Upper Basin
Laos
Sirikit Dam
Bhumibol Dam
Sukhothai
Phitsanulok
Middle Basin
Kampaeng Phet
Phichit
Myanmar
Bung Boraphet
Nakhon Sawan
Uthaithani
Chainat
Singburi
Pasak Dam
Lower Basin
Lop Buri
Angthong
Chaophraya river
Sara Buri
Ayuttaya
Suphanburi
Rangsit Canal
Pathun Thani
Nakon Phatom
Chachoengsao
Bangkok
Samut Prakan
Nonthaburi
Samut Sakhon
Cambodia
Gulf of Thailand
0
50
100 km
Myanmar
VIETNAM
Laos
Thailand
BANGKOK
Study Area
Cambodia
Malaysia
Legend
National Boundary
Provincial Boundary
Chaophraya river basin
Capital
Main City
Road
Railway



Legend

- Provincial Boundary
- Model Area
- Main road
- Railway

RID Large Scale Irrigation Project

- Plai Choompol Project Area
- Manorom Project area
- Maharaj Project area

Note

Data Source: RID

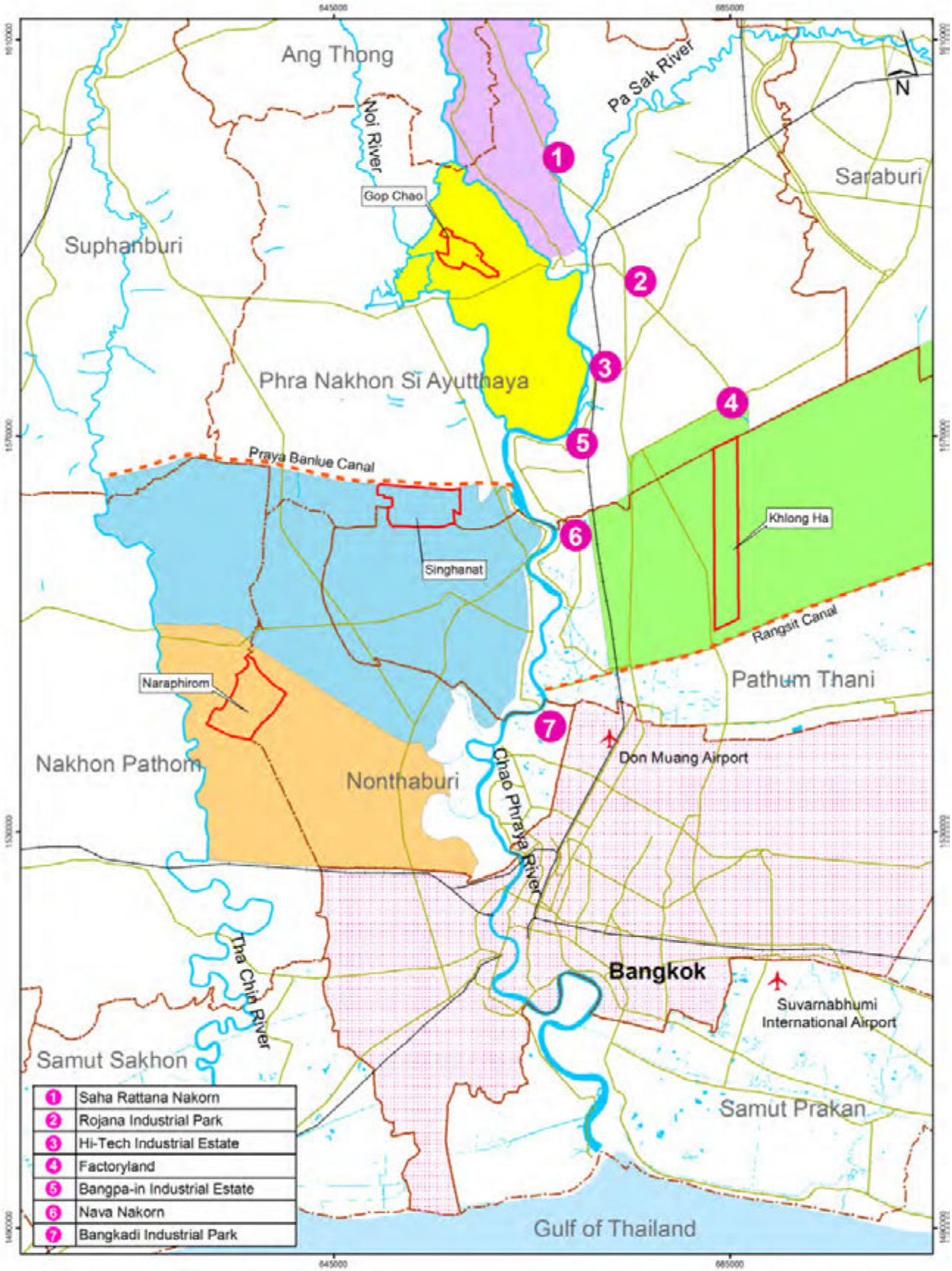
Scale 10 5 0 10 20 30 km

Date July 2013

Project for
Flood Countermeasures
for
Thailand Agricultural Sector

JICA

Location Map of Model Areas in Middle Chao Phraya River Basin



Legend

- Provincial Boundary
- Model Area
- Main road
- Railway
- Industrial Estate
- Bang Ban Project area
- Praya Banlue Project area
- Pra Pi Mon Project area
- North Rangsit Project area
- Bangkok

Note

Data Source: RID

Scale 5 2.5 0 5 10 15 km

Date July 2013

Project for Flood Countermeasures for Thailand Agricultural Sector

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Location Map of Model Areas and Major Industrial Estates in Lower Chao Phraya River Basin

Abbreviations

ADB	Asian Development Bank
ADRC	Asian Disaster Reduction Center
AIT	Asian Institute of Technology
ALRO	Agricultural Land Reform Office
BAAC	Bank for Agriculture and Agricultural Cooperatives
BMA	Bangkok Metropolitan Administration
CBDRM	Community-based Disaster Risk Management
CDD	Community Development Department
C/P	Counterpart
CSR	Corporate Social Responsibility
DDPM	Department of Disaster Prevention and Mitigation
DDS	Department of Drainage and Sewerage, BMA
DEDP	Department of Energy Development and Promotion
DIW	Department of Industrial Works
DLD	Department of Livestock Development
DM	Dry Matter
DO	Dissolved Oxygen
DOA	Department of Agriculture
DOAE	Department of Agricultural Extension
DOF	Department of Fishery
DOH	Department of Highway
DOLA	Department of Local Administration
DPM	Disaster Prevention and Mitigation
DRM	Disaster Risk Management
DRMS	Disaster Risk Management System
DWR	Department of Water Resources
EGAT	Electricity Generating Authority of Thailand
E/S	Engineering Service
FAO	Food and Agriculture Organization, UN
FAORAP	Regional office for Asia Pacific Food and Agricultural Organization
FFC	Flood Forecasting Center
FROC	Flood Relief Operations Center
GAP	Good Agricultural Practice
GMP	Good Manufacturing Practice
GDP	Gross Domestic Product
GIS	Geographic Information System
GISTDA	Geo-Informatics and Space Technology Development Agency
GOT	Government of the Kingdom of Thailand

GPS	Global Positioning System
HAII	Hydro and Agro Informatics Institute
HFA	Hyogo Framework for Action
ICHARM	International Center for Water Hazard and Risk Management
ICT	Information and Communication Technology
IEC	Irrigation Engineering Center, RID
IMPAC-T	Integrated Study Project on Hydro-meteorological Prediction and Adaptation to Climate Change in Thailand
JETRO	The Japan External Trade Organization
JBIC	Japan Bank for International Cooperation
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JV	Joint Venture
KMITL	King Mongkut's Institute of Technology Ladkrabang
KU	Kasetsart University
LAO	Local Authority Organizations
LDD	Land Development Department
LSIFP	Large Swamp Inland Fishery Project
LU	Livestock Unit
MCM	Million Cubic Meter
MI	Ministry of Industry
MOAC	Ministry of Agriculture and Cooperatives
MOI	Ministry of Interior
MONRE	Ministry of Natural Resources and Environment
MOT	Ministry of Transport
MOST	Ministry of Science and Technology
NDPMC	National Disaster Prevention and Mitigation Committee
NESDB	National Economic and Social Development Board
NEB	National Environment Board
NGOs	Non-Government Organizations
NSO	National Statistic Office
NWFPC	National Water Resources and Flood Policy Committee
OAE	Office of Agricultural Economics
OECF	Overseas Economic Cooperation Fund, Japan
O&M	Operation and Maintenance
ONWFMP	Office of National Water and Flood Management Policy
OPM	Office of the Prime Minister
OPS	Office of the Permanent Secretary
OSCWRM	Office of Strategic Committee for Water Resources Management、
OTOP	One Tambon One Product
OTOS	One Tambon One Search and rescue team
PACO	Provincial Agricultural Cooperative Office

PAO	Provincial Administration Office
PLOs	Provincial Livestock Offices
PRA	Participatory Rural Appraisal
RRC	Rice Research Center
RD	Rice Department
RFD	Royal Forest Department
RID	Royal Irrigation Department
RIO	Regional Irrigation Office
ROAE	Regional Office of Agricultural Economics
RTG	Royal Thai Government
SCRFD	Strategic Committee for Reconstruction and Future Development
SCWRM	Strategic Formulation Committee for Water Resources Management
SSIFP	Small Swamp Inland Fisheries Project
SSIP	Small Scale Irrigation Program
SSIRP	Small Scale Irrigation Improvement and Rehabilitation Project
SWOT	Strength, Weakness, Opportunity, and Threat
TAO	Tambon Administration Organization
TF	Task Force
UNDP	United Nations Development Program
WFMC	Water and Flood Management Committee
WUG	Water Users Group

Model Areas

CSS : Tambon Chum Saeng Songkhram, Bang Rakam District, Phitsanulok Province
NPM : Tambon Nakhorn Pa Mak, Bang Kratum District, Phitsanulok Province
WM : Tambon Wang Man, Wat Sing District, Chainat Province
KK : Tambon Khao Kaeo, Sapphaya District, Chainat Province
GC : Tambon Gop Chao, Bang Ban District, Ayutthaya Province
SHN : Tambon Singhanat, Lat Bua Luang District, Ayutthaya Province
KH : Tambon Khlong Ha, Khlong Luang District, Pathumthani Province
NP : Tambon Naraphirom, Bang Len District, Nakhon Pathom Province

Measurement Units

(Length)
mm : millimeter(s)
cm : centimeter(s)
m : meter(s)
km : kilometer(s)d, dy

(Time)
s, sec : second(s)
min : minute(s)
h, hr : hour(s)
: day(s)
y, yr : year(s)

(Area)

mm^2	:	square millimeter(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
ha	:	hectare(s)

(Volume)

cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)
l, ltr	:	liter(s)
MCM	:	million cubic meter(s)

(Weight)

g, gr	:	gram(s)
kg	:	kilogram(s) m/s
ton	:	ton(s)

(Speed/Velocity)

cm/s	:	centimeter per second
	:	meter per second
km/h	:	kilometer per hour

(Energy)

MJ	:	Mega Joule(s)

(Money)

USD	:	US Dollar(s)

Currency Exchange Rate

THB1.0 = JPY 3.352 (June, 2013)

USD1.0 =JPY 101.30 (June, 2013)

Summary

A. Introduction

1. Background of the Project

From the end of July 2011 and into 2012, Thailand experienced a massive flood in the Chao Phraya River basin, with vast areas submerged and significant after-effects on a scale that had not been experienced before in Thailand's recent history. People living and working in this basin suffered from the huge scale of damage caused by this long-term inundation. Economic losses due to the flood and subsequent loss of work opportunities is estimated to be between 400 and 1,300 billion baht or more than 10% of GDP. Damages to agriculture have been reported to be as high as 72 billion baht.

In response, the Government of Thailand established two committees to deal with long-term measures; the Strategic Committee for Reconstruction and Future Development (SCRFD) and the Strategic Committee for Water Resources Management (SCWRM). The former has already approved a plan to invest 2,270 billion baht to construct basic infrastructure during the coming decade. The latter presented a plan to disburse 22.6 billion baht for short-term preventive measures in preparation for the coming rainy season in 2012, and 350 billion baht to take medium to long-term measures, including the delineation of flood water retention areas (paddy fields and swamps) and the construction of floodways.

The Government has so far provided only limited measures for the benefit of the agricultural sector which suffered heavy damages to over 1.44 million hectares of paddy fields, 36 thousand hectares of aquaculture ponds and a loss of 29.5 million head of livestock. These benefits are in the form of compensation for inundated farmland, free distribution of seed paddy, and the provision of animal feed in some affected areas. Thus, farmers who suffered flood damage continue to face difficulties due to the lack of effective measures to provide compensation for loss of major harvests or lost income opportunities.

Under these circumstances, JICA dispatched three preliminary study missions during November 2011 to January 2012, and decided to conduct this Project titled "Flood Countermeasures for Thailand Agricultural Sector."

2. Project Outputs

The outputs of this project are: 1) recovery of productivity of damaged pastures, 2) guidelines on rehabilitation and reinforcement of irrigation facilities, and 3) guidelines on disaster-resilient agriculture and agricultural community planning. Thus, through this project, JICA provides support to both short-term and long-term efforts of the Government of Thailand in the agricultural sector.

3. Project Study Areas

The study areas under this Project include the watershed of Chao Phraya River as the main-stream basin, the Yom River basin where severe damage was caused by the 2011 flood, a part of the Nan River basin and Pa Sak River basin and Tha Chin River basin. The flood caused damages in 63 provinces (changwat) out of 77, including northern and northeastern parts of the country. This Project targets the areas in upper stream of Chao Phraya River and the Chao Phraya Delta in central region.

4. The 2011 Flood Disaster

According to a 2012 ADRC study; severe flooding occurred during the 2011 monsoon season in Thailand. Beginning at the end of July triggered by the landfall of Tropical Storm Nock-Ten, flooding soon spread through the provinces of Northern, Northeastern and Central Thailand along the Mekong and Chao Phraya basins. In October, flood waters reached the mouth of the Chao Phraya and inundated parts of the capital city of Bangkok. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths (as of Jan 17, 2012) (with 3 missing) and 13.6 million people in 4 regions affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometers (7,700 sq mi.) of farm land was damaged. The disaster has been described as 'the worst flooding yet in terms of the amount of water and people affected.'

The World Bank has estimated 1,425 billion baht (US$ 45.7 billion) in economic damages and losses due to flooding, as of December 1st, 2011. Most of this was to the manufacturing industry, as seven major industrial estates were inundated by as much as 3 meters (10 feet) during the floods." If the total economic loss caused by the 2011 flood in the agricultural sector is estimated at 72 billion baht, as announced by OAE in November 2011, then it corresponds to 5% of the total national damage. In order to reduce the economic damage from floods, it is essential to protect the highly economic area of industrial estates. While the scale of the total damage incurred by the 2011 flood was exceptionally large, flood-prone areas of the country experience damage from flooding regularly, one or twice every several years. For instance, flood-related damage in 2011 was comparable to that in 2006 and 2010 for many flood-prone areas in this Project's Study Area. Therefore, for people in these areas who live with floods, it is particularly vital for them to have plans for water management, farming and improved livelihoods.

5. Summary of the 2001 Flood Damage in Agricultural Sector

Damages in the agricultural sector by 2011 Flood Disaster are summarized as below:

- Out of a total 77 provinces in Thailand, 65 provinces were damaged by the 2011 flood.
- Nationwide, 1.09 million farmers were affected and 10.6 million rai (1.7 million ha) of farm land was damaged.
- In the crop sub-sector, 17,847 million baht worth of crops were destroyed (10,560 million baht for rice and 7,287 million baht for field crops).
- In the livestock sub-sector, over 29 million animals died, and 14,400 rai (2,300 ha) of pasture grass fields were damaged, affecting 220,000 farmers. Total losses are estimated at 6,483 million baht.
- In the fishery sub-sector, 699 districts suffered damages with 142,842 people affected. As many as 156,764 ponds and 18,912 stews were damaged. The losses are estimated at 4,033 million baht.
- The total economic loss in the agricultural sector is estimated at 72,000 million, which is 5% of the total national damage of 1,425 billion baht.

The Project is composed of three components, namely Component 1: Support for the Reproduction of Pastures, Component 2: Rehabilitation and Reinforcement of Irrigation Facilities, and Component3: Guidelines for Disaster-Resilient Agriculture and Agricultural Community. Each component is described below. The Project commenced in March 2012 and will be terminated in July 2013.

B. COMPONENT 1: SUPPORT FOR THE REPRODUCTION OF PASTURES

1. Distribution of Fertilizers and Seeds/seedlings

In the livestock sub-sector, the target provinces were increased from 26 to 49 as agreed in the kick-off meeting on March 28, 2012. On March 27, 1000 tons of compound fertilizer (15-15-15) and 200 tons of urea (46-0-0) were handed over from JICA to the Thai counterparts at the Animal Nutrition Research and Development Center in Chainat Province, and then were distributed to 29 centers/stations for distribution to 3,826 beneficiary farmers (original plan of DLD HQ). Seeds and seedlings, mainly of Pangola grass and Pakchong-1, were also distributed according to the original plan, 20 ton of seeds and 120 ton of seedlings, through DLD. The distribution of fertilizers and seeds/seedlings was completed in early July 2012.

The monitoring survey of 29 centers/stations and beneficiary livestock farmers was started in late June 2012 to learn how the fertilizers were distributed and how the beneficiaries used them to revive damaged pastures. A total of 515 farmers in 49 provinces were sampled, but data from only 488 were usable for the analysis.

The following summarizes the results of the monitoring survey:

- 1,200 tons of fertilizers were distributed by DLD HQ and local centers/stations in 29 provinces.
- The number of beneficiaries was increased from the original 3,826 to 3,911.
- The beneficiary area was also increased from the original 20,000 rai to 20,696 rai, and works out to one bag (50 kg)/rai of compound fertilizer (15-15-15) and 10 kg/rai of urea.
- Since pastures of centers/station themselves also suffered damage from the 2011 flood, they received fertilizers, equivalent of 30% of the total amount.
- Forage seeds of 25.709 tons comprising six species were distributed, which was an increase from the original 20 tons.
- Seedlings of Pangola grass and Pakchong-1 procured through DLD's seed centers were also distributed. Compared with the original plan of 120 tons, actual distribution was increased to 253.7 tons.
- All 488 beneficiaries surveyed had received fertilizers, and 64% had used the fertilizers to revive pastures as of end July 2012. Pasture grass grew about 20 cm in height in 2 weeks after planting. From this it can be concluded that the high quality fertilizers contributed to the reproduction of pastures.

2. Training of Farmers

To build capacity of livestock farmers on pasture recovery, three-day training workshops were held at eight sites in different regions. Approximately 40 farmers were invited to each event, including those who cultivate forage only for sale as well as those who cultivate for feeding. The training modules included pasture establishment and its management, feeding, forage selection, hay and silage making, animal health and management, pasture harvesting methods, irrigation, and livestock selection. Practical sessions for silage making and pasture establishment were also conducted. One DLD official

who participated in FAO's training on DRMS (Disaster Risk Management System) held in March 2012 lectured about disaster management.

Information collected from workshop participants in each site is summarized as shown below:

- Out of all participants, 91.4% were planting pasture,
- 60.8% were raising beef cattle, 15.5% were raising milk cows,
- On average, 61.5% of the participants' pasture lands were damaged,
- The maximum flooding period was 120 days and the maximum water depth was 4.0m, and
- 52% of the participants cultivate Pangola grass.

During the training sessions, group discussions were conducted to understand problems related to pasture management and animal raising during the 2011 flood. Participants also discussed countermeasures against flood based on their lessons learned from the previous year. The major problem on animal raising was the lack of feed, and the countermeasure for it was to keep feed, such as hay and silage, in storage. Another problem was that they did not have shelter for livestock on ground higher than flood water levels. The countermeasure for this was to look for higher ground. The major problem for pastures was that pasture areas were seriously damaged. The countermeasures were to stock forage seeds and fertilizers, and to have available pumps to drain water from flooded pasture land. Farmers can also use forage varieties with a higher plant height than the flood level.

3. Activities of the Component 1

The output of the Component-1 is that recovery of productivity of damaged pasture lands is promoted. In order to attain the output, the following activities are conducted.

- Monitoring on the distribution and use of seeds/seedlings and fertilizers,
- Capacity building on pasture reproduction, and others concerned, and
- Policy recommendation for recovery from disaster.

4. Recommendable Countermeasures against Flood

(1) Strengthening Forage Production and Storing

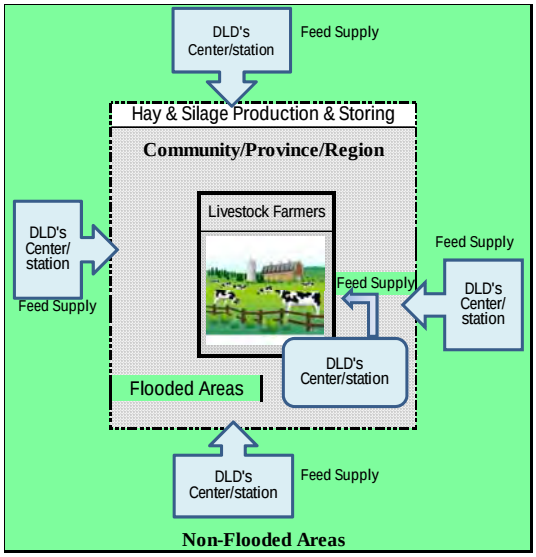
The monitoring survey conducted in this Project found that the most serious issue for the livestock sub-sector during and after the 2011 flood was the shortage in animal feed. This is important because all livestock need to be fed every day to maintain their health, so that they can produce good quality animal products such as meat and milk.

To produce forage for flood disasters, cultivation of Pangola grass and Pakchong-1 (Giant Napier grass), with high nutritious value, should be promoted to increase livestock productivity and feed storage. DLD recommends Pangola grass for lowland areas and Pakchong-1 for upland areas.

In the 2011 flood disaster, ANRDCs (also called DLD centers) supported livestock farmers by distributing stored hay bales from their storage in 29 provinces in the country. Considering the number of livestock, the magnitude of flooded areas and the duration of the flood, a huge amount of forage needs to be stored not only by ANRDCs but also by communities and individual livestock farmers targeting mainly cattle and goats/sheep. Feed storing at a community level is considered to be

weak because livestock farmers had not experienced serious flooding before 2011.

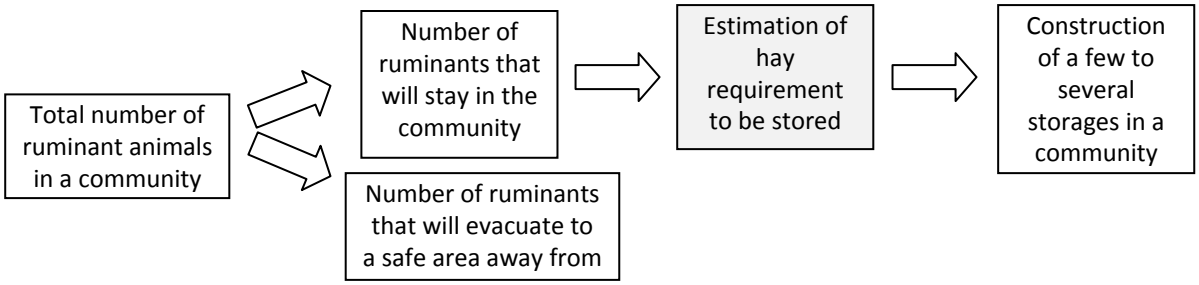
A national perspective is needed to review the feed supply system for emergency situations so that flooded areas are supported by supplies of stored feed from non-flooded areas (see figure to the right).



(2) Identification of Flooding and Non-Flooding Areas based on a Simulation Study

In order to implement a national-level feed supplying system for flood disasters, the first step is to identify areas expected to flood based on a simulation analysis using maps. By doing so, all the 77 provinces (*changwat*), districts (*amphoe*) and sub-districts (*tambon*) of the country can be divided into two categories, flooding area and non-flooding area.

For flooding areas, it will be necessary to identify: 1) the location of livestock farmers by animal type, 2) livestock farmers who will not be affected by flood, and 3) the higher areas in the community not affected by flood.



In order to estimate the feed requirement during floods, it is necessary to estimate the number of livestock, mainly cattle, buffaloes, goats and sheep, to be fed during and after flooding at community level. For estimation of the feed requirement, refer to Technical Paper No.16 “Feed Production and Storage for Livestock.”

(3) Estimation of Hay Storage

The floor area of a storage facility for 100 LU (livestock unit) can be calculated as shown below:

Conditions	Assumption
Body weight of a cattle (1 LU)	500kg
Intake of hay per day	13.5 kg/day/LU
Flood period	60 days (to be varied depending on areas
Number of cattle (LU)	100 LU(100 cattle)
Requirement of hay	81.0 ton
Cubic volume of hay per ton	3.9 m^3/ton
Estimated cubic volume of hay	315.9 m^3
Height of hay bale’s heap	4.0m
Required floor area	79.1 m^2 (8.9x8.9 for example)

Based on the finding of the site survey in flood area, it is advisable to construct not just one but a few to several storage sites scattered around the community in elevated locations. The storage should be located where it will be convenient to transport the stored hay bales when disaster hits the community.

(4) Hay Storage Monitoring by the DLD HQ

DLD HQ is required to monitor the status of feed stored in 29 ANRDCs in the country every month. There are 116 feed storage sites of varying sizes. The total storage capacity is about 100,000 m^3 which is able to cover the consumption of 190,000 cows feed per day. Out of 29 ANRDCs, 28 have 1 to 7 storage facilities of 10 m x 20 m. The Suphanburi ANRDC has 2 storage facilities of 10 m x 28 m each. To cope with future floods, ANRDCs have a very important role to play as seen during the 2011 flood, because they produce and store large quantities of forage (refer to ANRDC's storage facility in Lampang). As well as monitoring hay storage, DLD HQ is also expected to develop a national plan for transporting hay to disaster areas.

The existing storing capacity of hay storages in the 29 ANRDCs in the country is as follows:

Items	Hay Storage		
	10 x 20m size	10 x 28m size	Total
Hay storage (places)*	92	24	116
Estimated capacity of storing (m^3) **	73,600	26,880	100,480

Source: *:DLD HQ

Note:**: calculated by JICA Team assuming at 4.0m for height of hay

(5) Further Capacity Building of Livestock Farmers

Keeping livestock healthy and productive, even during disasters such as floods and droughts, is crucial because livestock farmers rely on these animals for their income. Ideally, everyone in the community should agree to make the necessary preparations to withstand a large flood, even if there are uncertainties about when or whether it will happen. However, not all farmers are aware of the importance of storing feed for animal health, and that it is important to meet nutrient requirement not only in normal times but also during and after floods. The JICA Team trained livestock farmers in eight sites in two model areas. Similar training events covering various matters on livestock management will be necessary throughout the country. This will build the capacity of livestock farmers, especially small-scale farmers with limited capital and knowledge, to improve production and, as a result, gain a more stable livelihood. The DLD HQ has the experience needed for this and should take the initiative for such training.

(6) Agricultural Machinery Requirements at ANRDCs

As mentioned above the role of ANRDCs in a time of disaster is very important to support affected livestock farmers who are short of animal feed. However, according to the DLD HQ, machinery for forage production and hay making in the 29 ANRDCs has deteriorated and need to be replaced. It is also necessary to increase the total number of units to increase the capacity for forage production in the country.

C. COMPONENT 2: REHABILITATION AND REINFORCEMENT OF IRRIGATION FACILITIES

1. Background

In the original plan, Component 2 mainly focused on: 1) flood recovery and prevention works implemented by RID, 2) flood recovery of Japan-assisted facilities in past projects, and 3) technical advice and assistance on rehabilitation and improvement works for irrigation facilities through the implementation of the pilot project. However, as the implementation of pilot project was canceled after selection, the third task was not fully attained.

RID is the main agency involved in planning, design, construction, operation and maintenance of water resources management projects in Thailand. The total irrigated area in 2010 was 29.3 million rai (4.7 million ha) of which 24.2 million rai (3.9 million ha) consisted of 86 large-scale and 731 medium-scale irrigation systems under the operation and maintenance of RID.

2. Flood Damage, Recovery and Prevention Works on Irrigation and Drainage Facilities operated by RID

2.1 Flood Damage to Irrigation and Drainage Facilities

The 2011 flood damage was very severe for irrigation and drainage facilities related to social, commercial and industrial infrastructure in rural and urban areas. Major facilities damaged were: river and canal banks and slopes that eroded and collapsed due to overtopping of flood water; village roads and bridges that collapsed or were washed away due to erosion; canals, reservoirs and ponds heavily silted by flood water; and drainage regulating gates at rivers and canals damaged and collapsed due to water pressure and overtopping. To repair these types of damage, an emergency recovery budget was used, instead of the regular annual budget.

There was also extensive flood damage on irrigation and drainage facilities related to agricultural production such as canal embankments, distribution structures and regulating gates in main and lateral canals, road crossing culverts and siphons, canal bridges, tail end outlets and on-farm facilities. For repair and rehabilitation of these structures, RID O&M Projects and Regional Irrigation Offices have carried out investigations, planning and design. These projects will be implemented as routine O&M activities within RID's O&M budget under the 6-year Medium-Term Expenditure Framework (MTEF).

2.2 Emergency Flood Recovery and Prevention Works on Irrigation and Drainage Facilities

As described above, flood damage was severe to facilities that have social, commercial and industrial functions. Therefore, recovery efforts also focus on these functions, and not necessarily on agricultural needs such as recovery of crop production.

Regarding the number of projects by type, the most common are repair, reconstruction or heightening of river banks and canal dikes, which make up 47% of the 1,283 projects in the study area, followed by repair of drainage regulators (25%), repair or reconstruction of roads and bridges (11%), dredging of rivers and canals (7%) and distribution of pumps and generators (5%). From this, it can be seen that social-related projects account for 95% of the total projects.

Current projects being implemented by RID for flood recovery and prevention are categorized into seven groups below depending on planning initiatives and budget approval processes. The total number of projects approved was 2,236, for a total of about 12 billion baht nationwide as of August 2012. The project team conducted field observations and reviewed the construction work and drawings at the sites. The team noted that implementation was in line with the drawings and was in good progress with the commendable efforts of RID.

1) Batch-1 (555 sites in the country) projects were the first ones approved covering the entire country. About 40% of the projects are located in the middle and lower Chao Phraya River basin. Projects are mostly small repair and rehabilitation works. Work progress was 96.5% as of September 2012.

2) Batch-2 (955 projects in the country) projects are the second ones approved and are located mostly in the middle and lower Chao Phraya River basin where the floods damage was most serious. Projects are mostly small repair and rehabilitation works. Work progress was 97.8% as of September 2012.

3) Batch-3 (481 projects in the country) projects are also mostly small repair and rehabilitation works, and are located in the lower Chao Phraya River basin where flood damage was the worst in the 2011 flood. Work progress was 94.6% as of September 2012.

4) Emergency - SCWRM (129 projects in the country) projects are big rehabilitation works programmed by the Strategic Committee for Water Resources Management (SCWRM). Construction of the concrete wall along the Chinat-Pasak canal is included in this group. These projects are located in the lower Chao Phraya River basin. Work progress was 69.4% as of September 2012.

5) Additional Sites No. 1 (116 projects in the country) projects were programmed late, and were only approved in May 2012, with particular focus on urban areas in the lower Chao Phraya River basin to protect them from flood disasters in 2012. Work progress was 14.9% as of September 2012.

6) Additional Sites No. 2 (11 projects in the country) projects are under approval process. The projects include two dam projects with implementation up to the year 2019 with a relatively large budget.

7) Additional Sites No. 3 (3 projects in the country) projects were proposed in late May 2012 to supplement the Emergency–SCWRM group mentioned above. The project scale is quite small.

2.3 MTEF Plan and Emergency Recovery and Prevention Works

RID formulates the MTEF plan annually as a 6-year expenditure proposal for all existing and new RID projects. The MTEF is divided into four categories. The total number of projects under MTEF 2012 – 2017 for the six RID regions in the middle and lower Chao Phraya River basin in the study area is 3,521. Most of these are in the C-1 (1,180 projects for existing O&M projects) and C-2 (1,400 projects for new irrigation projects) categories, which are allocated 36% each of the budget. In the case of the 2011 flood, however, the special emergency recovery budget, outside MTEF, was appropriated.

3. Review of Flood Damage and Recovery of Projects Assisted by Japan in the Past

A number of aid projects assisted by Japan have been implemented during the past several decades. Among these, projects located in the area affected by the Chao Phraya River flood were selected and

the flood damages were studied to identify suitable rehabilitation pilot projects for this Project.

(1) Chao Phraya Irrigation Project by the Agricultural Land Reform Office (ALRO):
The project is located in Ayutthaya Province. The total project area of 12,620 ha is divided into 10 Farm Blocks. At the completion of the project in 1988 through an OECF loan, the irrigated area had been protected by polder dikes with crest elevation of 3.5 m above msl. In the 2011 flood, water overtopped the polder dikes. As temporary dikes were built in Farm Blocks 1–4, paddy rice was harvested successfully, while in Farm Blocks 5–10, paddy rice was completely destroyed by long-term inundation. However the damage to the irrigation facilities was not serious.

(2) Pasak Irrigation Project (Kaeng Khoi-Ban Mo Pumping Irrigation Project) by RID:
The project is located in Sara Buri Province, between the Pasak River and the Chainat-Pasak Canal. With an OECF loan, the construction work was carried out from 2001 to 2005. The pumping station is on the Pasak River, but since the water level in 2011 did not reach the floor level of the pumping house, there was no damage to the pumping station. As the project area is located in a rather elevated area, no damages were caused to the irrigation and drainage canals either.

(3) Small Scale Irrigation Program (SSIP) and Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP) by RID:
Both the SSIP and the SSIRP were implemented nationwide with an OECF loan. The SSIP was implemented from 1977 to 1985 and the SSIRP from 1998 to 2003. The project team conducted an inventory survey of 106 facilities under the SSIRP in the study area. Most of the facilities had been transferred to TAOs. According to the survey, for 2 out of 4 seriously damaged facilities, repair plans had not been prepared. Seven slightly damaged facilities have been dredged and repaired by the Water Users Groups (WUGs).

(4) Large Swamp Inland Fishery Project (LSIFP) for Bung Boraped Sub-project by DOF:
This LSIFP sub-project, located in Nakhon Sawan Province in central Thailand, is for the Bung Boraped Swamp, the largest swamp in Thailand. The construction work was completed in 1993 with an OECF loan. The major facilities constructed are weirs, gates, dikes, roads, drainage canals and a fishery station. The swamp area was totally inundated for 3 months and a huge amount of sediment, estimated at 4 million m^3, was dredged by DOF together with the military. Offices and hatchery ponds were also inundated and buildings, facilities, laboratory equipment and O&M equipment were seriously damaged. However, the extent of damage to laboratory equipment, aquarium system, etc. has not yet been determined.

(5) Small Swamp Inland Fisheries Project (SSIFP) by DOF:
The SSIFP was implemented nationwide with an OECF loan in 1983. The area affected by the flood of the Chao Phraya River in 2011 is the Lower Northern Region with 91 small swamps. According to the survey conducted by DOF, 7 small swamps were reportedly damaged by flood sediment.

4. The Pilot Project

(1) Objective of the Pilot Project
The aim of the pilot project was to support rehabilitation works implemented by RID for flood

recovery, prevention and improvement of irrigation facilities in the Chao Phraya River basin.

(2) Selection of the Pilot Project

Candidates for the pilot project were categorized into three groups, namely i) flood recovery and prevention projects being implemented by RID, ii) flood recovery and improvement projects requested by RID for JICA support, and iii) projects assisted by Japan in the past. Current conditions, issues and necessity of projects were studied and assessed for the selection. The projects implemented by RID for the emergency recovery and prevention were excluded. Project suitability as pilot implementation was also taken into consideration. As a result, the improvement of the Phlai Chumphon O&M Project in Phitsanulok Province was identified as a potential pilot project.

The Phlai Chumphon irrigation system, built 30 years ago, is located in Phitsanulok Province under RID Regional Office 3 in the middle Chao Phraya River basin with an irrigation service area of 218,000 rai (34,880 ha), one of the largest irrigation systems in the country. The project area is situated in the lowlands between the Nan River and the Yom River where floods occur frequently every year. The Nan River is frequently flooded and causes extensive damage to the urban areas of Phitsanulok. The Yom River also floods between August and October every year into the urban areas of Sukhothai.

Subsequently, additional field work was conducted, and detailed discussions were held with the Phlai Chumphon O&M project office and RID central office taking into consideration the following factors; i) appropriateness to the agriculture sector, ii) applicability to other irrigation systems, iii) viability in terms of the construction period, iv) necessity of JICA support in view of urgency, and v) priority by RID. From this, it was finally agreed that the construction of outlet drainage structures on the main canal of the Phlai Chumphon irrigation system would be the first priority for the pilot project.

(3) Design of the Pilot Project

During floods, the main canal of the Phlai Chumphon irrigation system is often used as a bypass canal of the Nan River to prevent flooding in the city of Phitsanulok. Although this happens only in cases of emergency, flood water diverted into the main canal is discharged to the project area through lateral canals resulting in serious inundation and damage in lower areas along the Yom River. The purpose of outlet drainage structures is to allow the main canal to be used safely as a floodway or bypass canal when the Nan River is severely flooded. Diverted flood water is conveyed downstream by the main canal then discharged back into the Nan River at a point downstream of the Phitsanulok urban area.

The design for this project, “the construction of outlet drainage structures on the main canal”, was made by RID, and under the JICA project, one outlet drainage structure was reviewed and confirmed. Main points reviewed were; i) hydraulic design, related to design discharge, and existing and design flow capacity, ii) structural design, related to structural calculation and a comparative study for transitions, gate operation deck, box culvert, etc, iii) foundation treatment, and iv) temporary closure facility. The RID design was found to be in line with RID’s design standards. Moreover, construction, work quantity and construction costs were also reviewed and an implementation plan was prepared.

5. Conclusions and Recommendations

(1) Conclusions

1) Flood Recovery and Prevention Projects by RID

The total number of projects being implemented by RID nationwide for flood emergency recovery and prevention are 2,236. They are funded by a special emergency budget, in addition to RID's regular annual budget. These projects focus on the social, commercial and industrial functions of irrigation and drainage facilities in rural and urban areas. The 1,283 projects in the study area under the special emergency budget can be categorized into; 1) repair, reconstruction or heightening of river and canal dikes (47%), 2) repair of drainage regulators (25%), 3) repair or reconstruction of roads and bridges (11%), 4) dredging of rivers and canals (7%) and 5) distribution of pumps and generators (5%).

On the other hand, flood recovery of irrigation facilities related to agricultural production are part of the regular O&M works by O&M Project Offices (86 offices nationwide and 49 offices in the study area for large-scale irrigation systems) and RID Regional Irrigation Offices (731 systems nationwide and 151 systems in the study area for medium-scale irrigation). They are formulated as part of the 6-year MTEF plan (2012-2017) in which 1,180 O&M projects are listed in the study area.

The type of engineering involved in the emergency recovery projects are earth work, concrete work, stone work, pile driving, slope protection, cofferdam work, dredging, pump and generator supply, etc. For the design of those works, RID can generally handle the work required, such as damage investigation, topographic and geological survey, detailed design, and construction supervision. As for routine O&M work of existing facilities, there will not be any technical engineering difficulties for RID since it has extensive experience in this area of work.

2) Past Japan-Assisted Projects

Projects in the study area supported by Japan in the past are the Chao Phraya Irrigation Project, the Pasak Irrigation Project, the Small Scale Irrigation Project (SSIP), the Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP), the Large Swamp Inland Fishery Project (LSIFP), and the Small Swamp Inland Fisheries Project (SSIFP). Most of the recovery works on those projects are already underway through efforts of the respective agencies.

3) Cancellation of Pilot Project Implementation:

The Pilot Project for the support of flood recovery and prevention was identified as a result of field surveys and discussions with RID. The plan was to construct outlet drainage structures (flood waterways) at Phlai Chumphon O&M Project in Phitsanulok Province. However, JICA decided to cancel the Pilot Project, out of concern for potential duplication or other unintended consequences related to the international bidding for the infrastructure for water resources management and flood prevention initiated by the Thai government. Nevertheless, the project team reviewed the detailed designs for these structures that had been prepared by RID and concluded that the designs for the proposed facilities are technically appropriate.

(2) Recommendations

1) Flood countermeasure by use of irrigation canals as flood waterway

It is recommended that the use of irrigation canals as floodways be promoted. This can help prevent flood disasters in many places including residential and living areas, commercial and industrial areas, areas with public facilities, historical ruins, rural villages and farmland in local cities and towns situated along flood-prone rivers in Chao Phraya River basin. In other words, irrigation facilities of both existing and new systems can be utilized not only for agricultural production but also as components of flood disaster prevention systems. To construct such systems, factors such as cost effectiveness, hydraulic design during flood water discharge, floodway structural design and foundation treatment, should be taken into consideration, in addition to the usual requirements in planning and design of irrigation facilities.

2) Flood countermeasure by promotion of inundation prevention system

It is recommended that inundation prevention systems be widely promoted wherever applicable to reduce crop damage, mainly of paddy, due to long periods of inundation in irrigated farmlands in the Chao Phraya River basin. For this, particular considerations, such as inundation analysis at flood, drainage plan, evaluation of project viability and drainage method selection, shall be taken into account in planning and design.

D. COMPONENT 3: GUIDELINES FOR DISASTER-RESILIENT AGRICULTURE AND AGRICULTURAL COMMUNITY

1. Overview of Component 3

1.1 Component 3 Outputs

The output of Component 3 is guidelines on disaster-resilient agriculture and agricultural community planning.. These guidelines were designed for use in the entire Chao Phraya River basin so that rural agricultural communities in these areas will be ready and capable to cope with any future large floods.

1.2 Selection of Model Areas of Component 3

Model Tambon areas were selected from four provinces, Phitsanulok, Chainat, Pra Nakhon Si Ayutthaya (hereinafter Ayutthaya), and Pathum Thani to represent areas in the Upper Chao Phraya River Basin, the upper Chao Phraya Delta, the middle Delta, and the lower Delta, respectively.

Eight model areas were selected in each province based on the following criteria: 1) a variety of farming systems is represented, 2) the community is closely knit, is cooperative towards government agencies, and is recommended by provincial government offices, 3) the area suffered flood damage in 2011, and 4) may be affected by the government flood mitigation plans such as for water retention, including monkey cheek reservoirs, or floodways. As for the orchid cultivation sub-sector, Nakhon Pathom was selected as the model area.

1.3 Preparation Process for the Guidelines and Pilot Activities/Projects

In preparing the Guidelines, a participatory planning process was used in which communities were the main actors. A “learning process approach” was taken to formulate the Guidelines based on lessons learned from pilot projects and activities by provincial task force members and villagers. Among the activities implemented in 21 programs covering 5 sectors, detailed information about model projects, the pilot initiatives with successful results and considered useful to disseminate, are provided in the Guidelines, as well as information and communication materials such as leaflets, booklets and DVDs in the Thai language.

1.4 Stakeholders in Component 3

For Component 3, the main counterpart agency is the Office of Agricultural Economics (OAE), and nine Departments and Offices under MOAC were involved in the Project at central level as members of the Joint Coordinating Committee. At provincial level, a Provincial Task Force chaired by the Provincial Governor was organized in each model area province. The provincial offices of Department of Disaster Prevention and Mitigation (DDPM) and Community Development Department (CDD) under the Ministry of Interior were assigned as members in addition to those under MOAC. At field activity level, the JICA project team worked with seven faculties of five universities and one institute. An NGO was also hired by the Project team to monitor the pilot project field activities.

2. The General Guideline

2.1 Objective: Why is a Flood Disaster-Resilient Plan Necessary?

In most rural areas within the Greater Chao Phraya basin, people have learned to live with regular flooding, particularly in areas where floods are frequent. On the other hand, many areas suffered huge economic losses in recent years. These were areas which had not experienced severe flooding after irrigation and drainage facilities were constructed. The increase in the scale of damages and losses can also be attributed to recent changes in lifestyle. After the experience of the 2011 flood which brought about enormous damages and economic losses to the country, the Government of Thailand has conceived an ambitious Master Plan on water resource management and is planning to implement a large-scale flood countermeasure project. When these countermeasures are implemented, urban areas are expected to be protected from flood waters. However, the countermeasures do not provide any guarantees for the rural agricultural areas to be protected from flooding problems. Instead, there are plans to retain flood water in rural areas to protect urban areas and to release it after floods recede.

Under these circumstances, people in rural areas need to make all possible efforts to prepare for possible floods and to make their communities sufficiently resilient. To this end it is necessary to minimize the damage to agriculture and empower the rural communities to recover from disasters. This can be done by adapting their farming practices with support systems aimed at introducing new technologies and extension services. It is for this purpose that these “Guidelines for Disaster-Resilient Agriculture and Agricultural Community” were prepared.

2.2 Target Users of the Guidelines

These Guidelines are expected to be used primarily by concerned national government agencies, provincial level administrative authorities, as well as the Tambon level local governments in order to formulate the Tambon Plans for Disaster-Resilient Agriculture and Agricultural Community.

2.3 Basic Concepts of the Guidelines

(1) Resiliency: What makes agriculture and agricultural community resilient?

“Resilience,” a term commonly used in the field of disaster prevention and mitigation in recent years, means the ability to recover, or bounce back quickly, and implies the ability to adapt to maintain a minimum level of functionality for living in situations where the disaster cannot be avoided.. In formulating the National Economic and Social Development Plan (NESDP) of Thailand, this concept of “resilience” is captured in the term “self-immune system,” and is one of three main pillars of the “sufficiency economy” philosophy initiated by His Majesty, the present King of Thailand.

By building disaster-resilient agriculture and agricultural communities, it is possible to minimize the flood impact and strengthen the community’s ability to cope with the disaster by enabling them to maintain their livelihoods and to manage flood-related risks.

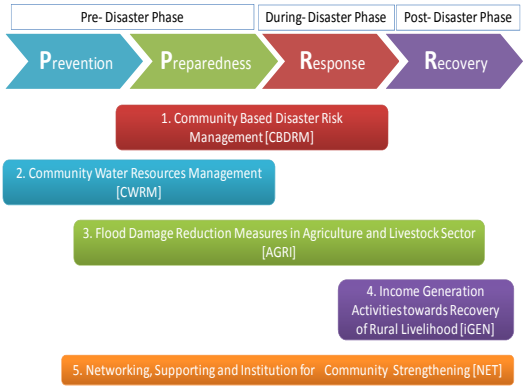
When people prepare for possible future disasters using plans they made by themselves based on their own previous experience, the community’s ability to adapt will be strengthened. Furthermore, it is important to learn from local wisdom and lessons learned regarding actions taken to solve problems in the past. An effective way for people to learn is to hear from other people with similar experience and

perspectives, and find out how they solved problems.

(2) Preparation of Activities by Stage of Disaster Cycle

In the Guidelines, the model activities/projects are presented separately for each issue, and are linked to each of the 2P2R stages as follows.

- Pre-disaster phase: "Prevention" and "Preparedness" to minimize damage and loss
- During disaster phase: "Response" to flood disaster and maintaining livelihoods during the flooding period, which may last for a long time
- Post disaster phase: "Recovery" from the disaster and return to normal conditions



(3) Selection of Co-Benefit Activities as Model Activities/Projects

It is difficult for people to change their activities and life style to cope with a large-scale flood disaster which might occur once in 100 years. And it is doubtful that the planning for such eventualities may be useful in reality. As such, the model activities and projects should be useful not only in the case of a large disaster, but also when there are no disasters or when there is regular flooding. In other words, the "co-benefit" concept was applied as a criterion when selecting activities/project components to include in these Guidelines.

(4) Development of Tambon Disaster Resilient Plan and Support from Provincial Administration

In rural areas, community means village or society, often built around the school as the core institution, and woven together by human networks of relatives, friends, and various groups sharing common values, such as religion and other customs. In the field of community disaster management, the first priority is to strengthen the self-help capacity of individuals and households, as well as that of the larger community. On top of this, support will be provided by local administrative authorities. The Tambon Administration Organization is the key local agency and is expected to play an important role as the interface between the people and the higher administrative authorities, such as provincial and national government offices.

2.4 Participatory Planning Process

To improve community resilience through self-help and mutual support, it is necessary to formulate plans with people's participation, not by giving a ready-made, top-down plan. As there are standardized procedures and tools for participatory planning processes, the following is a brief description.

1) Assessment of flood damages and PRA
2) SWOT analysis and plan formulation (Strategic planning method)
3) Action plans, budget and support from agencies concerned

It is highly recommended that study tours and training programs to learn from good lessons, as well as model activities and projects described in the Guidelines, are included in the Tambon plans.

3. Thematic Guidelines

3.1 Community Based Flood Disaster Risk Management Plan

(1) Community Characteristics, Flood Disaster Risks and Countermeasures

The most common disaster affecting Thailand is flooding. Floods affect Thai communities annually mainly in the rainy season between June and September. The Chao Phraya River is prone to swelling and overflowing during the rainy season, bringing along with it great destruction as experienced in 2011. Floods in Thailand are, in principle, seasonal. Therefore, people can prepare for possible floods before the flood season, and thus mitigate the impact on their lives and livelihoods. At the same time, inundation periods have tended to become prolonged in recent years. Communities can broadly be classified as in Table 4.3.4 below, which summarizes the issues related to community disaster risk management by community characteristics.

Characteristics of the community		General situation	Issues for community disaster risk management
Food risk	High (flood-prone area)	● People are familiar with living with water ● People's awareness on flood disaster risk management is high	● Planning/implementation of community flood disaster risk management, including water measurement, early warning, and evacuation ● Development and utilization of a flood hazard map ● Utilization of local knowledge and experience ● Coordination with external organizations for possible support and cooperation
	Low (non-flood-prone area)	• People are not familiar with floods • People's awareness on flood disaster risk management is low	• Planning/implementation of overall community disaster risk management, including floods • Awareness raising activities on disaster management, including floods, such as disaster education in schools
Type of flood risk	Flash Flood	● Caused by heavy rain mainly in sloping highlands ● Rapid flow of water to the lowlands	● Establishment of early warning and evacuation systems based on rainfall and weather forecasts ● Planning/implementation of community flood disaster risk management, focusing on the characteristics of flash floods
	Inundation	• Gradual overflow of water • Predicable to some extent	• Establishment of information/data collection/analysis on water level and warning system • Planning/implementation of community flood disaster risk management, including supply and assistance during inundation
Type of community	Rural	• People have relatively common interests and value • Collective activities are relatively easy to organize	• Planning/implementation of overall community disaster risk management • Utilization of community groups and networks
	Urban/ Sub-urban	• Interests of the people are different • Difficulty to organize collective activities due to inbound and outbound migrant residents	• Planning/implementation of overall community disaster risk management with stronger initiative of TAO and other authorities • Coordination with business entities in and around the community for possible support and cooperation

(2) Participatory Planning for Community Flood Disaster Risk Management

Participatory planning and implementation for flood disaster risk management is considered as an effective tool to prevent and mitigate disaster impacts, particularly for communities in flood-prone areas. Steps to develop a community flood disaster risk management plan and important

countermeasures are shown as below.

STEP 1) Collection and Analysis of Community Information
STEP 2) Risk Analysis and Development of a Community Flood Hazard and Evacuation Map
STEP 3) Establishment of a Flood Disaster Risk Management Committee and Working Groups
STEP 4) Development of a Flood Disaster Risk Management Plan

Based on past experience and characteristics of the community, necessary tasks and actions are identified to prevent and mitigate flood disaster impacts on the community for the each stage of 1) preparation, 2) pre-inundation, 3) during inundation, and 4) post-inundation phases. Establishment of effective warning systems, evacuation to safe places, supply and support during inundation are key components of flood disaster risk management.

(3) Collection of Water-Related Information and Establishment of Warning Systems

It is important to collect and analyze water-related information in a timely manner to assess flood disaster risks, particularly in flood–prone communities. Water information can be collected from the RID offices, neighboring communities, and by taking water level measurements in the community. Therefore, networking and communication with concerned external organizations, as well as establishment of water level monitoring and recording systems in the community are important tasks. In addition to the collection and analysis of the information, it is necessary to establish effective communication systems to deliver clear and prompt warnings.

(4) Flood Hazard and Evacuation Map and Evacuation Drill

Evacuation to safe places is crucial for people to protect themselves when faced with disasters. Evacuation should be done appropriately, swiftly, and in an orderly manner. Therefore, it is necessary for the community to identify possible evacuation centers and evacuation routes in advance not only for people but also for livestock and other assets, such as vehicles and machinery. Evacuation maps should be displayed in public places and be distributed to all households along with notices about preparation needed for an evacuation. Maintaining security at evacuation sites is also an important issue to be considered as a part of disaster management planning. Conducting disaster evacuation drills will; 1) raise people's awareness on disaster risk management, 2) strengthen networks among concerned organizations in the community, such as schools and health centers, and 3) provide an opportunity for the management committee and working groups to practice their duties.

(5) Provision of Supplies and Services

Provision of necessary materials and services for evacuees and people left in their houses should be considered both in terms of emergency support as well as relatively long-term support. Securing drinking water supply is one of the most urgent and important tasks for the management committee. Because the supply channels of drinking water may be disrupted during the disaster, it is good for the community to have its own sources of drinking water located in the community or in nearby areas. In order to provide safe drinking water during floods, a reliable water supply system is needed. A drinking water vending system, which can provide emergency stocks of drinking water and secure operation and maintenance costs, is recommended as a countermeasure against floods.

(6) Transferring Lessons to the Next Generation

While the memory of the devastating flood in 2011 is still fresh in people's minds, the experience and lessons of the disaster should be transferred to the younger generation. **Activities** such as disaster education can be implemented in collaboration with schools and community people, including parents of students. Schools in the community can function as disaster learning centers for the next generation.

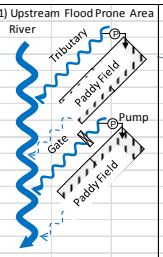
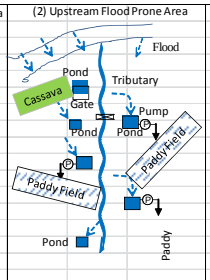
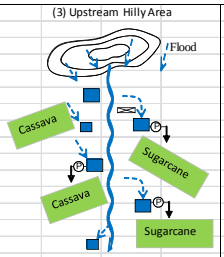
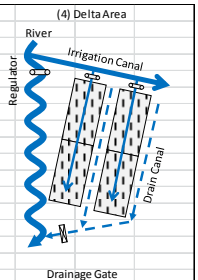
3.2 Community Water Resources Development and Management

(1) Importance of community level water resources development and management for floods and droughts

When a flood or a drought occurs, it is very difficult for community people to solve these problems. One possible ways to mitigate these frequently occurring disasters is to expand monkey cheek areas. Monkey cheeks can store flood water in the rainy season so that the water can be used for various purposes in the dry season, such as for irrigation or drinking water. Not only natural bodies of water, such as swamps and rivers but also existing canals, ponds and irrigation facilities can be expanded and rehabilitated as monkey cheeks. There are more than 520 Tambons in the upstream Study Area. If each Tambon stores 2 MCM of flood water, about 1,000 MCM of water could be stored, the equivalent of a large-scale dam. Similar to large dams, monkey cheeks can protect downstream areas from flood damage in the rainy season and store water for irrigation in the dry season.

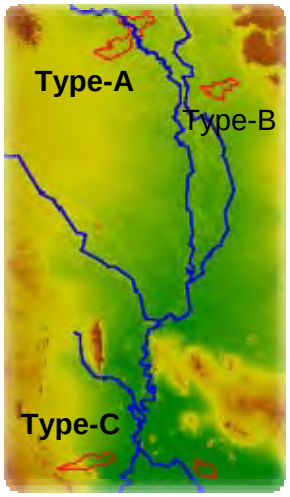
(2) Comparison between large-scale irrigation areas and small-scale irrigation or rain-fed agricultural areas

When comparing areas with large-scale irrigation schemes and areas with small-scale irrigation schemes and rain-fed agriculture, it is possible to see that impact of the flood depends on geographical features of the areas, as well as on the development levels of irrigation and drainage facilities. As noted above, areas with small-scale irrigation schemes and rain-fed agriculture are predominantly in the upper Chao Phraya River Basin. The causes of the flood in these areas are overflow of banks in the major rivers and surface runoff from mountainous or hilly areas. Flood damage during the rainy season and water shortage during the dry season are the main issues in these areas. On the other hand, floods in the downstream delta areas are caused by overflow of banks in the major rivers. However, since drainage canals and gates are well developed, flooding can be controlled by using these drainage facilities.

	(1) Upstream Flood Prone Area	(2) Upstream Flood Prone Area	(3) Upstream Hilly Area	(4) Delta Area
Basic Concept				
RID project type	Small Scale (SSIP,SSIFP)		Small Scale (SSIP,SSIFP)	Large Scale
Cause of Flood	Main River	Rainfall from /hilly area	Rainfall from mountainous area & Flash Flood	Main River
Issues	Flood & Drought		Flash Flood & Drought	Flood
Irrigation & drainage network	-			✓
Intake facilities	Small scale Mobile pump, Weir, Gate			Regulator, permanent pump station
Irrigation & Drainage canal	-			✓
Drainage gate	-			✓
Development Type	Type A	Type B	Type C	✓
	Structural Measures			Non Structural Measures

(3) Community Monkey Cheek Development

Based on the characteristics of the topography, flow channel of tributaries, flood outbreak situation and existing irrigation and drainage development levels in the Study Area, community monkey cheek development is classified into three types.



[Type-A] Community Monkey Cheek Development in lowland areas affected by flooding caused by overflow of major rivers

[Type-B] Community Monkey Cheek Development in lowland areas affected by flooding caused by runoff from hilly areas

[Type-C] Community Monkey Cheek Development in lowland and hilly rain-fed agricultural areas affected by flooding from mountainous areas

Work components are the same for Types A, B, and C and consists of heightening of the dike crest, expansion of the canal section by dredging, dredging of existing ponds, and rehabilitation and construction of regulators and weirs. With these improvements, it will be possible to store flood water in the canal and to reduce flood damage along the canal, as well as to store water for irrigation in the dry season. This micro watershed water resources development and management plan is a very important concept and useful for those Tambons in the upper Chao Phraya River basin as a model of monkey cheek development not only to reduce the flood and drought damage in their own area but also to reduce the flood damage to the downstream areas. The concept is to reduce damaged caused in the micro watershed by flood and drought occurring once or twice every several years by developing and managing water resources properly through Inter-Tambon collaboration. The rehabilitation of deteriorated small water resources to increase their storage capacity is the output of this project.

(4) Participatory Flood Management in Large-Scale Irrigation Areas

RID manages the irrigation and drainage facilities in large-scale irrigation project areas, but water management data distributed by RID often do not reach Tambons and farmers. In 2011, it was reported that flood information was not adequately transmitted to farmers, and as a result, the rice suffered damage before it could be harvested.

RID has classified the three zones of water volume discharge as a flood monitoring and warning system, with water level zones in three colors: green, yellow and red. By monitoring the levels, warnings can be issued when the yellow zone is reach, allowing for timely storage of drinking water and food, and for preparation of evacuation sites and measures, such as boat, well in advance of the arrival of a big flood. Warming systems for big floods in other large-scale irrigation areas should be formulated in accordance with RID's flood water discharge monitoring system.

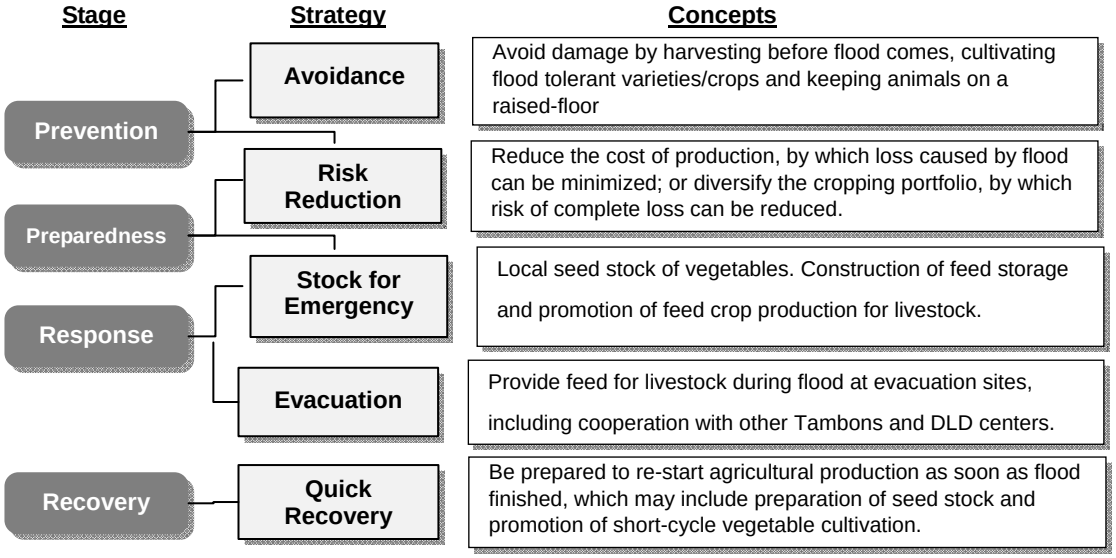
A community level flood water management website is proposed for the Tambon office. This website allows for comparison and analysis of the staff gauge water level data installed in the community and RID's water level data. Being a simple web-based system, the local community, the general public and government agencies can all access the data in real time. The website can also include

information related to community water management and warnings for floods and droughts.

3.3 Flood Countermeasures in the Agriculture and Livestock Sector

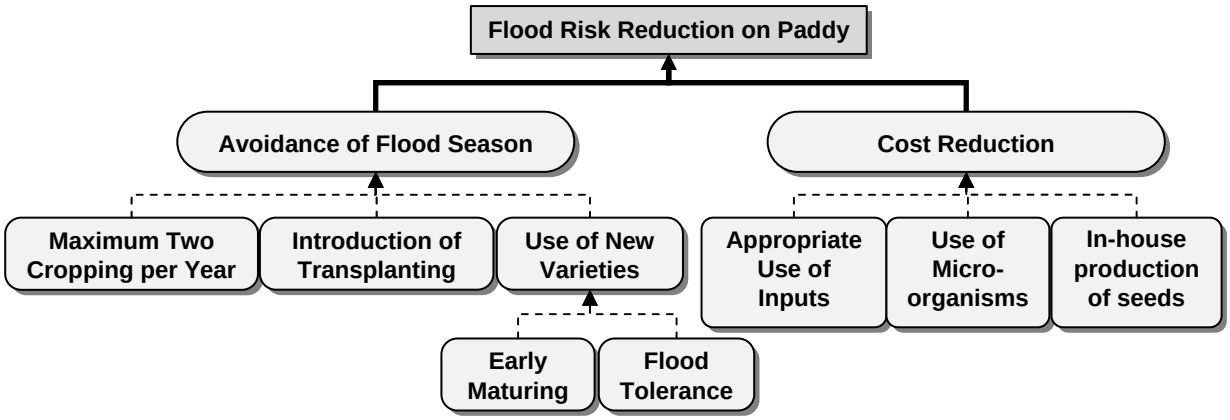
(1) Types of Countermeasures in the Agriculture and Livestock Sector

Proposed countermeasures in agriculture and livestock sector are categorized in four major stages of prevention, preparedness, response and recovery (2P2R). As a preventive measure, there are two major strategies, "avoidance," and "risk reduction." As strategies for response, "evacuation" is proposed. Then, after communities experience flood damage in the agriculture and livestock sector, "quick recovery" is the main strategy for recovery.



(2) Paddy

Paddy makes up approximately 70 % of the total agricultural land in the lower Chao Phraya River basin. Furthermore, paddy was estimated to account for approximately 60% of the total damage caused by the 2011 flood. Thus, strategic planning of paddy cultivation is a central issue in the agriculture sector. There are two major ways to reduce the risk of flood regarding paddy cultivation: avoiding the flooding season and reducing cost. For the avoidance strategy, three specific approaches are proposed: 1) limit the number of crops to two per year, 2) introduce transplanting and 3) use early maturing varieties of rice. For cost reduction, on the other hand, 1) appropriate use of chemical inputs, 2) the use of microorganisms, such as "*por dor*," and/or 3) use of home-grown rice seeds are recommended.



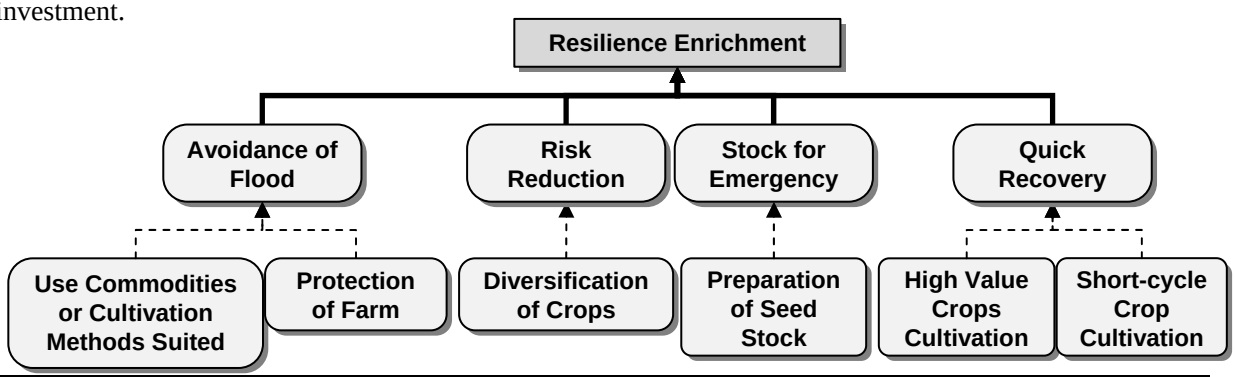
First of all, although its impact is limited (10 to 15 days), transplanting is an effective flood countermeasure as it shortens the cultivation period in the main field. Moreover, weed management in the early stages of cultivation is easier when transplanting. In principle, machine transplantation is the preferred approach because it can manage a bigger area of paddy and requires less labor. However, there are some areas where transplanting machines cannot be used because of soft foundations or inappropriate land preparation. Thus, in the short term, or as a transition phase, parachuting would the first priority because it is less costly to implement.

On the other hand, it was found that service providers for machine transplantation and parachuting are still limited. Thus, the development of service providers in this field should also be a priority. One of the recommendations for the government sector is to support this process, especially for training in parachuting.

(3) Vegetables

As a means of coping with flood situations, vegetable cultivation can be a useful tool for individual farmers. There are four major strategies to strengthen resilience of agricultural communities: avoidance of flood, risk reduction, stock for emergency and quick recovery.

Avoidance of flood may include the use of commodities or cultivation methods suited to flooded environments. It also includes protection of farm plots by constructing dikes around the plots, particularly for high-value crops like fruits. On the other hand, for the risk reduction strategy, diversification of crops is recommended. Vegetable cultivation can provide farmers with more alternatives, making them more resilient to flood disaster. Moreover, preparation of seed stocks for emergency use is recommended. If farmer households can produce their own seeds, restarting vegetable cultivation will be easier. Lastly, quick recovery is possible with vegetable production since short-cycle crops require lower initial investment.



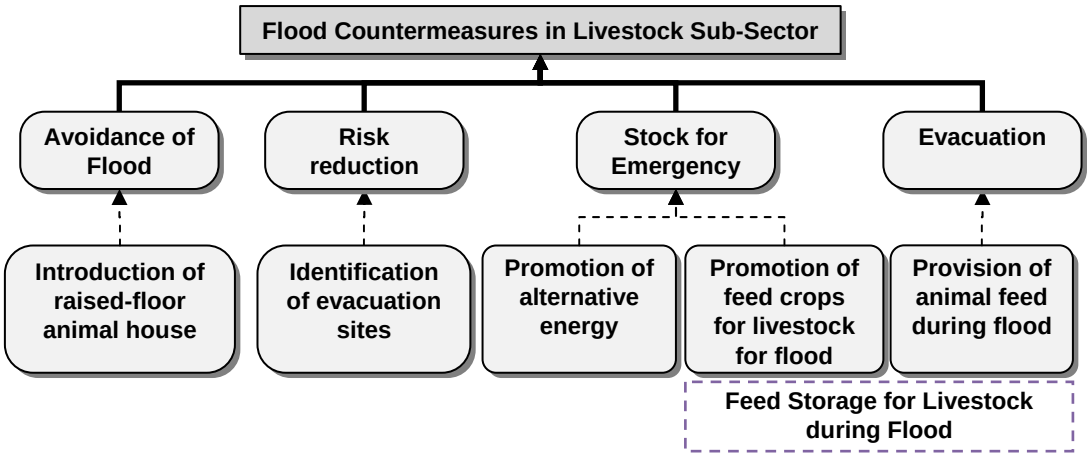
Although income from a small plot is quite limited, with vegetable cultivation farmers can earn cash in about three to four weeks. This kind of small but quick cash income can help farmers in the recovery process since the cash can be used for agricultural inputs, foods or house repairs.

Thus, the cultivation of safe vegetables using less chemical inputs and thereby reducing the production cost, can be a good means to a smooth recovery. In addition, if farmers already have access to an established market, this will help speed up the recovery process. Green markets are markets where farmers sell good-quality vegetables, produced with less chemical inputs, directly to consumers. These markets make vegetable production activities more sustainable and easier to restart after floods. Therefore, establishing green markets is recommended as a model activty to promote.

(4) Flood Countermeasures in the Livestock Sub-Sector

The most serious issue in the livestock sub-sector during and after the 2011 flood was the shortage of animal feed. Therefore, the preparation of feed crop is proposed as a major countermeasure for the livestock sub-sector. As shown in the figure below, this consists of two programs; the preparation of stock for emergency before the flood, and the provision of animal feed under the evacuation strategy. Identification of evacuation sites is a program under the risk reduction strategy aimed at ensuring the safety of animals during floods. The identified evacuation sites will be included in maps indicating flood hazards and evacuation routes, which are prepared as part of the community-based flood disaster risk reduction plan. In Thailand, goats are mostly raised by Muslim communities, and for these communities, the raised-floor animal house program is proposed as an avoidance strategy.

A national perspective is needed to review the feed supply system for emergency situations. Considering the number of livestock, size of flooded areas and the duration of the flood, feed stocks from the Animal Nutrition Research and Development Center (ANRDC) will not be adequate, communities and individual livestock farmers will also need to store feed. In the past, feed stock was not usually prepared at community level because livestock farmers had not experienced serious flooding before 2011. Therefore, it is proposed to strengthen feed production and storing at the DLD centers and at the community level for the reduction of future flood risks.



Feed storage at community level contributes to strengthening feed supply in a time of disaster, keeping ruminant animals healthy and productive, which in turn ensures a stable income for livestock

farmers. When there are floods, communities in non-flooded areas can support livestock farmers in flooded areas by supplying hay and silage from their storage. The recommendation is to identify a few to several storage sites at elevated locations in the community, taking into consideration the locations of farmers raising ruminant animals, and the locations of pastures and how hay and silage bales will be transported during the flood.

3.4 Income Generation Activities Towards Recovery of Rural Livelihoods

(1) Resiliency based on diversity in rural livelihoods and vulnerability to floods in intensification agriculture

In rural areas, people are engaged in various livelihood activities utilizing available local resources to make their living. Especially in rain-fed agricultural areas, people dependent on rainfall and other forces of nature, tend to focus on reducing risk, rather than maximizing benefit due to the uncertainties of nature. On the other hand in paddy mono-culture areas with well-developed irrigation facilities, livelihoods of farmers are more vulnerable to flood disasters. Furthermore, diversity is decreasing in peri-urban areas, where non-farm activities are increasingly replacing agriculture as the main source of income.

It is possible to increase income during and after floods by introducing new income generation activities, or by improving on current activities. Such efforts will contribute to the recovery of livelihoods and strengthen the resilience of rural communities, but at the same time will also have the added benefit of diversifying livelihood during normal times.

(2) Sustaining livelihoods during long inundation periods

Fish capturing is the most important income source during a flood. In flood-prone areas, it is said that a flood is not disaster but an opportunity to gain income by catching fish. Although the proportion of people relying on fish for their livelihood may normally be about 10 to 20 percent in a given community, during floods, the majority will gain cash income by catching fish. The fish are sold to middlemen, or at the local markets or are traded within the community. Other traditional adaptations of income generation during floods is simple food processing through sun drying, smoking, grilling and fermentation of fish products, both for household consumption and for sales of surplus.

The three issues below are important to take into account as indicated in the Guidelines;

1) It is necessary to consider the impact of construction of flood prevention structures on fish and fisher folk in flood-prone areas.

2) The production capacity of existing simple processing methods can be enhanced so as to increase sales volume and expand the market to increase benefits to the community, and

3) In the newly assigned water retention areas, which have increased flood risk, it is recommended to introduce fish capturing and processing to compensate for the lost opportunity costs from farming. Marketing and sales of the produce can be supported by the provincial government.

Groups formed for food processing can also have a social function. Especially women and aged people often prefer to gather and work together even during flood periods. Bonds between group

members are important for helping each other during long inundations, for example by asking after each others' health and problems. Specifically in an aging society, it is important to nurture such ties or social capital in the community, which will result in enhanced resilience.

Processing activities based on local resources available during floods are recommended, not only fish processing but also water hyacinth, for example. Approaches to be encouraged for processing activities during long-inundation periods are the use of local resources, simple processing, and processing that can be done at home.

(3) Role of External Support for Livelihood Recovery

After floods, recovery strategies that include income generation activities involving processing are effective in that they will result in a faster recovery of livelihoods compared to a strategy that relies solely on farming which requires a longer period to generate income. However, the following are important points to keep in mind for external agencies supporting the promotion of income generation activities;

1) Considering the current strict policy on food standards, which does not allow the sale of food products outside the community without FDA approval, it is recommended to manage sanitary and hygiene conditions of the processing unit and operators at pre-GMP standard levels in order to obtain FDA certification. In case FDA-certified processing units are damaged by flooding, it is advisable to assess the feasibility of re-certification in terms of the cost required to repair and improve the processing facilities.
2) Marketing is important for selling products outside the community. This is an area where external support is relevant and critical, since villagers lack relevant knowledge and experience. While government agencies organize OTOP events and tourism promotion fairs inviting OTOP and community groups free of charge, the private sector and individuals can provide effective support by internet and word-of-mouth marketing
3) There have been some cases in which different OTOP-related government agencies were not well coordinated in their support to groups. For instance they supported the same group with different approaches, confusing and dividing the group. This kind of external support can undermine the group's initiative and will subsequently have a negative impact on the resilience of a community.
4) The recent trend has been for supporters of OTOP and community products to focus on improved packaging as a marketing strategy, thereby increasing costs. Considering the competitive market, such cost increases would further reduce the profit margin, which is already very small.
5) Government support tends to focus on group activities. However, it is also possible for individual and private entrepreneurs in communities to produce and sell the same product by hiring other group members. If the objective is the recovery of livelihoods, supporting such individual entrepreneurs to enhance production and sales will result in enhancing the livelihoods of a wider group of people, e.g. through employment and purchase of raw materials from community members.

3.5 Networking and institutional support for communities

(1) Institutions and Organizational Arrangements at National Level

Public agencies responsible for flood countermeasures include DDPM under MOI and MOAC at the national level, local governments at provincial level and a variety of departments under the MOAC. The Single Command Authority including the ONWFP under the OPM is assigned for large-scale water related disaster management. This Authority was established in May 2012 to remedy the weaknesses seen during the long-lasting 2011 flood.

(2) Roles of Provincial Line Agencies and Integration

Tambon Disaster Resilient Plans are to be formulated and implemented mainly by Tambons in a participatory manner. In most cases, however, technical and budgetary support by the provincial government is required for each step of the process. The provincial government will direct the high priority Tambons to formulate their plans, but the role of line agencies is critical to the success of this process. One practical approach is to set up a task force, headed by the provincial governor to support this process. The task force will be responsible for prioritizing the Tambons in need of plan formulation, depending on flood risks and for supporting Tambon's actions in an integrated manner.

(3) Organizations at Tambon level

Tambon level organizations include the TAO, representatives from each village community who play major roles in formulating the Tambon's Disaster Resilient Plan, and farmer groups responsible for various activities. The following table shows the actors and supporting organizations for some model projects and activities as examples organizations at Tambon level.

Issues	Model projects/activities	Actors	Supporting Org. at provincial level
Community disaster prevention and management plan	1)Preparation of hazard map 2) Secure safe water 3) Flood disaster management plan	TAO TAO, Water Management Committee TAO, Flood Disaster Management Committee, Local School	DDPM, RID, Private companies DDPM,
Community water resources management	4)Development of monkey-cheek projects 5) Inter-Tambon Micro Watershed Development 6)Participatory flood water management	TAO TAOs TAO, PDA	RID RID, PAO/DOLA RID, Universities
Countermeasures for mitigating/reducing flood damages in agriculture and livestock sectors	7)Transplanting of rice 8)Safe vegetable production + Green market 9)Production and stockpiling feed for livestock	Individual farmers Marketing committee, Vegetable production group Pasture/livestock group/TAO	RRC DOAE, LDD, Health promotion foundation, Universities, DLD
Securing income for restoring livelihood	9)Processing by using local resources	Processing group Rural enterprises, OTOP group	CDD, DOAE, Universities

(4) Inter-Tambon Network and Cooperation with the Provincial Administration Organization

Since the area covered by water resource development as well as flooding is quite extensive, what can be achieved by one Tambon is quite limited, making collaboration among neighboring Tambons necessary. Moreover, in terms of the budget for project development, the available budget of one Tambon is usually too small for any substantial project. Therefore, it is proposed that Tambons work together to formulate projects, which will also enable them to access PAO budgets for this purpose. Another JICA-supported DOLA project called Project on Enhancing the Capacity of Local Public Service Provision through Local Management Cooperation provides good lessons learned on inter-TAO collaboration.

(5) Networking with Universities, Foundations, NGOs and Private Sector

Communities were able to strengthen their external networks through this Project. Through the process of receiving technical and financial support from various external organizations, including government agencies, private sector, foundations, NGOs, universities and other research institutes, partnerships were established. These partnerships may also help the communities to receive urgently needed support in any future floods, thereby strengthening their resilience to disasters.

(6) Towards collaboration among stakeholders to improve resilience in agricultural sector

For recovery of high value horticulture crops, sub-sectors such as orchid and fruit which were completely destroyed by the 2011 flood, the aim of the recovery efforts was not to reconstruct the situation prior to the disaster. This required an innovative solution which was difficult to achieve by a farmer or a farming enterprise alone, but which was possible through collaboration with various stakeholders, including government agencies, universities, and private sector operators. In the pilot project, alternative media development for orchid cultivation and conjunctive use of bio-fertilizer and bio-control were experimented as example. Research and development can be a lengthy process to achieve visible development results, but when successful, the results will contribute to further progress in the relevant sectors and to economic development at the national level.

4. Conclusion and Recommendations

4.1 Conclusion

The large flood in 2011 caused tremendous hardship for many people throughout the country. Based on this experience, people in the project's model areas formulated the Disaster–Resilient Agriculture and Agricultural Community Plan at Tambon level. When implementing pilot activities for flood countermeasures, participants learned important lessons, which were captured in the form of a General Guideline, five Thematic Guidelines and 22 Technical Papers. These Guidelines and Technical Papers have been translated into the Thai language as well. Activities that were found to be effective flood countermeasures during pilot implementation have been written up as Model Programs to be promoted and expanded to other areas. These Guidelines and Model Programs are important and concrete recommendations aimed at enhancing disaster-resilience in agriculture and rural communities.

4.2 Recommendations

(1) General

1) Recommendations to the Government of Thailand

- ✓ The main recommendation is to implement these Guidelines, particularly in areas which will be affected by the Government's countermeasure project for flood mitigation, such as flood water retention areas. Where special budget allocation may be required, it is proposed that priority be given to high risk areas. For extension of the model activities, information and communication materials prepared by the Project, such as leaflets, booklets and DVDs shall be utilized.
- ✓ MOAC is well-positioned not only to implement compensation program for flood damage, but also to inform departments under MOAC about the concept of strengthening resilience of agricultural communities.
- ✓ Since "sufficiency economy" is a key concept in Thailand's National Economic and Social Development Plan, it is also necessary to give more importance to the concept of "resilience in agriculture and agricultural communities", in view of the risk of natural disasters, in addition to increased income and productivity through agricultural development.

2) Recommendations to provincial governments and TAOs

- ✓ It is recommended that "Disaster Resilient Agriculture and Agricultural Community Plans" are formulated for all Tambons with high flood risk, and implemented as soon as possible.
- ✓ Model projects should be reviewed to determine their suitability to the local conditions and possible expansion to other parts of the province.
- ✓ In the plan formulation at Tambon level, some high priority emergency projects and parts of the learning process, such as study tours, should be implemented by TAO's own budget in order to increase ownership of the project by the communities. As for countermeasures which require coordination in wider area than a single Tambon, requests for budget support can be submitted to PAO in collaboration with neighboring Tambons.

3) Recommendations to JICA

- ✓ It is necessary to monitor whether and how these Guidelines are being used.
- ✓ It is also necessary to follow-up on the implementation of the ongoing model projects.

(2) Recommendations by Sector

1) Community Based Disaster Risk Management

- ✓ The methodology for participatory preparation of flood hazard maps is described in the Guidelines. For areas with high flood risk, hazard maps are required, and for this, collaboration with DDPM and RID is necessary. To ensure smooth coordination among these agencies, it is recommended to establish an implementation body at provincial level similar to the Provincial Task Force that includes the provincial DDPM, and is led by the provincial governor.
- ✓ The provision of small-scale water purification systems will enable communities to produce and stock drinking water to be used during floods. It is recommended that TAOs introduce such a system as a flood countermeasure.

2) Community Water Resources Development and Management

- ✓ The installation of water level gauges in Tambons will make it possible for communities to monitor water levels themselves. By comparing the local measurements with water level data from major RID stations using a web-based system, projections of water levels in the Tambon can be made, thus allowing for flood forecasting and early warning. In Tambons located within irrigation areas with high flood risk, it is recommended that this participatory system is introduced.
- ✓ With a monkey cheek system, flood water can be retained during the wet season and used for irrigation during the dry season. If each Tambon in the upstream basin area retained 2 MCM of flood water, a total of as much as 1,000 MCM could be retained, the equivalent of a large dam or reservoir, which would help prevent flooding downstream. Monkey cheek development in small river basins is in line with the government policy to promote development projects by inter-Tambon collaboration, so it is recommended that PAO supports this as the main promoting body.
- ✓ SSIP has been implemented nation-wide since 1977, with the total number of projects reaching more than 6,000 to date. The project consists mainly of construction of small infrastructure facilities such as weirs, regulators, farm ponds and small dams. These project facilities have been transferred to TAOs due to an administrative reform, but no longer function well due to deterioration and insufficient operation and maintenance. MOI is well-positioned to formulate plans to improve these SSIP facilities to function as monkey cheeks, as well as to support the TAOs to rehabilitate and expand the SSIP facilities with cooperation from RID.

3) Flood countermeasures in Agriculture and Livestock Sector

- ✓ In order to promote transplanting as a countermeasure to flood damage, an urgent issue is to increase the number of service providers for the transplanting method of parachuting. Either RRCs stationed in each province or DOAE under MOAC is expected to develop service providers. For this, the government agencies concerned should provide necessary training not only on transplanting techniques but also on other technical issues such as seedling preparation, reduction of seeds input and seed selection methods. The production of safe vegetables is actively promoted under the MOAC policy, but roles and responsibilities of various government agencies are not clearly defined for the important activity of securing reliable markets for sale. To address this issue, the recommendation is for TAOs and farmer producers to establish green markets in cooperation with foundations and universities and also to expand sales to schools and hospitals with support from the provincial government. DOAE and LDD are jointly expected to provide necessary support for farmer producers on production-related matters.
- ✓ In areas with high risk of flood and with many small scale livestock farmers, animal feed should be stocked at both household and community levels as a precaution against future floods. Furthermore, cultivation of fodder crops in these areas should be promoted. It is recommended that DLD fully brief all officers in charge at provincial and district (Amphoe) levels to provide required support for livestock groups working to set up community fodder storage facilities.
- ✓ The activities proposed above are to be promoted not only when there is flooding but also in periods without floods. These recommendations are in line with government policies, and can therefore be supported through the regular government budget in areas with high flood risk. In other words, such activities can be implemented without special budget support for flood

countermeasures. Extension work for farmers is necessary, and these Guidelines can be used to ensure that the measures proposed are effective flood countermeasures.

4) Income generation for recovery of livelihood

- ✓ Fish capture is an important activity in areas often affected by flood, and it is recommended that the Government conducts a survey on fish resources as well as impact on local farmers before implementing any flood countermeasure projects.
- ✓ A new policy has been introduced to apply stricter standards in the food processing industry. It is, however, doubtful that the required investment needed to obtain certification will result in sufficient return for rural enterprises and OTOP groups to make it worthwhile. In addition to setting up standards for safety, government agencies concerned, such as DOAE and CDD, are requested to provide necessary guidelines for quality improvement, as well as training programs about hygiene issues for community members. Further, some financial support is also necessary for certification, although compensation for the processing facilities damaged by the 2011 flood disaster has not been provided. It is necessary for the Thai Government to introduce policies to bridge the gap between the capacity of OTOP groups and rural small enterprises and the stricter quality standards enforced.

5) Networking and institutional support for communities

- ✓ It is recommended that provincial governments support TAOs so that the PAO budget may be available for TAO projects, not only for water resources development but also for flood countermeasures when they are implemented in collaboration with other Tambons.
- ✓ While communities themselves make efforts to enhance their resilience against flood disasters by applying the Guidelines, the government should ensure a system for rapid flood disaster assessment and appropriate valuation for victims in water retention areas designated by the government to save urban areas from flooding.
- ✓ A GIS land parcel database was established to accelerate and ensure compensation payments to farmers as a pilot project. It is recommended that the Office of Agricultural Economics (OAE) continue the work on practical application of the database for flood damage assessment. OAE shall consider to solve some issues as follows;
    - ✧ Remote sensing technologies to analyze satellite images on rice growing stages
    - ✧ Acceleration and standardization of data collection procedure for practical database construction at Tambon level
    - ✧ Outsourcing of work to institutes/ companies in order to expand the system nationwide

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CHAPTER 1. INTRODUCTON

1.1. Background and Project Outputs

(1) Background of the Project

From the end of July 2011 and into 2012, Thailand experienced a massive flood in the Chao Phraya River Basin, with vast areas submerged and significant aftereffects that had not been experienced before in Thailand's modern history. People living and working in this basin suffered from the huge scale of damage caused by this long-term inundation. The areas affected by this flood included Ayutthaya, residential areas of Metropolitan Bangkok and its outskirts, and several industrial estates. Economic losses due to the flood and subsequent loss of work opportunities is estimated to be between 400 and 1,300 billion baht or more than 10% of Thailand's GDP. Damages to agriculture have been reported to be as high as 72 billion baht.

2011.11.02, Source: GISTDA

In response, the Government of Thailand established two committees to deal with long-term measures; the Strategic Committee for Reconstruction and Future Development: (SCRFD) and the Strategic Committee for Water Resources Management: (SCWRM). The former has already approved a plan to invest 2,270 billion baht to construct basic infrastructure during the coming decade. The latter presented a plan to disburse 22.6 billion baht for short-term preventive measures in preparation for the coming rainy season in 2012, and 350 billion baht to take medium ~long term measures including the delineation of flood water retention areas (paddy fields and swamps) and the construction of floodways.

The Government has so far provided only limited measures for the benefit of the agricultural sector, which suffered heavy damages to over 1.44 million hectares of paddy fields,

2011.11.28, Source: GISTDA

36 thousand hectares of aquaculture ponds and a loss of 29.5 million head of livestock. These benefits are in the form of compensation for inundated farmland, free distribution of un-husked paddy, and the provision of animal feed in some affected areas. Thus, farmers who suffered from flood damage continue to face difficulties due to the lack of effective measures to provide compensation for loss of major harvests or lost income opportunities. JICA has so far dispatched experts to advise SCWRM, and in addition, is carrying out another emergency development study, Chao Phraya River Basin Flood Measures Project, as an antecedent survey of this project. Also JICA was already conducting the Integrated Study Project on Hydro-meteorological Prediction and Adaptation to Climate Change in Thailand (IMPAC-T), a science technology cooperation project, before the flood occurred. The IMPAC-T project helped establish substantial linkages, including information sharing, among key organizations involved in flood management. This current project sought close collaboration with stakeholder organizations within the framework shown in the figure below.

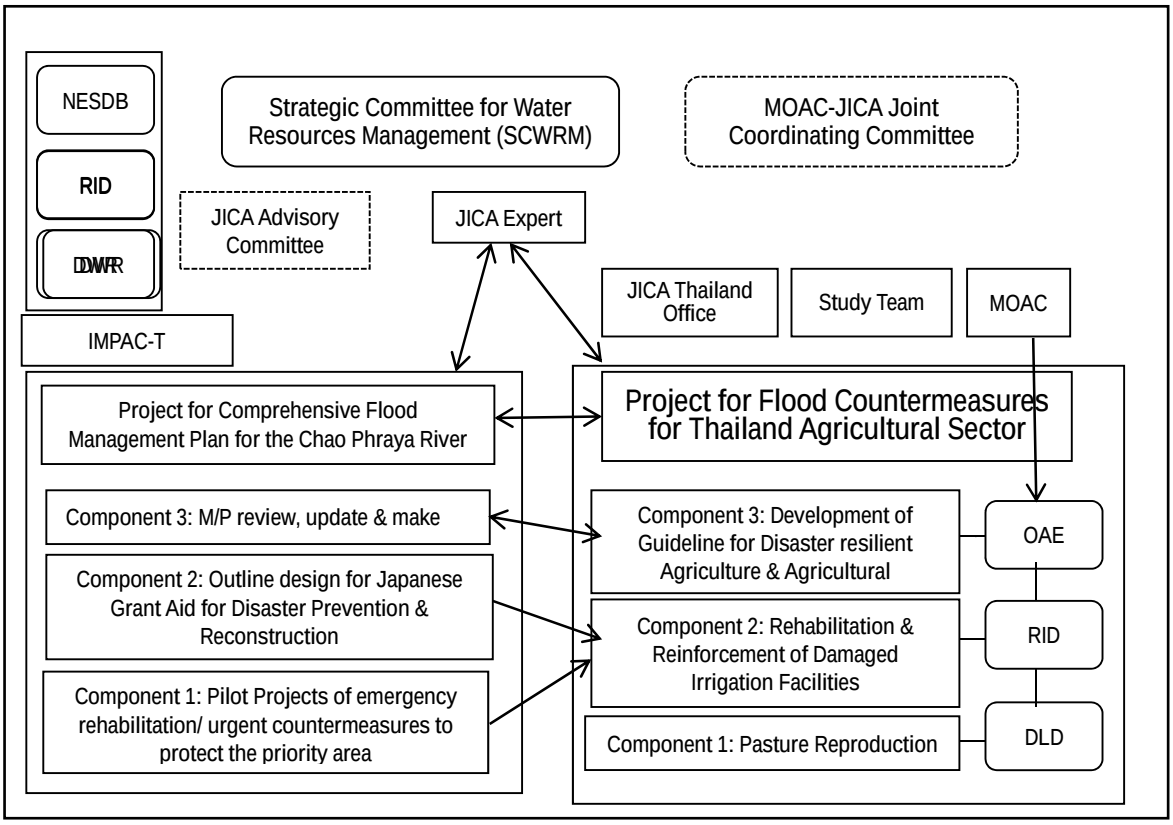


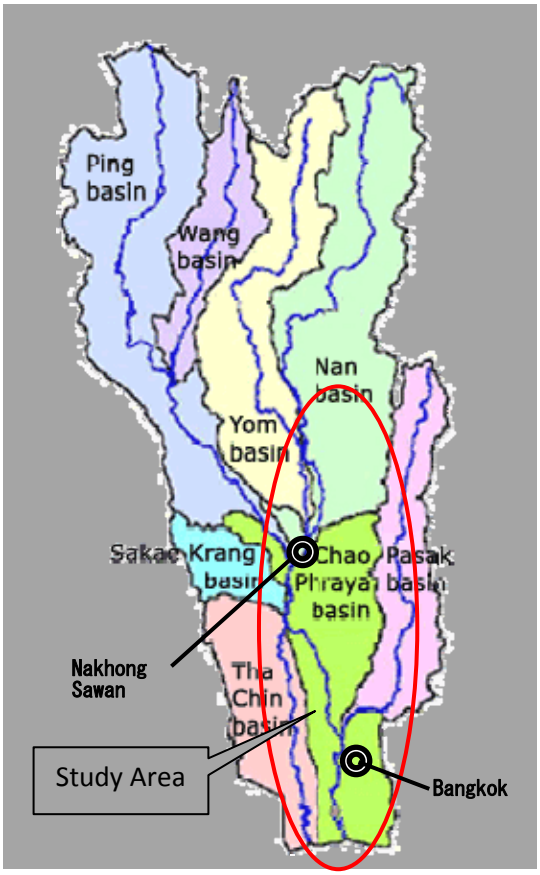
Figure 1.1.1 Framework of the Project and Relationship with other JICA activities

(2) Project Outputs

The outputs of this project are: 1) recovery of productivity of damaged pastures, 2) guidelines on rehabilitation and reinforcement of irrigation facilities, and 3) guidelines on disaster-resilient agriculture and agricultural community planning. Thus, through this project, JICA will provide support to both short-term and long-term efforts of the Government of Thailand in the agricultural sector.

(3) Study Area of the Project

The study areas under this project include the watershed of the Chao-Phraya River as the main-stream basin; the Yom River basin adjacent to the mid-stream area of the Chao Phraya River where damage was caused by the large 2011 flood; a part of the Nan River basin; the Pa Sak River basin, adjacent to the downstream area of the Chao Phraya River; and the Tha Chin River basin. During the flood, 63 out of 77 provinces (*changwat*) in Thailand, including the Northern and Northeastern Regions, suffered damage. This project concentrates on the areas in the middle of the Chao Phraya Delta.



1.2. Implementing Agencies and Implementing System of the Project

(1) Implementing Agencies

The government counterpart organization for this project is the Ministry of Agriculture and Cooperatives (MOAC), and the Deputy Permanent Secretary of MOAC chairs the Joint Consultative Committee (JCC). There are three components to this project. Component 1 was managed by the Department of Livestock Development (DLD), component 2 was managed by the Royal Irrigation Department (RID), and component 3 was managed by the Office of Agricultural Economics (OAE). Other organizations in MOAC, such as the Agricultural Land Reform Office (ALRO), the Land Development Department (LDD), the Department of Agricultural Extension (DOAE), and the Department of Rice (DOR) are members of the JCC. These government organizations in charge of project management are also implementing bodies for projects under SCWRM, therefore the Project Team shared information and collaborated closely with all organizations. Implementing System of the Project

To execute this project, JICA organized a Project Team consisting of Sanyu Consultants Inc. and Nippon Koei Co. Ltd. The counterpart organizations on the Government of Thailand side consisted of the MOAC in which the main counterpart organizations were DLD, RID and the OAE. These agencies worked with the Project Team for the project. Furthermore, with a view to coordinate the various agencies and organizations concerned, the JCC was established under the leadership of the MOAC. This project team adopted a group management system, co-led by "Leader/Project Planning" and "Sub-Leader/Rural Infrastructure" under which three component teams were organized, each aiming to fulfilling the outputs of each component.

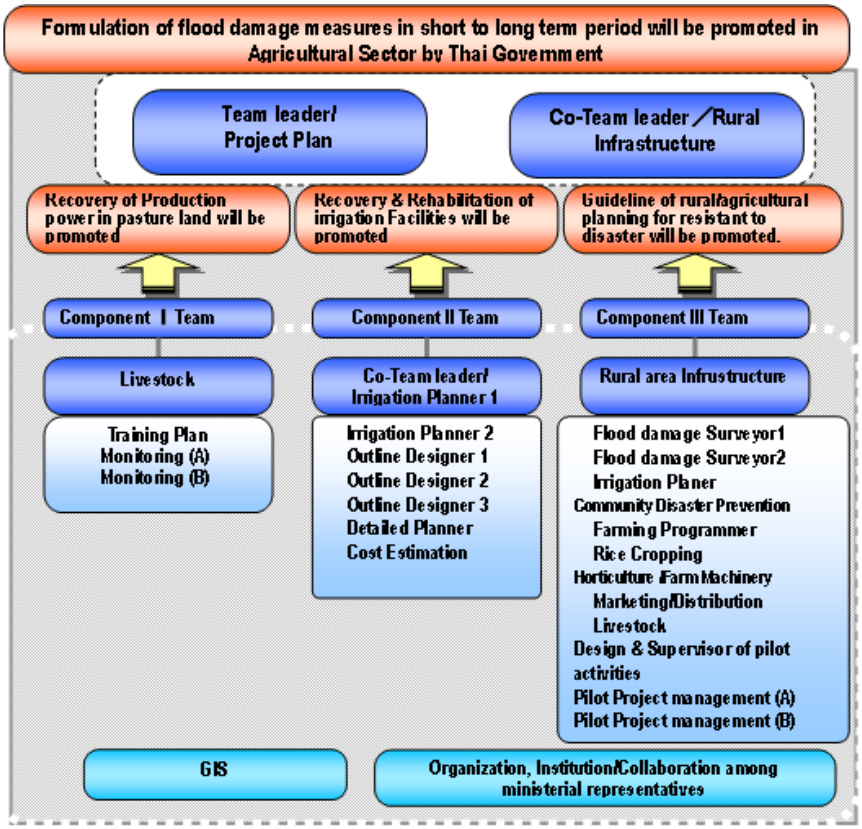


Figure 1.2.1 Project Implementation Organization

(2) Work Plan

The project consisted of two phases of field surveys. The first phase was from March to July 2012, and the second started in August 2012 and ended in June 2013. The overall schedule for the project is outlined below in Table 1.2.1.

Table 1.2.1 Overall Schedule for the Project

Year		2012										2013							
Study Schedule		First Field Survey					Second Field Survey												
Month		3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Rainy and Dry Season		Dry			Rain					Dry							Rain		
Submission on Report/ JCC Meeting		▲ ICR ■					▲ ITR ■									▲ D/FR	■	▲ FR	
Component I: Supports for reproduction of pastures																			
I-1	Monitoring on the distribution of fertilizer and seeds/seedling																		
I-2	Training on sustainable production of pasture																		
I-3	Proposition of quick recovery plan of pasture production after the Flood																		
Component II:Rehabilitation and reinforcement of irrigation facilities																			
2.1	Flood recovery and prevention works tackled by RID																		
2.2	Confirmation survey for Flood Damage on Irrigation Facilities																		
(1)	Irrigation and Facilities operated by RID																		
(2)	Japan assisted Projects in the Past																		
2.3	Selection and review of Pilot Project, cancellation						■												
2.4	Study on Countermeasures and Recommendations																		
Component III : Guideline for disaster resilient agriculture and agricultural community																			
3.1	Selection and grasp in detail of model areas																		
3.2	Flood Damage Survey in Model Area, PRA/Community Study																		
3.3	Collection of Good Practices																		
3.4	Participatory Planning Process for Disaster Resilient Community																		
3.5	Pilot Project Activities																		
(1)	Selection of Pilot/ Activity																		
(2)	Implementation																		
(3)	Monitoring																		
(4)	Lessons Learned from Pilot Projects																		
3.6	Set-up Provincial Task Force																		
3.7	Preparation of Technical Papers																		
3.8	Formulation of Guideline for disaster resilient agriculture and agricultural community (Draft)																		
3.9	Final Workshop																		
Site Survey by Advisory Team		■			■	■							■						

(4) Composition of the Project Team and their TORs

The Project Team was composed of 27 members. The members' TORs and final assignment schedule are summarized in Tables 1.2.2 and 1.2.3 respectively.

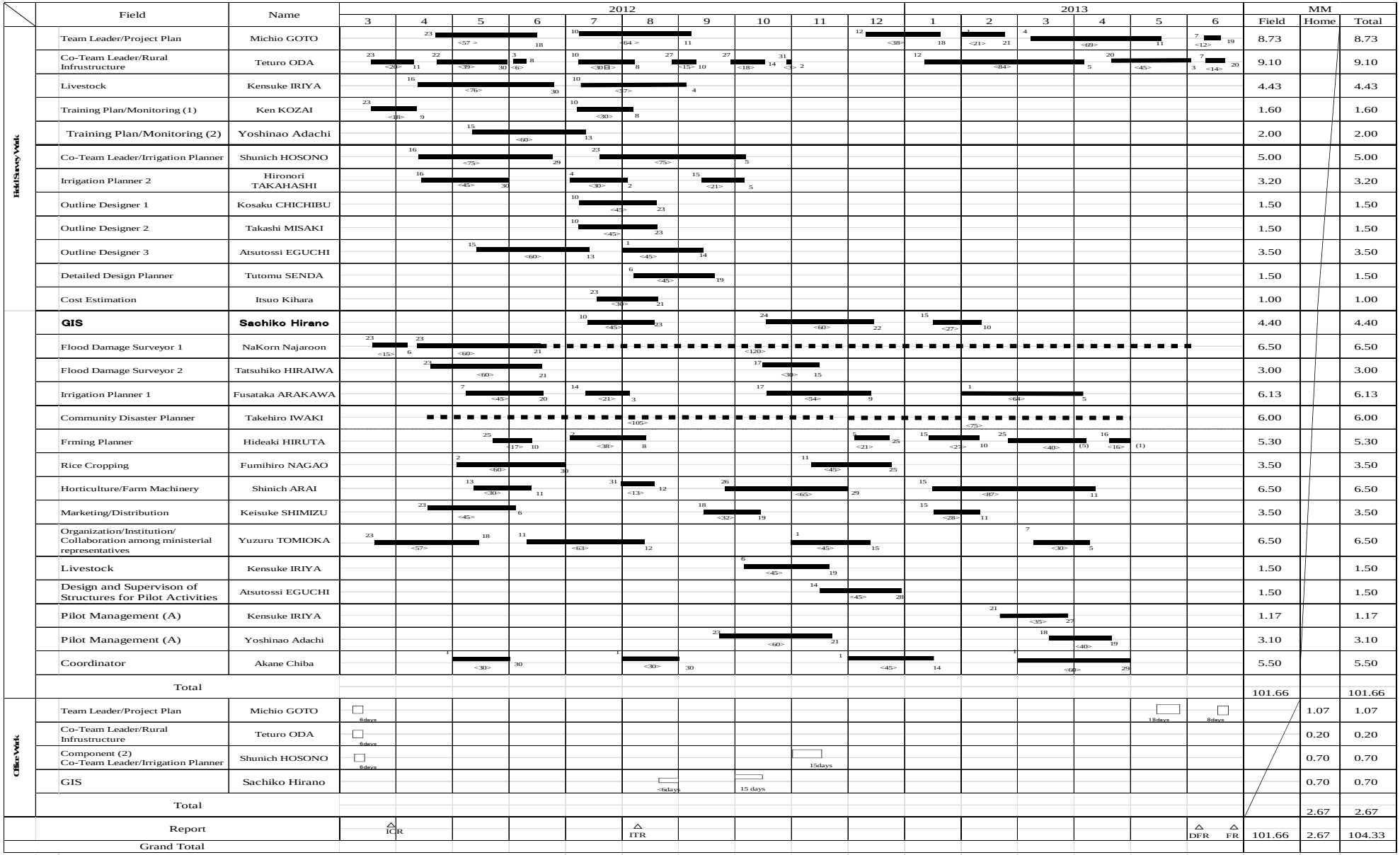
(5) Composition of the Report

This Project is an emergency study in support of the recovery from the 2011 flood disaster in the agricultural sector. Specifically, the project supports countermeasures for livestock, irrigation & drainage as well as activities to increase disaster resilience of the rural community. Because the components were relatively independent in terms of outputs, content, timing, conclusions and recommendations, the report is compiled independently as follows. Information on Component 1 is found in Chapter 2: Support for the reproduction of pastures, Component 2 is in Chapter 3: Rehabilitation and reinforcement of irrigation facilities, and Component 3 is in Chapter 4: Guidelines for disaster-resilient agriculture and agricultural community.

Table 1.2.2 Contents of TOR by Team Member

Name	Task/TOR	Assignments
Overall management （under a group management system）		
Michio Goto	Team leader ／Project Planning	・ Operational management of overall Project ・ Consultation with C/P on the implementation and management of projects ・ Summarizing the Guideline ・ Summarizing various reports and explanation to stakeholders
Tetsuro Oda	Co-Team leader ／Rural infrastructure	
Component 1: recovery of productivity on pasture land		
Kensuke Iriya	Livestock	I-1 Monitoring on the distribution of fertilizer and seeds/seedlings I-2 Training on sustainable production of pasture I-3 Proposal for quick recovery plan of pasture production after the Flood
Ken Kozai	Training supervision ／	
Yoshinao Adachi	Monitoring (1) Monitoring (2)	
Component 2: Rehabilitation and reinforcement of irrigation facilities		
Syunich Hosono	Sub-leader/ irrigation plan1	II-1 Assessment of the status of recovery works for irrigation facilities by Thai counterparts II-2-1 Situation assessment for flood recovery and prevention on irrigation & drainage facilities operated by RID II-2-2 Damage assessment and consideration of measures for JICA supported irrigation and other agricultural related facilities II-3-1 Selection of pilot project area and its design II-4-1 Implementation of the pilot project, canceled by JICA in August 2012 II-4-2 Advice and recommendation for formulating the direction of the rehabilitation plan
Hironori Takahasi	Irrigation plan 2	
Kosaku Chichibu	Outline design 1	
Takashi Misaki	Outline design 2	
Nobutoshi Eguchi	Outline design 3	
Tsutomu Senda	Detailed design	
Itsuo Kihara	Cost estimation	
Component 3: Creation of disaster resilient agriculture/ rural communities		
Tetsuro Oda	Sub-leader／Rural infrastructure	III-1 Selection of Model Areas and Site Survey III-2 Flood Damage Survey in Model Areas III-3 III-3 Participatory Planning Process III-4 Model Activity and Project to Mitigate Flood Damage III-5 Review of Government Policy and Programs III-6 Implementation of Pilot Activities and Projects III-7 Formulating a plan for disaster resilient agriculture and agricultural community in model area III-8 Final Workshop, inclusion of lessons learned from the pilot activities into Guideline for disaster resilient agriculture and agricultural community III-9 Formulation of Guideline for disaster resilient agriculture and agricultural Community
Nakorn Najaroon	Survey of flood damages （Rural village survey） 1	
Tatsuhiko Hiraiwa	Survey of flood damages （Rural village survey） 2	
Fusataka Arakawa	Irrigation plan	
Takehiro Iwaki	Community disaster control	
Hideaki Hiruta	Farming plan	
Fumihiro Nagao	Rice paddy cultivation	
Shinichi Arai	Horticulture/ agricultural machinery	
Keisuke Shimizu	Agricultural marketing	
Kensuke Iriya	Livestock	Design of Livestock Facilities and select priority projects for Pilot Activities
Nobutoshi Eguchi	Designer of Facilities	Design of Facilities and Supervision
Kensuke Iriya	Pilot Project management A	Management of Pilot Activities, especially Livestock
Yoshinao Adachi	Pilot Project management B	Management of Pilot Activities
Common items		
Sachiko Hirano	GIS	・ Analysis and cartography of geographic information required for the activities ・ mentioned above ・ Provision of references for presentation
Yuzuru Tomioka	Organization/ institution Coordination among ministries concerned	・ Collaboration and coordination among related ministries and departments ・ required for the above-cited activities ・ Analysis of organizations/institutions at ministerial level and rural community level
Akane Chiba	Project coordinator	・ Coordination of meetings between related agencies concerned, etc. and accounting

Table 1.2.3 Assignment Schedule



1.3. Challenges for the Flood Countermeasures in Thailand

1.3.1. The Characteristics of Natural Disasters in Thailand

(1) General

Thailand had long been considered as one of the most favored countries in Asia, in terms of a low incidence of severe natural disasters such as earthquakes, storms, flash floods and volcano eruptions. These disasters have often led to large-scale destruction to people's lives and property in other Asian countries with more frequent natural disasters such as China, India, Philippines and Bangladesh. The situation, however, changed when Thailand experienced the Indian Ocean Tsunami disaster in December 2004 with the loss of as many as 8,345 lives and tremendous damage to property. The situation further worsened with the flood disaster in 2011.

(2) Thailand's position in respect of flood disasters in Asia (2007 – 2010)

Prior to discussing the damage caused by the 2011 flood disaster, the position of Thailand overall in the Asia region will be reviewed by analyzing the data from the Asian Disaster Reduction Center (ADRC) in Kobe, Japan. The ADRC data only covers the four years from 2007 to 2010, but they are adequate as background information for Thailand's 2011 flood.

Based on the ADRC Natural Disaster Data Book (2007-2010), the damage caused by floods in Thailand and all 23 Asian member nations during the period can be seen in Table 1.3.1.

Table 1.3.1 Thailand's position in respect of flood disasters in Asia (2007 – 2010)

Year	People killed	People affected	Cos of damage	
2007	53	183,000	1,500	Thailand
	6,749	156,128,983	7,595,175	(Total- 23 nations)
	(0.8 %)	(0.1 %)	(0.02 %)	(Share by Thailand)
2008	39	1,572,157	27,844	Thailand
	2,763	27,956,209	3,722,183	(Total- 21 nations)
	(1.4 %)	(5.6 %)	(0.7 %)	(Share by Thailand)
2009	15	200,000	0	Thailand
	2,461	52,532,514	5,367,310	(Total- 19 nations)
	(0.6 %)	(0.4 %)	(0 %)	(Share by Thailand)
2010	258	8,970,653	332,000	Thailand
	6,344	179,236,982	31,335,000	(Total- 21 nations)
	(4 .1%)	(5.0 %)	(1.1 %)	(Share by Thailand)

Note: The cost of damage is shown in units of US$'000

In 2007, the country with the highest economic loss due to floods was China accounting for 64% of total economic loss by Asian countries, followed by Indonesia (12%) and Vietnam (7 %). Japan suffered the biggest loss in Asia in 2007 with an earthquake causing US$ 12.5 billion in damage.

In 2008, the three top countries with the highest economic losses due to floods were China (64%), Vietnam (13%) and Yemen (11%). China also suffered severe damage in 2008 from earthquakes, extreme temperatures and storms with losses totaling US$ 85.5 billion, US$21.1 billion and US$ 2 million respectively. Myanmar also suffered storm damage totaling US$ 4 billion..

In 2009, the three countries with the highest loss due to floods were India (45%), China (26%) and Philippines (17%). China lost US$ 5.9 billion due to drought and US$ 3.6 billion due to storms, while Indonesia suffered a devastating earthquake with damages reaching US$ 2.4 billion.

In 2010, the three countries with highest economic damage due to floods were China (US$ 18.2 billion), Pakistan (US$ 9.5 billion) and Indonesia (US$ 78 million). The 2010 flood damage in Thailand was more severe as compared with the period 1961-2000 as well as with 2002-2010, as will be reviewed in the following section. Nevertheless, the damage was limited relative to other countries that suffered major damage due to floods. Other types of disasters were not very substantial in the Asia region in 2010. More details about the history and situation of natural disasters in Thailand are described in Appendix I-A-7.

It can be seen that prior to 2011, Thailand was a nation that suffered limited flood damage compared with other nations in Asia. However, in recent years, due mainly to the change of people's lifestyles and the effects of global warming, Thailand has become more vulnerable to flood disasters.

(3) The 2011 Flood Disaster

However in 2011, Thailand experienced a flood disaster unlike any that had previously been seen in its modern history. The ADRC Report, "Thailand Country Profile 2011" describes the 2011 flood as follows. "Severe flooding occurred during the 2011 monsoon season in Thailand. Beginning at the end of July triggered by the landfall of Tropical Storm Nock-Ten, flooding soon spread through the provinces of Northern, Northeastern and Central Thailand along the Mekong and Chao Phraya basins. In October flood waters reached the mouth of the Chao Phraya and inundated parts of the capital city of Bangkok. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths (as of Jan 17, 2012) (with 3 missing) and 13.6 million people in 4 regions affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometers of farm land was damaged. The disaster has been described as 'the worst flooding yet in terms of the amount of water and people affected.' The World Bank has estimated 1,425 billion baht (US$ 45.7 billion) in economic damages and losses due to flooding, as of December 1st, 2011. Most of this was to the manufacturing industry, as seven major industrial estates were inundated by as much as 3 meters (10 feet) during the floods."

In Table 1.3.2, damage by the 2011 flood disaster is compared with the averages for the period between 2002 and 2010. Since the flood damage in this period was already worse compared to the years prior, the comparison highlights the size, seriousness and the magnitude of the 2011 flood disaster.

Table 1.3.2 Thailand's flood disasters between 2002/2010 and 2011

Items/periods	2002-2010	2011	Ratio increased
Number of disasters	9.22	------	
People killed	141.8	815	495 %
People injured	355.0	------	
People affected	6,923,395	13,600,000	196 %
Total damage cost	US$ 229 mil	US$ 4,570 mil	1,800 %

The big difference in terms of the total cost of damage of the 2002-2010 period and the amount in 2011 can mainly be attributed to the inundation of the industrial estates.

1.3.2. Damage in the Agricultural Sector by the 2011 Flood Disaster

(1) National level

Out of a total of 77 provinces in Thailand, 65 provinces were declared "disaster affected areas" by

the 2011 flood. The most seriously affected areas were in the low-lying Chao Phraya plains including the areas with large-scale irrigation schemes and high-value industrial estates located near Ayutthaya. Nationally, as many as 1.09 million farmers were affected and 10.6 million rai (1.7 million ha) of farmland was damaged.

For the crop sub-sector, the 2011 flood disaster resulted in nationwide damages worth 17.8 billion baht, based on estimated compensation costs, with 10.6 billion baht for rice and 7.3 billion baht for field crops.

With regards the livestock sub-sector, the disaster resulted in a total of 29.4 million animals lost, 14,400 rai (2,300 ha) of pasture fields destroyed and 220,000 farmers affected. The total financial losses are estimated at 6.5 billion baht, based on the compensation value of animals as indicated in the MOAC Manual for Aid to Disaster Victims. The breakdown of animals lost is reported as in Table 1.3.3.

Table 1.3.3 Summary of 2011 flood damage in Livestock Sub-Sector

Name of animal	Number of loss	Compensation payable/head	Name of animal	Number of loss	Compensation payable/head
Cow	319,361	15,800	Buffalo	35,629	15,800
Pig	296,880	1,200	Goat	29,272	1,400
Sheep	1,826	1,400	Duck	4,678,616	15
Native chicken	6,821,675	22.5	Egg & meat chicken	14,248,675	15
Quail	2,945,148	12	Goose	30,950	50
Total (head)					29,408,032
Total Amount (THB)					6,482,921,528

In the fishery sub-sector, the number of districts (*amphoe*) that suffered damage was 699 with 142,842 farmers affected. As many as 156,764 ponds and 18,912 stews were damaged with an estimated economic loss of 4 billion baht. In summary, the total damage by the 2011 flood in the agricultural sector is calculated at 28.4 billion baht, based on compensation estimates. This accounts for about 2 % of the total national damage of 1,425 billion baht for all sectors. However, if the total economic loss caused by the 2011 flood in the agricultural sector is assumed at 72 billion baht, as announced by OAE in November 2011, the percentage of damage loss in the agriculture sector works out to 5% of the total national damage.

While the scale of the total damage incurred by the 2011 flood was exceptionally large, flood-prone areas of the country experience damage from flooding regularly, one or twice every several years. For instance, flood-related damage in 2011 was comparable to that in 2006 and 2012 for many flood-prone areas in this Project's Study Area. Therefore, for people in these areas who live with floods, it is particularly vital for them to have plans for water management, farming and improved livelihoods..

(2) Maps showing flooded areas in 2008 and 2011.

The year 2008 is considered to represent an average year for flood damage during the 5 year period from 2006 to 2010 in terms of the size of the area usually flooded. This data was prepared by GISTDA. To illustrate the magnitude of the 2011 flood, the flood area maps of 2008 and 2011 are presented in Figure 1.3.1. The total area flooded in 2011 was 27 million rai (43,200 km^2), or three times the flooded area in 2008 which affected 9 million rai (14,400 km^2).

(3) Provincial/model areas at local level

Details of the damage in the agricultural sector at the local level are described in Appendixes I-

D-4 Flood Damage in Agricultural Sector in Model Area Provinces and I - D-5 2011 Flood Damage in Model Areas.

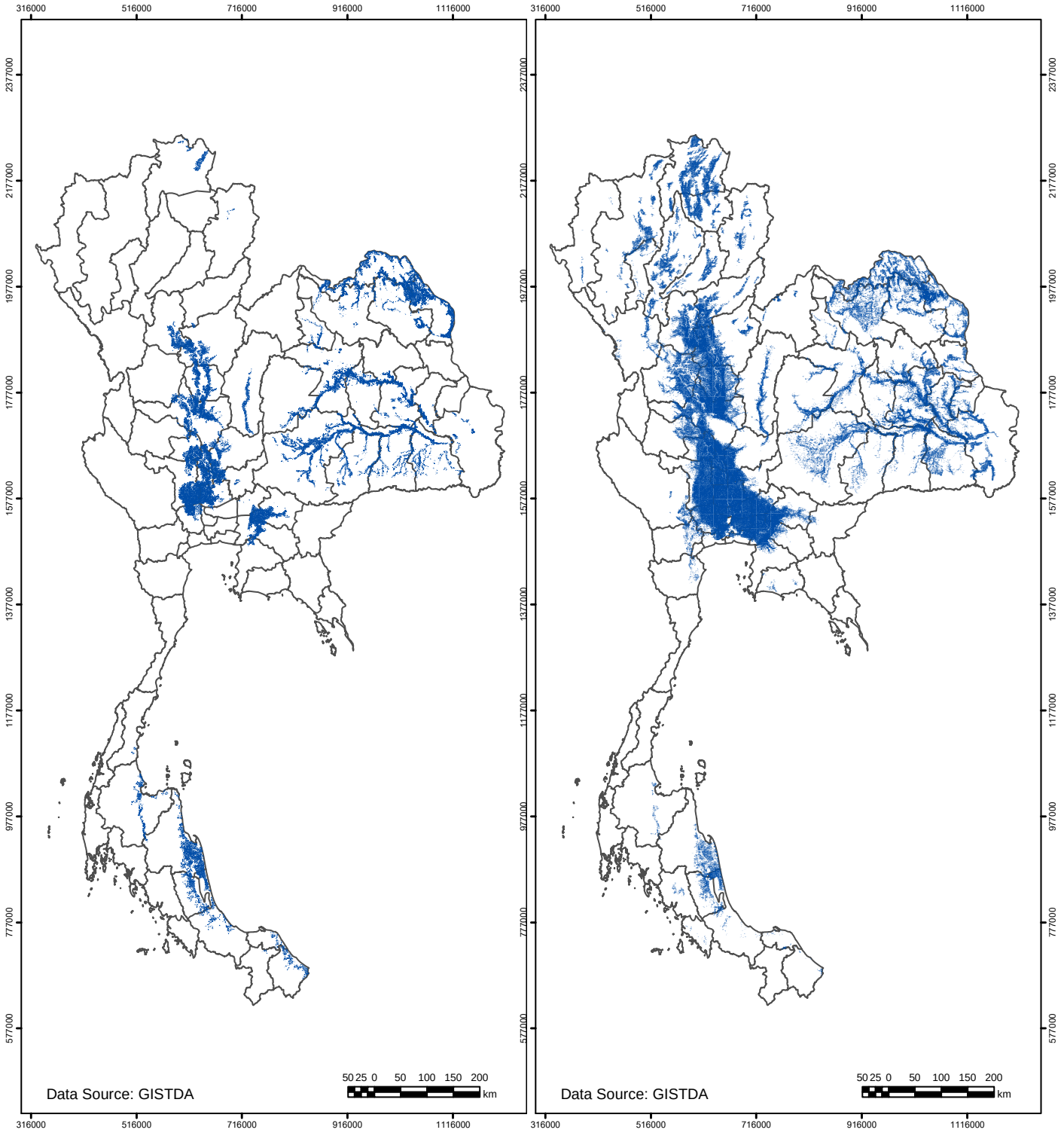


Figure 1.3.1 Comparison of Flood Area in Thailand between 2008 and 2011

1.3.3. Organization and Institutional Background of the Project

The administration system of the Government of Thailand (GOT) is highly centralized and the organizations are well-developed and functional, although some sectionalism can be seen.

In 2002, a major government administrative reform was implemented, and the government structure changed from of 13 ministries plus the Office of the Prime Minister to 19 ministries plus the Office of the Prime Minister. The current administration structure is shown in the following figure. (Asterisk (*) denotes ministries established in the 2002 reform.)

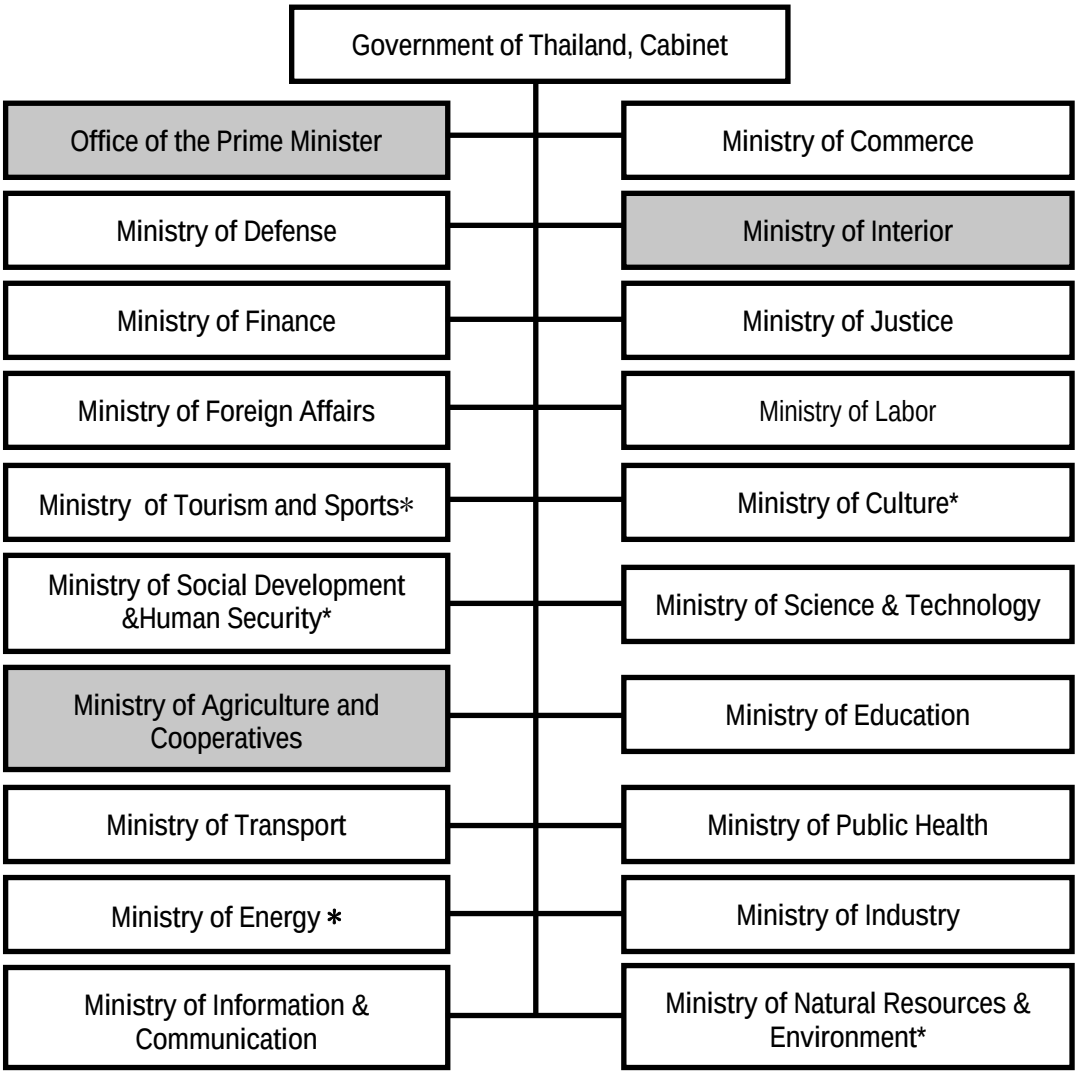


Figure 1.3.2 The Thai Government Administration Structure

In the above, the ministries closely related with the current project are: 1) the Ministry of Agriculture and Cooperatives, which is responsible for the overall agriculture sector, 2) the Ministry of Interior, which is in charge of national level disaster prevention and mitigation as well as provincial and local administration, and 3) the Office of the Prime Minister (OPM). The OPM coordinates among various government ministries and agencies, including high-level policy-making or planning bodies such as the NESDB, the Bureau of the Budget and the Office of the National Security Council. In addition, high-level national committees on National Water Resources and

Flood Policy (NWFPC) and the Water and Flood Management Committee (WFMC), which reports to the NWFPC, are established under this Office. The Office of the National Water and Flood Management Policy (ONWFMP) was established under the two Committees mentioned above as the secretariat to manage work plans, supervise and follow up on the policies formulated. The roles and responsibilities of the government ministries and bodies involved in prevention and mitigation of flood damages are described in Appendixes I-A-3-1, I-A-3-2 and I-A-3-3.

1.3.4. Supporting activities by JICA and other donors

In response to the request from the Government of Thailand or because of the extraordinary scale of flood damage, donors other than JICA have also supported recovery efforts, such as through repair and rehabilitation of infrastructure or through technical policy-level support against flooding in future. Main initiatives are listed below, and details of each project are described in Appendix I-A-5-1.

Name of supporting activities

- The Project for Comprehensive Flood Management Plan for the Chao Phraya River Basin in Kingdom of Thailand by JICA
- The Project on Capacity Development in Disaster Management in Thailand (Phase II) by JICA
- Support for Thailand's Flood Management Knowledge Forum by Asian Development Bank (ADB)
- FAO support for flood- affected livestock farmers in Thailand

CHAPTER 2. COMPONENT 1: SUPPORT FOR THE REPRODUCTION OF PASTURES

2.1. Background

2.1.1. Monitoring of the Distribution and the Use of Seedlings and Fertilizers

Livestock farmers experienced huge damage from the big 2011 flood. Many animals died, and pastures were damaged due to inundation lasting two to three months. The DLD provided 2,750 tons of hay and silage and 1,500 tons of fresh forage from their stores to the 52 provinces and to 20,250 livestock farmers as an emergency measure, but this amount was not enough. Moreover, the DLD budget was insufficient to procure fertilizers and pasture seeds for emergency support. As a result, the DLD requested JICA to provide fertilizers and technical support for the production and management of the pastures in the flood damaged areas.

JICA in cooperation with the Department of Livestock Development (DLD) provided and distributed compound fertilizer (15-15-15) along with urea and forage seeds and seedlings to promote the recovery of pastures that were damaged by the 2011 flood. The amount of fertilizers includes 1,000 tons of compound fertilizer (15-15-15) and 200 tons of urea which was intended to be distributed to 3,826 farmers who suffered losses from the flood. In addition, 20 tons of forage seeds and 120 tons of seedlings procured from DLD's Seed Center were also distributed. Distribution from the Animal Nutrition Research and Development Center (ANRDC) in Chainat to 29 centers and stations covering the whole country was managed and conducted by DLD. The farmers received fertilizers and seeds and seedlings from the center or station in their respective areas.

The Project Team monitored how the fertilizers were distributed and used on individual farms to assess the effectiveness of this operation.

2.1.2. Training on sustainable pasture production (and disaster risk management)

In Thailand, beef cattle, dairy cows, goats, sheep and poultry are raised mainly by small-scale livestock farmers relying on feed stocks, grazing on grass lands, improved pastures and crop residues such as rice straw. However, most of the farmers are not aware of pasture management and livestock management. As a result of not understanding the importance of keeping fodder and rotating pastures, both their livestock and their pastures suffered damage from the 2011 flood. In order for the farmers to keep the livestock in good, healthy condition, and get income from the animals, it is necessary to prepare alternative feed sources of adequate quantity and quality.

The Project Team designed training modules for farmers to improve their knowledge and skills in various topics from pasture establishment and management to animal health. The training included practical sessions.

2.1.3. Policy Recommendations for Recovery from Disaster

The flood in 2011 caused huge damage to the livestock sector. Such disasters may take place again in the future; therefore the Thai government and the people have to be prepared to deal with another possible disaster. In this regard, the Project Team recommended possible countermeasures to cope with floods and implement possible pilot projects in the selected model areas linking with Component-3 to establish farming communities which are disaster resilient.

2.1.4. Activities of Component 1

The output of the Component-1 is that recovery of productivity of damaged pasture lands is promoted. To attain this output, the following activities were carried out:

1) Monitoring the distribution and use of seedlings and fertilizers,
2) Training on sustainable pasture production (and disaster risk management), and
3) Policy recommendations for recovery and preparation from imminent disasters.

2.2. General Overview of the Livestock Sector in Thailand

(1) Contribution to the National Economy and Exports

1) The National Economy and the Livestock Sector.

The contribution of the agricultural sector to the national economy has been declining since the 1980s. The agriculture sector accounted for 12.5% of GDP in the early 1990s; however it had fallen to 11.6% by 2008 (Thailand Development Research Institute 2008), as shown in Table 2.2.1. In 2000, the livestock sector's share in the agricultural GDP was the highest at 23.6%, which corresponded to only 2.5% of the total GDP, according to FAO statistics.

Table 2.2.1 Contribution of Livestock GDP

Year	GDP (Million Baht)	Share of Agricultural GDP in Total GDP(%)	Share of Livestock GDP in Agr. GDP(%)	Share of Livestock GDP in total GDP(%)
1980	662,482	23.2	17.9	-
1990	2,182,545	12.5	23.0	2.9
2000	4,922,731	10.	23.6	2.5
2008	9,104,959	11.6	-	-

Source: FAO RAP-P2002.23

(2) Government Policy on the Livestock Sector

The government policy on the livestock sector for 2011-2012 is shown in Appendix I-B-1. The DLD raises three important issues in their policies; 1) to supply safe animal products by maintaining animal health and preserving the environment, 2) to involve livestock farmers themselves in the prevention of animal diseases and reduction of infectious diseases in order to supply safe organic foods, and 3) to maintain animal feed stocks and to establish a system to supply feed in times of natural disasters.

(3) Number of Livestock and Farmers

1) Number of Dairy Cows and Livestock Farmers

In 2011 the total number of dairy cows in the country was 560,659 and they were being raised by 20,645 livestock farmers, as seen in Table 2.2.2.

Table 2.2.2 Number of Dairy Cattle and Farmers in Thailand (2011)

Region	Total Dairy Cattle (Head)		Farm Household		Average per Farm Household (head)
	Head	%	No.	%	
Total	560,659	100.0	20,645	100.0	27.2
1	173,289	30.9	5,748	27.5	30.2
2	42,163	7.5	1,552	7.5	27.2
3	103,616	18.5	3,676	17.8	28.2
4	28,326	5.1	1,200	5.8	23.6
5	53,273	9.5	1,894	9.2	28.1
6	7,761	1.4	391	1.9	19.9
7	147,541	26.3	5,764	27.9	25.6
8	1,791	0.3	137	0.7	13.1
9	2,899	0.5	283	1.4	10.2

Source: DLD statistics 2011

2) Top 10 provinces with dairy cattle in 2011

The province with the highest number of dairy cows was Saraburi where 104,372 heads were raised by 3,336 farmers, followed by Nakhon Ratchasima, and thirdly Ratchaburi.

Table 2.2.3 Top 10 Provinces Raising Dairy Cattle and Number of Farmers.(2011)

No.	Province	Dairy cattle		Farm Household		Average per Farm Household (head)
		Head	%	No.	%	
1	Saraburi	104,37	18	3,33	16.2	31.3
2	Nakhon	93,533	16	3,16	15.3	29.6
3	Ratchaburi	53,812	9.6	2,39	11.6	22.5
4	Lopburi	66,162	11.8	2,23	10.8	29.6
5	Sa Kaew	35,116	6.26	1,30	6.3	26.9
6	Kanchanaburi	26,868	4.79	1,23	6.0	21.8
7	Chiang Mai	31,569	5.63	1,14	5.6	27.6
8	Prachuap Khiri	35,259	6.29	965	4.7	36.5
9	Nakhon Pathom	22,672	4.04	861	4.2	26.3
10	Khon Kaen	13,630	2.43	499	2.4	27.3

Source: DLD statistics, 2011

3) Number of Beef Cattle and Livestock Farmers

In 2011 the total number of beef cattle in Thailand was 6,583,106, being reared by 1,035,072 farmers as shown in Table 2.2.4.

Table 2.2.4 Number of Beef Cattle and Farmers in Thailand. (2011)

Region	Total Beef Cattle (head)		Farm Household		Average/Household (head)
	Head	%	No.	%	
Total	6,583,106	100.00	1,035,072	100	6.36
1	419,690	6.38	24,956	2.41	16.82
2	191,663	2.91	18,805	1.82	10.19
3	2,087,283	31.71	412,589	39.86	5.06
4	1,220,500	18.54	247,972	23.96	4.92
5	649,110	9.86	70,444	6.81	9.21
6	561,133	8.52	39,940	3.86	14.05
7	719,022	10.92	51,887	5.01	13.86
8	285,186	4.33	62,355	6.02	4.57
9	449,519	6.83	106,124	10.25	4.24

Source: DLD statistics 2011

4) Top 10 provinces with Beef Cattle in 2011

The province with the highest number of beef cattle was Nakhon Ratchasima with 388,108 heads accounting for 5.90%, followed by Srisaket, and thirdly Ubon Ratchathani.

Table 2.2.5 Top 10 Provinces of Beef Cattle Nourishing and Farm Households (2011)

No.	Province	Beef Cattle (head)		Farm Households		Average/Household (head)
		Head	%	No.	%	
1	Nakhon Ratchasima	388,108	5.90	49,004	4.73	7.92
2	Srisaket	294,556	4.47	66,822	6.46	4.41
3	Ubon Ratchathani	290,430	4.41	61,645	5.96	4.71
4	Surin	282,856	4.30	60,342	5.83	4.69
5	Roi Et	247,373	3.76	59,729	5.77	4.14
6	Buriram	237,964	3.61	45,611	4.41	5.22
7	Khon Kaen	225,113	3.42	45,983	4.44	4.90
8	Sakon Nakhon	204,394	3.10	39,987	3.86	5.11
9	Mahasarakham	199,285	3.03	48,119	4.65	4.14
10	Nakhon Si Thammarat	160,569	2.44	36,334	3.51	4.42

Source: DLD statistics 2011

5) Number of Poultry and Farmers

In 2011 the total number of poultry in Thailand was 316,536,364 birds reared by 2,714,283 farmers as shown in the table below.

Table 2.2.6 Number of Chicken and Farmers.(2011)

Region	Total Chicken (Bird)		Farm Household		Average/ household (bird)
	Bird	%	No.	%	
Total	316,536,364	100.00	2,714,283	100.00	116.62
1	76,684,797	24.86	127,073	4.68	619.21
2	69,576,264	21.98	108,768	4.01	639.68
3	50,595,537	15.98	812,351	29.93	62.28
4	20,189,986	6.38	559,722	20.62	36.07
5	19,820,720	6.26	402,046	14.81	49.30
6	23,588,321	7.45	262,677	9.68	89.80
7	29,776,516	9.41	79,618	2.93	373.99
8	12,147,265	3.84	156,833	5.78	77.45
9	12,156,958	3.84	205,195	7.56	59.25

Source: DLD statistics 2011

6) Top 5 provinces with most poultry in 2011

The province that raised the highest number of Poultry was Lopburi rearing 35,118,540birds, accounting for 11.09%, followed by Chonburi, and Saraburi.

Table 2.2.7 Five Most Provinces of Poultry Population in 2011

No.	Province	Total Chicken (Bird)		Farm Household		Average/Household (bird)
		Bird	%	No.	%	
1	Lopburi	35,118,54	11.09	29,208	1.08	1,202.36
2	Chonburi	26,876,93	8.49	19,212	0.71	1,398.97
3	Saraburi	22,836,55	7.21	14,689	0.54	1,554.67
4	Nakhon Ratchasima	20,980,30	6.63	171,075	6.30	122.64
5	Prachinburi	16,355,20	5.17	12,525	0.46	1,305.80

Source: DLD statistics 2011

7) Number of Swine and Farmers

In 2011 the total number of swine in the country was 9,681,774 heads raised by 227,406 farmers, as seen in Table 2.2.8 below.

Table 2.2.8 Number of Swine and Farmer in Thailand (2011)

Region	Total Swine (head)		Farm Household		Average/household (head)
	Head	%	No.	%	
Total	9,681,774	100.00	227,406	100.00	42.57
1	1,098,703	11.35	7,567	3.33	145.20
2	1,821,213	18.81	4,968	2.18	366.59
3	1,084,503	11.20	51,469	22.63	21.07
4	583,957	6.03	29,353	12.91	19.89
5	1,067,507	11.03	65,492	28.80	16.30
6	666,768	6.89	27,464	12.08	24.28
7	2,253,536	23.28	9,051	3.98	248.98
8	541,521	5.59	19,503	8.58	27.77
9	564,066	5.83	12,539	5.51	44.98

Source: DLD statistics 2011

8) The top 10 provinces that raised Swine in 2011

The Province that raised the highest number of swine was Ratchaburi, accounting for 15.42% (1,442,560 head) of the total swine raised in the country, followed by Chonburi and Nakhon Pathom.

Table 2.2.9 Top 10 Provinces of Average Swine Nourishment per Household (2011)

No.	Province	Swine (head)		Farmer Household		Average/household (head)
		Head	%	No.	%	
1	Ratchaburi	1,492,560	15.42	1,523	0.67	980.01
2	Chonburi	953,190	9.85	653	0.29	1,459.71
3	Nakhon Pathom	511,563	5.28	1,912	0.84	267.55
4	Chachoengsao	314,797	3.25	529	0.23	595.08
5	Saraburi	220,741	2.28	413	0.18	534.48
6	Prachinburi	159,874	1.65	596	0.26	268.24
7	Nakhonnayok	142,035	1.47	267	0.12	531.97
8	Chanthaburi	92,553	0.96	353	0.16	262.19
9	Rayong	70,554	0.73	270	0.12	261.31
10	Ayutthaya	39,976	0.41	193	0.08	207.13

Source: DLD statistics 2011

(4) Livestock Production

1) Beef Production

The cattle industry in Thailand largely consists of small farms. Cattle have been kept traditionally for draft purposes while meat was merely a by-product. The recent trend shows that the cattle industry in Thailand still very much remains a small farm industry. The limited land available means that obtaining feed is likely to be a problem for the operators of these farms, particularly during the dry season (FAO RAP, 2002a). There are three different types of beef farms in Thailand: (i) Breeding farms that mainly sell breeding stock to other farmers (the number of these farms has decreased in recent times due to the unfavorable market conditions); (ii) Traditional farms that usually have small backyard operations with cattle being occasionally used as draft animals and only slaughtered at old age and therefore only producing low quality beef; and. (iii) Feedlot operations where the sole purpose is to fatten cattle before slaughter. The feedlot operators either purchase old stock from

traditional farms or fatten stock for two to three months for slaughter and then sell at fresh markets.

2) Milk Production

Milk production in Thailand is dominated by small dairy farms which typically have five to ten milking cows. However, recently farms are getting larger, with about 20% of dairy farms now having more than 20 head, compared with 6% 10 years ago. Generally, dairy farming is characterized by low productivity and problems with infertility and/or mastitis with as many as 30% of the dairy cattle being affected. Poor feed quality is also a major problem, leading to low milk production and poor reproductive health (Quirke et at., 2003).

3) Poultry Production

Most poultry production in Thailand now takes place in commercial operations with the industry being dominated by large multinational companies. By the mid-1990s, family farms accounted for less than 25% of total production due to the expansion of commercial poultry farms. Independent commercial growers often engage in contracts with small growers, however, the number of contract growers is likely to decline due to their inability to equal the economic advantage attainable by the large commercial growers (FAORAP, 2002a).

4) Pork Production

Pork production has moved from a system dominated by small growers to larger scale commercial operations. Around 80% of the total pork production now takes place on large farms and at feed mill companies. In particular, the collapse in production in the wake of the financial crisis in 1998 had a large impact on small swine farms. Low prices and high costs of production forced many small farms out of operation. Much of the resurgent introduction has been generated by larger operations. Lack of credit has made re-establishing small farms a difficult task. Moreover, the introduction of European high lean live pigs contributed to higher costs due to the housing and feeding requirements, and this also favored large-scale production operators. Growing concern over diseases in recent times has led to a wider use of vaccines, which has further increased production costs; however, over half of the total production cost can be attributed to feed costs (Quirke et at., 2003).

(5) Marketing of Animals

1) Beef cattle

Figure 2.2.1 shows the marketing channels of beef cattle in Thailand. Livestock markets are open weekly, and farmers who want to sell their livestock go to a nearby market in their area. Livestock prices are decided through negotiation between buyer and seller.

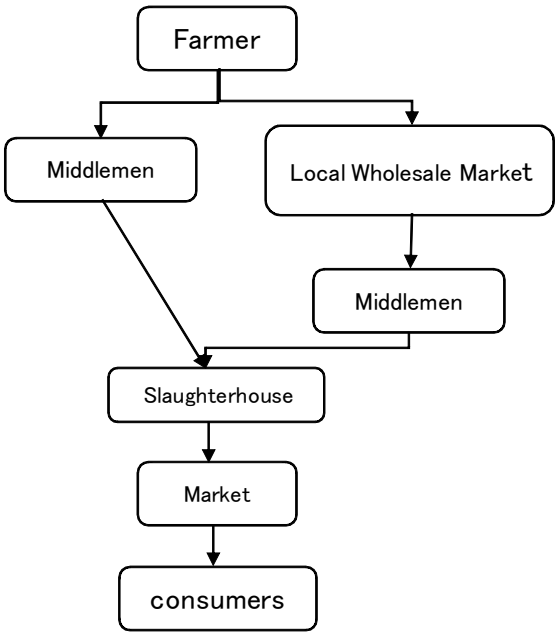


Figure 2.2.1 Marketing Channel of Beef Cattle

2) Broiler

Figure 2.2.2 shows the broiler marketing channels in Thailand. As shown in the figure, the broiler market is more commercialized and systemized compared to the system used to market cattle.

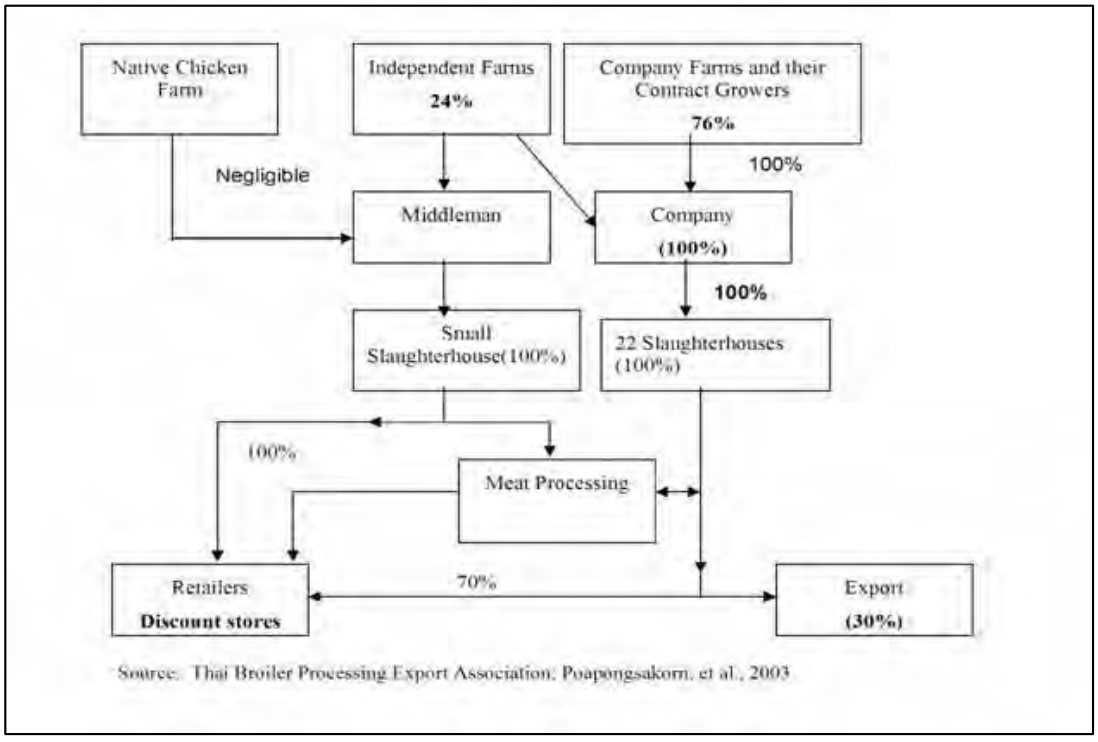


Figure 2.2.2 Marketing Channel of Broiler

(6) Animal Feeds and Feeding System

1) Feeding system

The two feeding systems mainly used in Thailand are grazing with supplementary feed and the zero-grazing system.

- Grazing with supplementary feed: In this system the animals graze on natural or on improved pastures such as communal or private land. The animals' diet is supplemented with fodder crops and/or with concentrates.
- Zero-grazing: With this system the animals are confined to the feeding area and all the feed is brought to them with a cut-and-carry feeding system. This means that not only the supplementary feed but also the roughage, such as grass and hay, and drinking water has to be provided to the livestock.

2) Seasonal Feeding System

Figure 2.2.3 shows the seasonal feeding system for livestock in Thailand. Rice straw is used all year round in conjunction with feeding forage crops such as Pangola grass. Grazing also takes place on harvested paddy fields and grazing grounds. However, farmers in general are not sufficiently aware of the important relationship between nutritional requirements and the quality of animal feed.

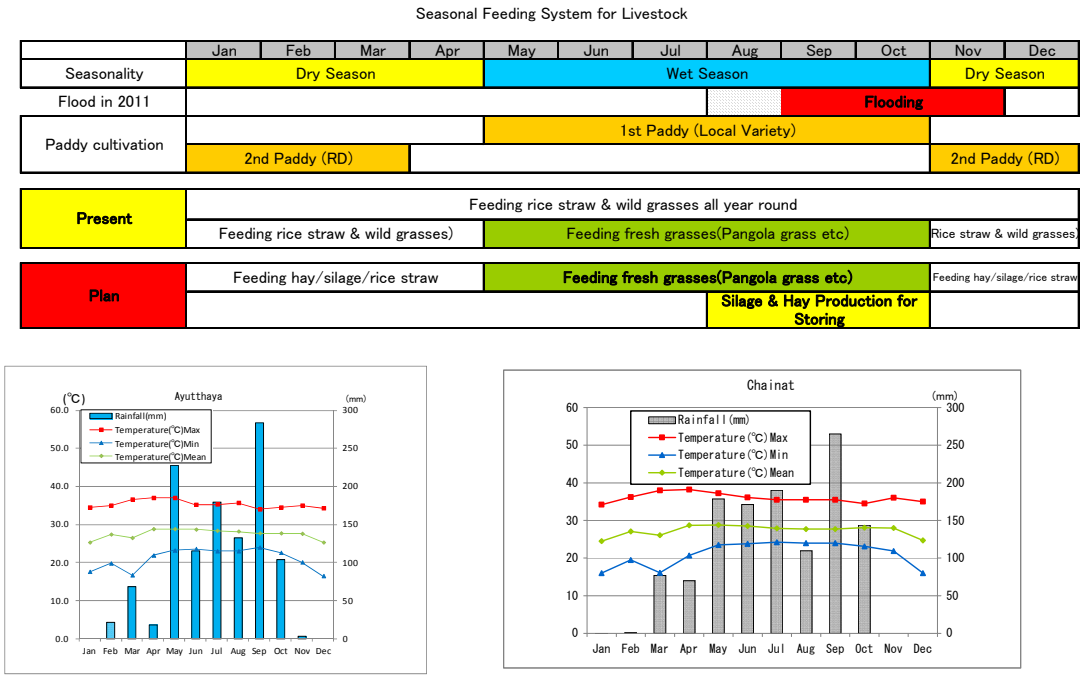


Figure 2.2.3 Seasonal Feeding System for Livestock in Thailan

2.3. Organization of the Department of Livestock Development (DLD)

2.3.1. DLD Central Administration and Mandate

(1) Organization structure

The administration of the DLD is divided into two parts; central and provincial administrations. The central administration, located in Bangkok, is composed of three divisions, 15 bureau offices, including the Office of the Department Secretary, the National Institute of Animal Health,

the Information Technology Centre, the Internal Auditing Unit, and the Administrative Development Unit. The organizational structure of the DLD is illustrated below in Figure 2.3.1.

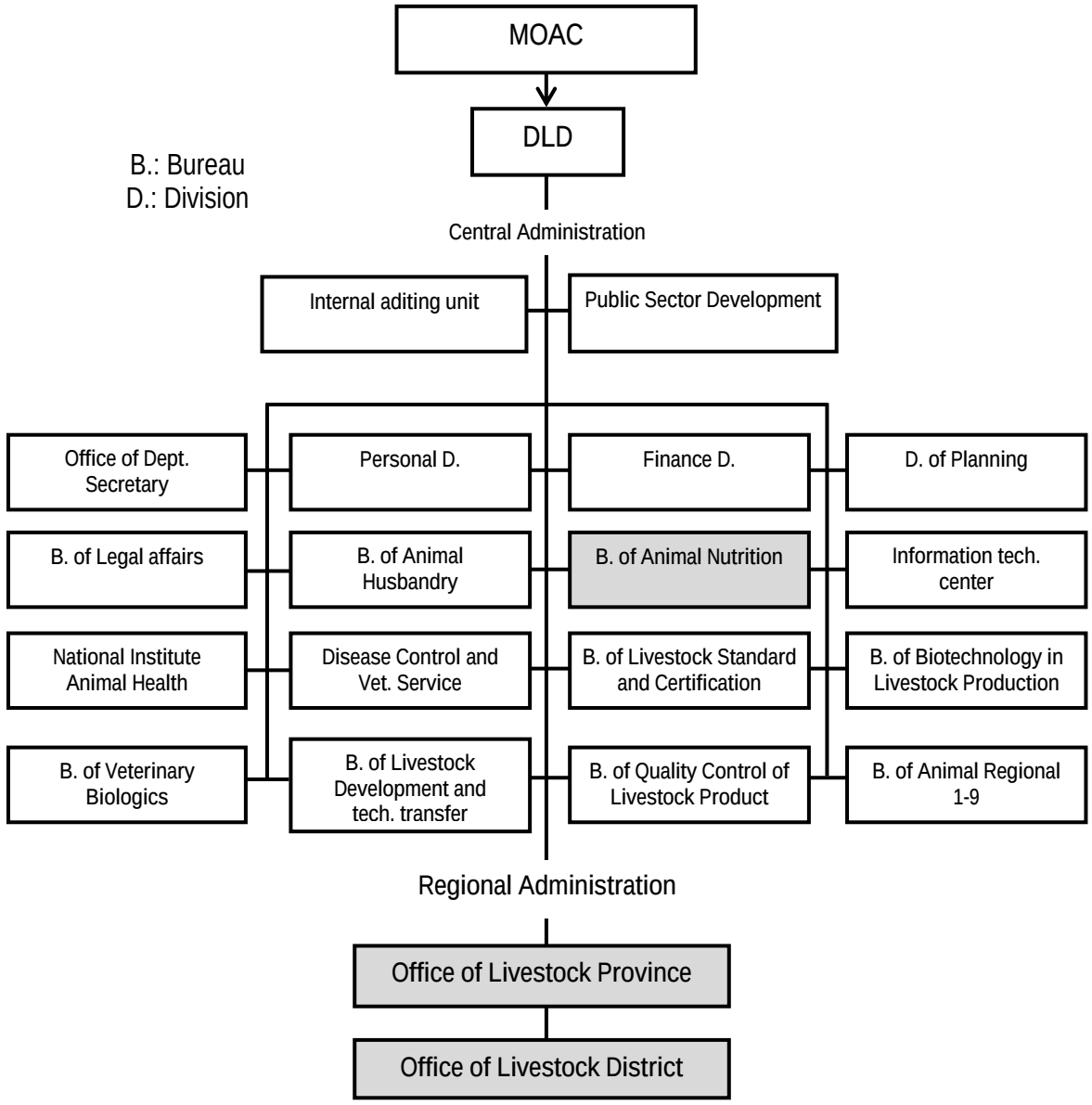


Figure 2.3.1 Organizational Structure of DLD

(2) Mandate of Units

The mandates of the department units and their duties and responsibilities are summarized in Appendix I-B-2.

2.3.2. DLD Administration (Provincial and District)

The provincial administration comprises Provincial Livestock offices (PLOs) consisting of 887 units at district level, working with 7,409 Sub-District Agricultural Technology Transfer Centers nationwide. At the village level there are 80,000 Voluntary Livestock Workers who are responsible for carrying out the DLD's work. The organization chart of the Office of Livestock as it operates in provincial areas is shown in Figure 2.3.2.

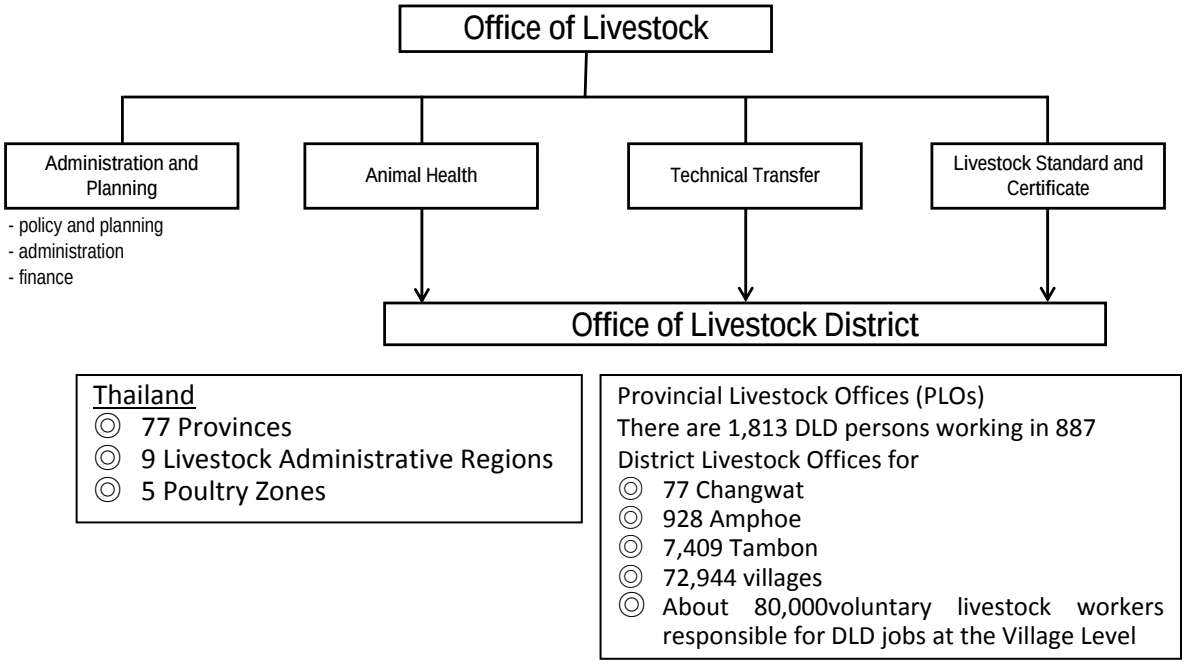


Figure 2.3.2 Organization Chart of the Office of Livestock

2.3.3. Animal Nutrition Division (Forage Seed Center)

The Animal Nutrition Research and Development Center is a government organization under the DLD, providing good quality seeds for forage, providing advice and services on pasture establishment and utilization, forage storing and animal feeding. The organizational chart of the Animal Nutrition Division is shown in Figure 2.3.3.

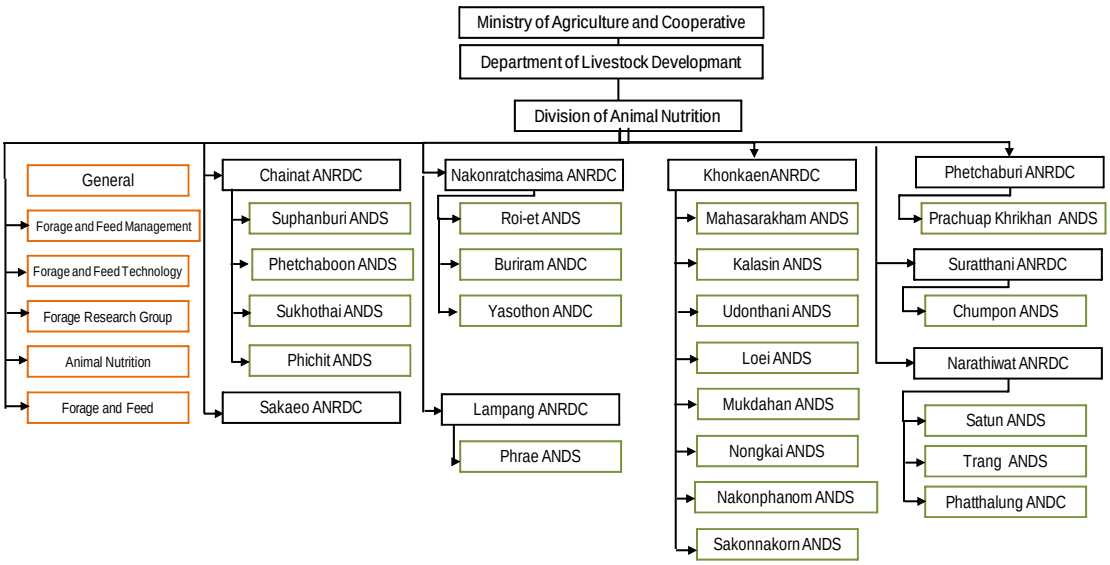


Figure 2.3.3 Organizational Chart of the Animal Nutrition Division

2.4. Flood Damages to Livestock in 2011

2.4.1. Estimated Amount of Damage to Livestock

According to the DLD, a total of 29 million livestock including cattle and poultry were lost as well as pasture areas of 14,370 rai (2,299 ha), with 220,221 livestock farmers affected. The losses are estimated at 6,483 million baht, based on the unit prices for compensation.

Table 2.4.1 below shows the number and percentage of livestock lost out of the total livestock population prior to the flood. The table also shows that not only cattle, but also a high percentage of poultry (chicken, duck) and goats were lost.

Table 2.4.1 Number and Percentage of the Damage on Livestock by Breed

Livestock	Number	No. of livestock lost	% to the total	Remark
Buffalo	1,234,179	35,629	2.9	
Cattle	6,583,106	319,361	4.9	
Chicken	316,536,364	6,821,675	2.2	Native
		14,248,675	4.5	Egg & Meal
Duck	32,179,227	4,678,616	14.5	
Goat	427,567	29,272	6.8	
Sheep	51,735	1,826	3.5	
Swine	9,681,774	296,880	3.1	

Source: Impact from Disaster Report (DLD)

2.4.2. Damage on the Livestock Sector by Province

The tables below present the summary of damage of livestock by province.

- Cows

The province with the highest number of cows lost was Suphanburi, in the central plain, accounting for 9.9% of the total, followed by Chaiyaphum, and Ayutthaya.

Table 2.4.2 Top 4 Provinces of Damage to Cows

	Rank	Province	No. lost (heads)	
Cow	1	Suphanburi	31,611	(9.9%)
	2	Chaiyaphum	24,852	(7.8%)
	3	Ayutthaya	21,952	(6.9%)
	4	Roi Et	19,111	(6.0%)

Source: Impact from the Disaster Report (DLD)

- Swine

For swine, Suphanburi was the province with most serious damage, accounting for 14.4 % of the total, followed by Ayutthaya, and Sukhothai. All these provinces are located mainly in the central plain.

Table 2.4.3 Top 4 Provinces of Damage to Swine

	Rank	Province	No. lost (heads)	
Swine	1	Suphanburi	42,796	(14.4%)
	2	Ayutthaya	29,976	(10.1%)
	3	Sukhothai	29,499	(9.9%)
	4	Nakhon Prathom	29,083	(9.8%)

Source: Impact from the Disaster Report (DLD)

- Egg and Meat Chicken

With respect to chickens for egg and meat production, Ayutthaya recorded the heaviest damage with 34.1% of the total, followed by Nakhon Prathom and Suphanburi in third place.

Table 2.4.4 Top 4 Provinces of Damage to Chickens

	Rank	Province	No. lost (Bird)	
Egg & Meat Chicken	1	Ayutthaya	4,863,469	(34.1%)
	2	Nakhon Prathom	3,051,987	(21.4%)
	3	Suphanburi	2,815,652	(19.8%)
	4	Nakhon Sawan	1,306,081	(9.2%)

Source: DLD

2.4.3. Magnitude of the Flood Damage on Pastures

According to the DLD data dated 30 November, 2011, shows 14,370 rai (2,299 ha) of pasture land, cultivating mainly Pangola grass, suffered damage from the flood. This damage was sustained mainly in the provinces located in the central plain such as Suphanburi and Chaiyaphum, but including Tak in the Northern Region. However, the duration of the flooding period and water depth differed considerably between the provinces, because of the geographical characteristics of the land. Accordingly, the level of pasture damage differs significantly between the provinces.

Table 2.4.5 Damage to the Livestock Sector by Province

No.	Province	District	Tambon	Moo	Number of Farmers being damaged	Duration of disaster	Type	Number of Animals Lost												Immediate Assistance		
								Cow	Buffalo	Swine	Goat	Sheep	Duck	Native chicken	Egg & meat chicken	Quail	Goose	Total	Pasture grass field (rai)	Forage crop (kg)	Animal health care	Mineral & Pharmaceutical
1	Bangkok	31	121	1,103	4,935		All flood	5,967	200	90	3,933	264	10,398	94,264	104	-	79	115,299	511	18,000	60	-
2	Chainat	6	32	162	4,865		All flood	4,984	187	3,746	2,349	30	106,417	138,014	191,365	-	52	447,144	20	25,000	146,141	2,360
3	Patumthani	7	60	529	6,029		All flood	8,760	989	4,600	1,987	35	210,000	135,000	126,948	45,000	-	533,319	-	9,480	-	-
4	Nontaburi	6	52	328	5,750		All flood	3,100	240	550	2,700	71	35,000	42,500	8,800	5,000	190	98,151	-	10,000	347	-
5	Ayutthaya	16	181	1,269	18,590		All flood	21,952	1,680	29,976	3,380	248	682,280	517,027	4,863,469	1,216,213	29,588	7,365,813	72	222,480	13,054	1,000
6	Lopburi	7	63	477	12,369		All flood	17,211	1,442	21,800	859	184	764,870	369,637	995,341	13,000	-	2,184,344	716	70,100	152,841	-
7	Singburi	6	33	169	3,206		All flood	4,106	63	12,689	421	-	92,865	68,671	214,824	250,000	291	643,930	66	101,880	33,126	-
8	Saraburi	12	40	240	2,377		All flood	2,784	131	789	297	-	41,430	88,858	52	40	10	134,391	19.5	15,020	28,146	-
9	Suphan Buri	9	96	903	15,493		All flood	31,611	392	42,796	4,349	-	393,878	632,459	2,815,652	611,080	-	4,532,217	3,058.00	30,000	-	-
10	Angthong	7	64	397	7,518		All flood	11,525	298	17,357	978	30	608,114	776,951	542,600	742,800	421	2,701,074	765.5	1,059,500	502,793	30
11	Chanthaburi	2	2	-	13		All flood	-	-	5	-	-	20	100	-	-	10	135	-	10,000	-	-
12	Chacherngsao	6	21	156	1,534		All flood	9,418	75	2	759	110	-	1,478	-	-	-	11,842	-	265,400	844	240
13	Trad	2	5	43	1,157		All flood	1,123	494	800	189	-	-	10,405	-	-	-	13,011	-	10,000	-	-
14	Nakorn Nayok	4	14	32	104		All flood	1,112	528	35	-	-	1,547	80	36,700	-	17	40,019	-	50,600	99	12
15	Prachinburi	6	30	116	1,893		All flood	6,472	1,906	11,174	-	-	677	18,766	-	-	-	38,995	-	31,000	592	156
16	Chaiyaphum	11	48	379	12,764		All flood	24,852	1,440	12,335	-	-	61,594	286,445	3,000	-	-	389,666	2,500.00	27,320	41,294	-
17	Burirum	4	9	24	708		All flood	1,512	903	-	-	-	-	-	-	-	-	2,415	-	20,000	-	-
18	Roi-et	9	30	185	7,171		All flood	19,111	3,103	2,135	-	-	43,228	145,283	-	-	38	212,898	22	434,020	69,620	79
19	Yasothorn	5	14	47	1,627		All flood	3,296	752	88	-	-	124	525	-	-	-	4,785	-	233,160	2,272	984
20	Srisakhet	5	14	46	1,476		All flood	4,331	1,756	-	-	-	-	-	-	-	-	6,087	-	100,000	-	-
21	Surin	3	5	40	2,233		All flood	7,949	1,239	1,625	-	-	-	-	-	-	-	10,813	-	65,200	-	-
22	Ubonratchatani	10	23	125	6,126		All flood	10,418	4,641	2,166	-	52	17,841	118,416	55	-	38	153,627	190	111,000	12,807	-
23	Amnardcharoen	1	2	2	84		All flood	189	58	5	-	-	-	-	-	-	-	252	-	16,800	-	-
24	Kalasin	9	16	48	1,144		All flood	4,066	991	266	-	-	1,864	13,761	-	-	-	20,948	-	160,000	-	1,000
25	Khon Kaen	13	28	156	4,686		All flood	10,155	1,802	5,608	2,206	-	72,818	347,577	-	-	-	440,166	-	69,840	429	-
26	Mukdahan	1	1	1	229		All flood	350	110	-	-	-	-	4,607	-	-	-	5,067	-	87,000	-	-
27	Mahasarakham	3	14	55	528		All flood	1,726	65	-	-	-	-	-	-	-	-	1,791	95	186,450	88	-
28	Nong Khai	5	12	44	1,499		All flood	1,253	534	7,107	-	-	6,044	15,335	7,960	-	-	38,233	503	73,800	511	-
29	Nongbua Lamphu	3	14	79	1,015		All flood	5,546	1,309	240	-	-	3,621	12,114	-	-	-	22,830	-	25,910	64	678
30	Bungkan	4	8	36	545		All flood	488	400	277	16	-	2,502	7,446	-	-	-	11,129	2	27,860	1,969	-
31	Loei	6	26	157	6,880		All flood	8,489	-	1,517	157	-	-	280,364	-	-	290,527	270	362,106	-	2,220	
32	Udonthani	5	9	38	461		All flood	922	642	-	-	-	1,954	11,752	-	-	-	15,270	-	1,600	-	-
33	Chiengrai	6	10	31	791		All flood	166	-	9	-	-	33	16,834	-	-	-	17,042	-	31,820	6	200
34	Chiengmai	6	21	66	2,556		All flood	11,524	414	3,609	82	-	3,752	858,342	77,563	-	16	955,302	60	15,600	75,000	-
35	Nan	1	3	9	414		All flood	-	-	34	-	-	2,154	11,655	-	-	-	13,843	-	-	190	-
36	Payao	1	2	3	63		All flood	-	-	-	-	-	-	712	-	-	-	712	-	56,500	-	-
37	Phrae	8	39	219	3,055		All flood	5,279	459	3,790	-	-	1,253	98,404	-	-	-	109,185	-	-	2,729	-
38	Maehonson	2	3	7	50		All flood	1	7	50	-	-	244	1,803	-	-	-	2,105	-	23,000	-	-
39	Lampang	9	27	83	3,578		All flood	4	2	95	-	-	624	28,624	-	-	6	29,355	-	15,000	-	-
40	Lampoon	2	4	21	234		All flood	500	-	301	-	-	71	11,274	2,700	8,000	-	22,846	-	10,000	5,500	-
41	Kampaengphet	6	11	60	1,633		All flood	3,497	278	5,562	-	-	17,737	141,157	-	-	-	168,231	-	2,000	27	-
42	Tak	2	3	17	1,088		All flood	6,284	38	1,278	-	-	-	100,914	-	-	-	108,514	2,883.00	84,080	-	-
43	Nakornsawan	15	123	1,270	18,509		All flood	12,259	1,331	27,193	761	325	611,275	194,321	1,306,081	-	52	2,153,598	-	81,000	55,241	-
44	Pichit	11	74	565	11,166		All flood	4,192	525	7,614	323	-	398,105	368,389	2,260	-	108	781,516	225	136,000	780,958	2,907
45	Pitsanulok	7	29	111	1,811		All flood	2,177	79	3,698	76	-	1,031	54,123	-	-	-	61,184	249	316,000	28,238	2,376
46	Petchaboon	4	21	82	3,708		All flood	1,725	94	2,866	-	-	3,634	94,204	-	-	-	102,523	-	157,220	330	32
47	Sukhothai	5	48	426	19,881		All flood	13,215	1,060	29,499	255	-	232,211	471,935	-	-	-	748,175	-	29,000	711	-
48	Utharadit	3	9	24	348		All flood	438	94	41	-	-	110	6,847	-	-	-	7,530	-	30,000	1,650	250
49	Uthaithani	5	18	81	2,160		All flood	1,471	2,633	1,388	100	100	57,997	88,289	5	54,015	14	206,012	25	17,000	25,469	1,329
50	NaKkhon Phanom	7	88	600	6,486		All flood	10,340	236	29,083	1,075	373	172,399	76,148	3,051,987	-	20	3,341,661	-	7,000	23,529	-
51	Rajburi	1	3	17	271		All flood	940	-	-	-	-	-	-	-	-	-	940	1,777.00	-	-	-
52	Samutprakan	1	1	1	1		All flood	-	-	-	-	-	7,000	-	-	-	-	7,000	-	-	-	-
53	Pang-nga	2	5	22	106		All flood	100	-	40	55	-	470	1,680	-	-	-	2,345	-	-	16	-
54	Suratthani	1	2	10	675		All flood	277	4	952	-	-	858	7,106	-	-	-	9,197	-	212,250	-	-
55	Satoon	4	18	55	6,628		All flood	10,194	5	-	1,965	4	8,572	51,079	1,209	-	-	73,028	341	212,250	-	-
Total		333	1,649	11,166	220,221	-	-	319,361	35,629	296,880	29,272	1,826	4,678,616	6,821,675	14,248,675	2,945,148	30,950	29,408,032	14,370.00	5,366,246	2,006,691	15,853

2.5. Monitoring Survey on Distribution of Fertilizers and Seeds/Seedlings

2.5.1. Distribution System

On December 27, 2011, it was decided that a total of 1,200 tons of fertilizers, as well as seeds and seedlings would be distributed. And on March 18, 2012, the DLD Bangkok Headquarters (HQ) informed 29 centers and stations to conduct a survey of flood damage to livestock and pastures in each province. The hand-over ceremony was held on March 27, 2012, at the Chainat Animal Nutrition Research and Development Center under the DLD. On March 28, a kick-off meeting was held and it was agreed that the number of target provinces would be increased from 26 to 49. Each center and station then held a meeting with all staff where the director instructed them to conduct a full assessment of flood damage and its effects on livestock farmers and pastures. A meeting at DLD HQ was held on April 2 with the directors of centers and stations to plan the distribution of fertilizers, seeds and seedlings.

Some farmers became aware that JICA and DLD would distribute fertilizers, seeds and seedlings through reports on TV and other media, while others were informed by the staff of DLD centers and stations. Farmers who had suffered from the flood, registered for assistance with the DLD by filling out the designated Format-1 forms. Each center and station forwarded the designated Format-2 to DLD HQ in Bangkok, and finally, the Bureau of Animal Nutrition of DLD organized a Project Steering Committee meeting to decide which livestock farmers would receive the benefits.

The fertilizers stored in the Chainat Center were distributed to the 29 centers and stations from the beginning of May to early July (refer to Figure 2.5.1). Beneficiary livestock farmers received fertilizers, seeds and seedlings according to this system.

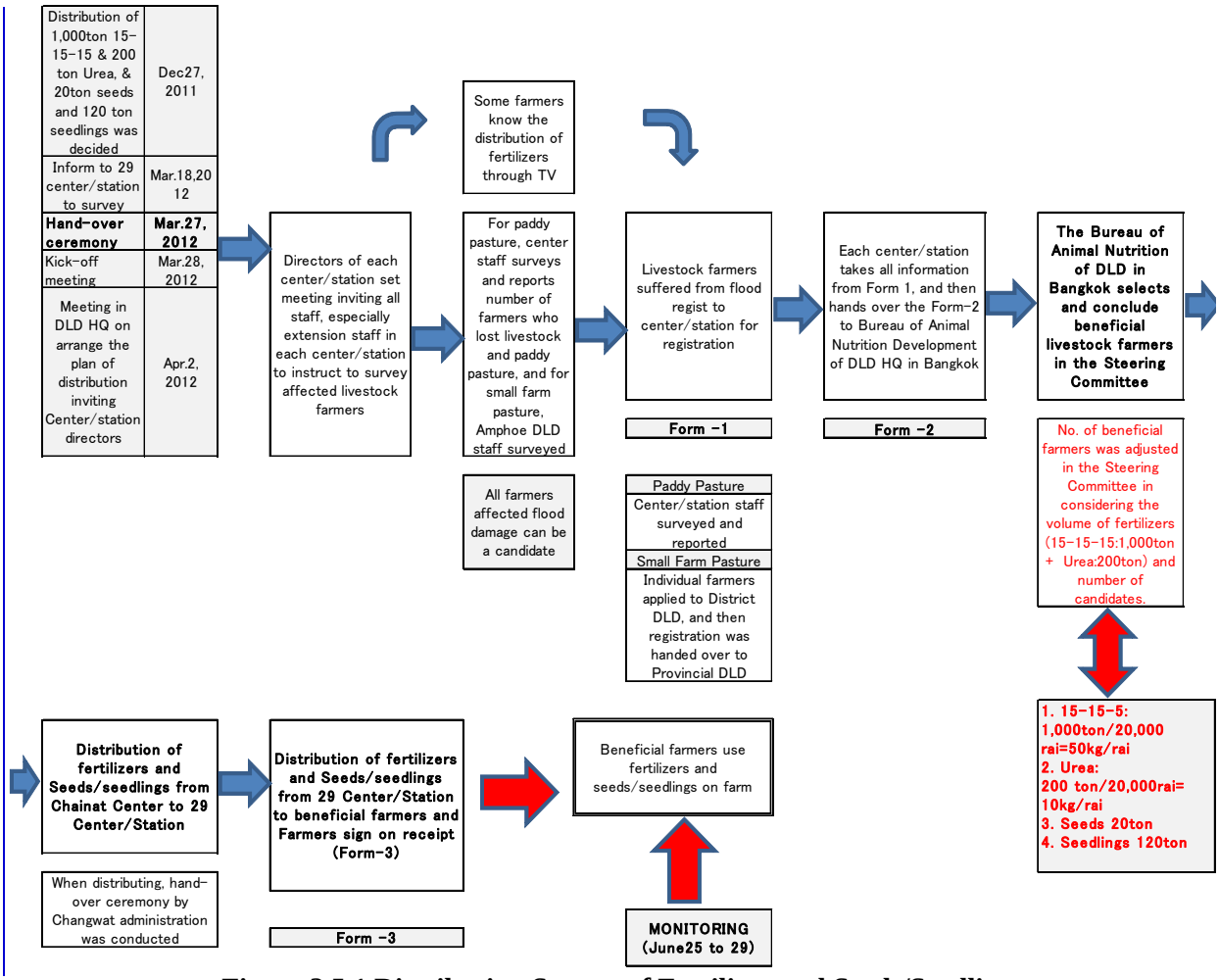


Figure 2.5.1 Distribution System of Fertilizer and Seeds/Seedlings

The DLD surveyed and decided on the beneficiary areas and livestock farmers using six formats listed below, and included in Appendix I-B-3.

Form-1 Register of flood-affected farmers and pastures
Form-2 Summary of farmer household information
Form-3 Receipt for fertilizer
Form-4 Schedule of fertilizer delivery
Form-5 Hand-over of fertilizer, seed and seedlings
Form-6 Detailed distribution report from each center/station

2.5.2. Volume of Fertilizers and Seeds/Seedlings Distributed

Under the original plan of the project, 1,000 tons of compound fertilizer (15-15-15) and 200 tons of urea were distributed to revive 20,000 rai (3,200 ha) of damaged pastures. These areas included; 1) paddy pasture, 2) small farm pasture, 3) communal land, and 4) pastures under DLD centers and stations.

Table 2.5.1 shows DLD's distribution plan dated April 2nd and the findings of the monitoring survey. DLD centers and stations were allocated 29.8% of the fertilizer because pastures belonging to the centers and stations were also damaged by the 2011 flood. The monitoring survey found that fertilizers had been distributed largely in accordance with the original plan.

Table 2.5.1 Comparison of Original Allocation Plan and Monitored Results

	1. Paddy pasture project	2. Small farm pasture	3. Pasture in center/station	4. Public pasture	Total
Compound fertilizer 15-15-15 (kg)	367,300	298,800	299,050	34,900	1,000,050
Urea 46-0-0 (kg)	70,800	59,760	59,800	6,980	197,340
Total	438,100	358,560	358,850	41,880	1,197,390
Share based on the Monitoring Result (%)	36.6	29.9	30	3.5	100
Share in the Original Distribution Plan (%)	36.9	29.1	29.8	4.2	100

To cover 20,000 rai (3,200 ha), 1,000 tons of compound fertilizer and 200 tons of urea were distributed. This is equivalent to 50 kg (1 bag) per rai and 10 kg per rai, respectively, which meet the standard requirement of fertilizer per rai for Pangola grass.

2.5.3. Number of Beneficiaries

In DLD HQ's original plan, the number of livestock farmers to benefit from the distribution was 3,826, which are composed of four categories as shown in Table 2.5.2 below. The result of the monitoring survey showed that the number of beneficiaries increased from 3,826 to 3,911. A significant increase is seen in the category of communal land which increased from 10 to 139, especially in Yasothon Province where the number increased from zero to 130, and similarly in the pastures under DLD centers and stations where it increased from zero to 28.

Table 2.5.2 Number of Beneficiaries of Fertilizers

(unit: No. of beneficiaries)

Item		Paddy pasture	Small farm pasture	Pastures in Center/Station	Communal land	Total
Original plan*		1,007	2,809	0	10	3,826
Result of the Monitoring**	Plan	1,082	2,756	28	10	3,876
	Result	1,237	2,507	28	139	3,911

Source: * DLD HQ, ** Result of the Monitoring Survey by JICA Survey Team

2.5.4. Beneficiary Areas

The beneficiary provinces were increased from the original number of 26 to 49, as decided at the kick-off meeting on March 28, 2012. As shown in Table 2.5.3, the original target of 20,000 rai (3,200 ha) increased slightly to 20,696 rai in the actual distribution. The distribution of fertilizers was completed successfully in line with the original plan both with respect to the area coverage and the number of beneficiaries.

Table 2.5.3 Beneficiary Areas

Item		Paddy pasture	Small farm pasture	Pastures in Center/Station	Communal land	Total
Original plan*		7,384	5,818	5,964	834	20,000
Result of the Monitoring**	Plan	7,075	5,976	6,048	698	19,797
	Result	7,100	6,679	6,048	870	20,696

Source: *DLD HQ, **Result of the Monitoring Survey by JICA Survey Team

2.5.5. Distribution of Seeds and Seedlings

Seeds and seedlings provided from the DLD were also distributed to affected livestock farmers. DLD HQ's original plan was to distribute 20 tons of forage seeds and 1,200 tons of seedlings. For seeds, the varieties of Ruzie, Atratum, Plicatulum, Cavacade, Bombaza and Purple Guinea were distributed depending on the relevant conditions of the provinces. For seedlings, Pangola grass and Pakchong -1 were provided.

The results of the monitoring survey on seeds and seedlings are summarized in Tables 2.5.4 and 2.5.5. Forage seeds of six species totaled more than 20,000 kg (20 tons), with Ruzie grass seeds being the main variety provided and accounting for 53% of the total.

Table 2.5.4 Distribution of Seeds

(unit: kg)

Seed variety		Ruzie	Atratum	Plicatulum	Cavacade	Purple Guinea	Bombaza	Total
Original plan*		20,000 kg (20tons)						20,000
Result of the Monitoring**	Plan	13,960	6,795	3,887	873	546	50	26,111
	Result	13,734	6,589	3,907	883	546	50	25,709

Source: *DLD HQ **Result of the Monitoring Survey by JICA Survey Team

As well as seeds, forage seedlings of Pangola grass and Pakchong-1 were distributed to revive affected pastures. Compared with the original plan of 120,000 kg, the actual distribution of seedlings was increased to 253,700 kg though it is less than the planned 1,201,350 kg.

Table 2.5.5 Distribution of Seedlings

(unit.kg)

Item		Pangola	Pakchong-1	Total
Original plan*		120,000 (120 ton)		120,000
Result of the Monitoring**	Plan	129,300	1,072,050	1,201,350
	Result	94,900	158,800	253,700

Source * DLD HQ **Result of the Monitoring Survey by JICA Survey Team

All the monitoring results are shown on Appendix I, B-4.

2.6. Results of the Monitoring of Beneficial Livestock Farmers

(1) Fertilizers Distributed through the Project

Number of the sample farmers was planned more than 10% against 3,826 beneficial farmers in total decided by DLD. In order to select beneficial farmers, Chainat and Supanburi provinces were duly taking consideration where were the biggest flood damage areas located in central Chao Phraya plain. As for other provinces, at least 5 farmers were selected even though there were few flood damaged livestock farmers.Out of the sampled 515 beneficial farmers, 488 responses are considered to be usable, and all of them received fertilizers. 462 beneficiaries, equivalent to 94.7%, received fertilizers from May 1st 2012, to July 2nd 2012.

Q1: Were you provided chemical fertilizers under the Project?

Responses	No. of FHH*	%
Yes	488	100.0
No	0	0.0

Note.* FHH: Farm household

Q2: When did you get the fertilizer from JICA?

	No. of FHH	%	Latest	Earliest
When	462	94.7	July 2nd, 2012	May 1, 2012
Not yet	26	5.3	-	-

To obtain the fertilizer 38.9 % of beneficial FHHs went directly to a center/station in their region to receive the fertilizer, 30.5%, of FHHs had the fertilizer transported and delivered to the farm by the center/station and a further 24.2% of FHHs went to a district or provincial DLD office.

Q3: How did you get the fertilizers?

	No. of FHH	%
Went to the center/station	190	38.9
Center/station transported to their farms	149	30.5
Went to the district/provincial office of DLD	118	24.2
Other person went to take it	8	1.6
Others	0	0.0
No answer	23	4.7

Out of the 488 FHHs, 64.1% of them have already used and applied the provided fertilizer on their damaged pastures to assist with reproducing forage.

Q4: Have you already used fertilizers for the pasture?

Responses	No. of FHH	%
Yes	313	64.1
No	155	31.8
No answer	20	4.1

As for the volume of fertilizers distributed to them, 56.6% of sample FHHs are satisfied with the quantity provided, but 36.1 % stated that the provided amount was “too small” and considered that it is was not adequate.

Q5: What do you think about the volume of fertilizers?

Responses	No. of FHH	%
Too much	1	0.2
Much	20	4.1
Enough	276	56.6
Small	144	29.5
Too small	32	6.6
No answer	15	3.1

The reasons given by the farmers for “small and too small” responses, is that 72.7% of sample FHHs feel that the pasture needs more nutrition, and 39.2% feel the pasture is very large.

Q5: If you think the volume of fertilizers is small, why did you think so?

Responses	No. of FHH	%
Flood damage was serious	50	28.4
Pasture is very large	69	39.2
Pasture needs more nutrition	128	72.7
Selection and distribution system is not good	5	2.8
Others	0	0.0

(2) Seed/seedlings Distributed through the Project

As for distribution of seeds/seedlings, the result of the monitoring survey shows considerable difference with the results of the fertilizer distribution. The reasons are followings;

- 100% of sample farmers received the fertilizer but only 44.5% of farmers received the seed/seedlings in the time of monitoring
- Good quality fertilizer was contributed to the recovery of pastures and reproduction of the feed crop because the livestock farmers were suffered by the shortage of feed during 2011 flood. On the contrary, needs of seed/seedlings distribution was very low because the livestock farmers had already planted the Pangola grass, etc.
- For the above reason, 44.5% of farmers who received the seed/seedlings in the beginning of monitoring were planted the distributed seed/seedlings

More than half of the beneficial FHHs did not receive seeds/seedlings by early July in 2012.

Q6: Did you get the seeds/seedlings from the Project?

Responses	No. of FHH	%
Yes	217	44.5
No	271	55.5

In the earlier case, beneficial FHHs had received the seeds and seedlings was on May 1st 2012, and the latest was on July 2nd 2012, which matches the distribution schedule of the fertilizers.

Q7: When did you get the seeds/seedlings?

	No. of FHH	%	Latest	Earliest
When	211	97.2	July 2nd 2012	May 1st 2012
Not yet	6	2.8	-	-

Regarding the varieties, Ruzie (Brachiaria Ruziziensis) seeds were the main ones distributed. For other varieties, only 6.6% of households received Pangola grass seedlings, 14.7% for Guinea grass, and 29.9% for Pakchong-1.

Q8: What kind of seeds/seedlings were you provided from the Project?

Responses	No. of FHH	%
Guinea grass	31	14.7
Ruzie grass	138	65.4
Other seeds	96	45.5
Seedlings of Pakchong-1	63	29.9
Seedlings of Pangola grass	14	6.6
Other seedlings	3	1.4

Even when households had received the seeds or seedlings, 51.6% of them had not used them by early July 2012. Picture (right) is Pakchong-1 of a beneficiary FHH.

Q9: Have you already used the seeds/seedlings on your farm?

Responses	No. of FHH	%
Yes	102	47.0
No	112	51.6

As for the quantity of seeds/seedlings, 71.9% of the FHHs answered favorably that it was "enough". The reason for this response is that the demand for fertilizers was higher than that for seed/seedlings. This is because most of them were already cultivating Pangola grass and other forages before and after the flood in 2011.

Q10: What do you think about the quantity of seeds/seedlings distributed through the Project?

Responses	No. of FHH	%
Too much	1	0.5
Much	8	3.7
Enough	156	71.9
Small	39	18.0
Too small	13	6.0
No answer	0	0.0

More than 71% of sampled FHHs had not received any supporting services for pasture reproduction from the government as shown below.

Q11: Have you ever received support for pasture reproduction?

Responses	No. of FHH	%
Yes	112	23.0
No	347	71.1
No answer	29	5.9

About 50% of the farmers own some form of animal feed storage or barn, and more than 55% of them store only rice straw implying that they are greatly dependent on rice straw which has lower nutritional value than Pangola grass and Pakchong-1.

Q12: Do you have a storing space or barn for forage?

Responses	No. of FHH	%
Yes	240	47.1
No	248	50.8

Q13: What kind of animal feed do you store?

Responses	No. of FHH	%
Yes, rice straw	270	55.3
Yes, hay	85	17.4
Yes, silage	36	7.4
Yes, others	13	2.7
No	126	25.8

In the 2011 flood, the damage to farmers was twofold; 1) loss of livestock, and 2) damage or destruction of pastures. Out of 488 sampled FHHs, 229 FHHs, or 47%, lost livestock. The highest loss was to beef cattle, followed by chickens.

For pastures, 23.6% of pastures were destroyed completely, and 11.7% reported having no damage. This implies that flood damage to pasture lands differed considerably depending on land conditions. About 60% of affected FHHs replanted or reseeded their pasture after flooding to enable reproduction.

Q14: Number of livestock lost in the 2011 flood

Livestock	No. of FHH lost livestock		No. of Livestock Lost	
	No.	%	Max.	Min.
Buffaloes	3	0.6	6	4
Dairy cows	20	4.1	30	1
Beef cattle	117	24.0	60	1
Swine	6	1.2	28	2
Goats	12	2.5	20	1
Sheep	1	0.2	2	2
Ducks	17	3.5	200	1
Chickens	53	10.9	1,000	2

Q15: Water depth and period of flooding in the 2011 flood

	No. of FHH	%	Max.	Min.	Average
Days of flooding	461	94.5	180 days	1 day	32.2 days
No answer	27	5.5	-	-	-
Water level(cm)	461	94.5	70 cm	0.02 cm	2.3 cm
No answer	27	5.5	-	-	-

Q16: How was the pasture damaged by the 2011 flood?

	No. of FHH	%
100%	115	23.6
80 to 90%	35	7.2
70 to 80%	35	7.2
60 to 70%	28	5.7
50 to 60%	94	19.3
Less than 50%	119	24.4
No damage	57	11.7
No answer	5	1.0

Q17: Did you replant/reseed the damaged pasture after the flood in 2011?

	No. of FHH	%
Yes	281	57.6
No	195	40.0
No answer	12	2.5

The following tables show the current status of pastures they are cultivating.

Q18: How many rai of pasture do you have?

No. of FHH	%	Max.	Min.	Ave.
488	100	800 rai	0.5 rai	11.2 rai

Q19: What kind of forage are you cultivating?

Varieties	No. of FHH	%
Pangola grass	302	61.9
Pakchong-1	111	22.7
Ruzie grass	73	15.0
Guinea grass	69	14.1
Atratum grass	29	5.9
Whip grass	12	2.5
Para grass	6	1.2
Others	36	7.4

Q20: Where do you cultivate forage?

	No. of FHH	%
Paddy field	328	67.2
Upland	210	43.0
Others	11	2.3

Q21: Height of cutting

	No. of FHH	%	Highest	Lowest	Average
Pakching-1	115	23.6	30 cm	0.02 cm	4.4 cm
Pangola grass	300	61.5	15 cm	0.5 cm	3.3 cm

(3) Monitoring Method and Schedule

1) Survey Method

The surveyors were required to collect every item according to the Formats prepared by the Project Team through interviews with beneficiaries at a designated place and date. As well as farmers, centers and stations under DLD were also surveyed to confirm information such as the status on the arrival date of fertilizers from Chainat Center and the volumes received. A one-day training session was held at DLD HQ to train surveyors who were invited from 29 centers and stations.

2) Number of Sample Farmers

In total, 515 beneficiary farmers were surveyed using Format-1. Provinces under the control of Chainat and Suphanburi Centers made up 220 samples, or 41% of the total. Out of the 515 samples, 488 were valid responses and considered usable. The number of farmers surveyed by province is shown in Appendix I-B-5, and the questionnaire used is in Appendixes I-B-6 and I-B-7.

3) 29 Centers and stations

All the eight centers and 21 stations under the DLD in Table 2.6.1 below were surveyed using Format-2 attached as Appendix I-B-3.

Table 2.6.1 Centers and Stations under the DLD

DLD's Centers and Stations			
1. Chainat	10.1Kalasin	19. Lampang	28. Phichit
2. Suphanburi	11.1Udonthani	20. Phrae	29. Sukhothai
3. Sakaeo	12. Loei	21. Suratthani	
4. Nakhon Ratchasima	13. Mukdahan	22. Chumphon	
5. Roi Et	14. Nongkhai	23. Narathiwat	
6. Buriram	15. Sakon Nakhon	24. Satun	
7. Yasothon	16. Nakhon Phanom	25. Tran	
8. Khon Kaen	17. Phetchaburi	26. Phatthalung	
9. Mahasarakham	18. Prachuapkhirikhan	27. Phetchabun	

4) Work Schedule

The monitoring survey at field level commenced on June 26 and ended on June 29, 2012. All the questionnaires were mailed to DLD HQ, and the analysis was completed by late July 2012.

2.7. Training

(1) Training Modules and Schedule

The project organized training for farmers engaged in pasture production and animal breeding. The training was conducted over three days and the topics covered were: pasture development and fodder for ruminant production; animal selection, and management of beef cattle for small farm holders; pasture establishment and management; intensive pasture production, paddy pasture production, backyard pasture production; hay and silage making; practice on pasture establishment and its management and utilization; animal health care during flood and drought situation; and disease prevention, countermeasures and disaster risk management. All of the lecturers consisted of local staff, includingofficers from DLD HQ in Bangkok, officers from each animal nutrition center or station, and officers from provincial DLDs. The training was conducted in eight sites in different provinces as shown below. Approximately 40 livestock farmers participated at each site.

1. Khon Kaen Province, Northeastern Region: May 10 to May 12
2. Mahasarakham Province, Northeastern Region : May 10 to May 12
3. Chainat Province, Central Region : May 14 to May 16
4. Suphanburi Province, Central Region : May 21 to May 23
5. Nakhon Si Thammarat Province, Southern Region : June 5 to June 7
6. Sakaeo Province, Central Region : June 11 to June 13
7. Lampang Province, Northern Region: June 13 to June 15
8. Phitsanulok Province, Central Region : June 16 to June 18

Training in Sakaeo Province

Training in Phitsanulok Province

1) Information collected from the participants

During the 3-day training session, information was collected from participants in order to understand the nature of the damage caused by the 2011 flood to their farms, as well as general information about livestock raising and management. The information compiled from all sites is summarized in Table 2.7.1 and that of each site is in Appendix I-B-8.

Table 2.7.1 Information about the training participants

All training				
No. of participants	291			
No. and % of farmers raising milk cow	No.=	45	%=	15.5%
No. and % of farmers raising beef cattle	No.=	177	%=	60.8%
No. and % of farmers raising buffalo	No.=	4	%=	1.4%
No. and % of farmers raising pigs	No.=	9	%=	3.1%
No. and % of farmers raising goats	No.=	7	%=	2.4%
No. and % of farmers raising sheep	No.=	0	%=	0.0%
No. and % of farmers owning pasture	No.=	266	%=	91.4%
Maximum and average pasture size in rai	Max=	100.0	Ave=	10.2
No. and % of farmers damaged pasture	No.=	214	%=	73.5%
% of damaged pasture	%=	61.5%	-	
Flooding period (days)	Max=	120.0	Ave=	28.3
Water depth of the flood in 2011 (m)	Max=	4.0	Ave=	0.6
No. and % of farmers cultivating Pangola grass	No.=	151	%=	51.9%

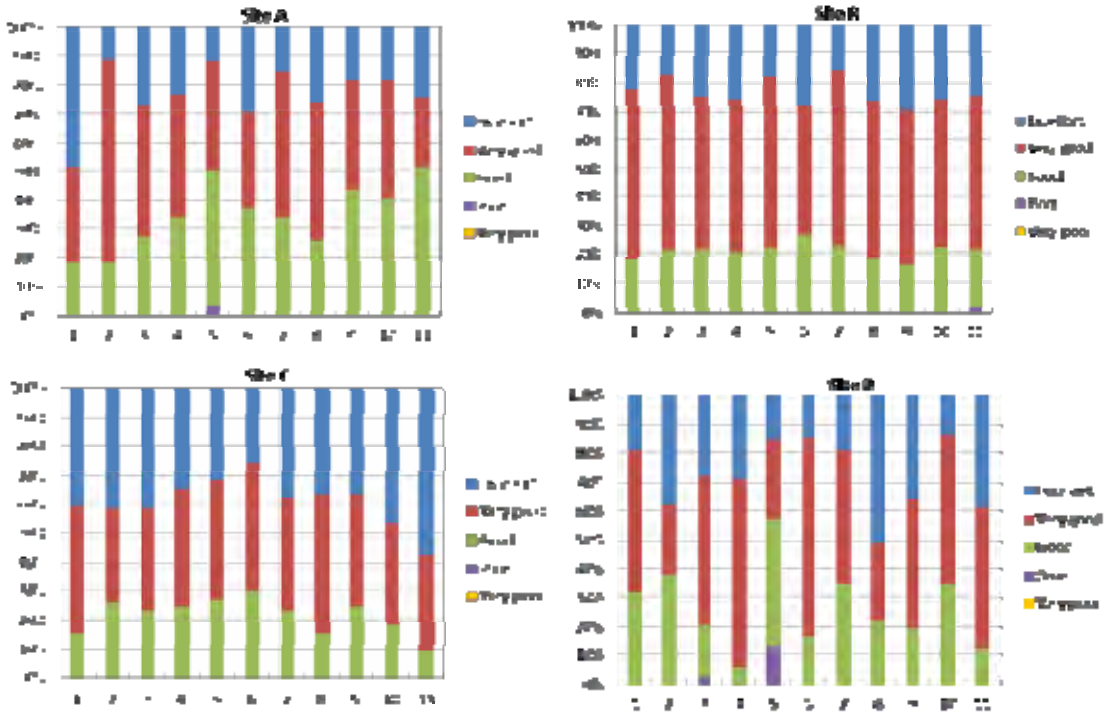
Out of all participants, 91.4% were planting pasture, 60.8% were raising beef cattle, and 15.5% were raising milking cows. Furthermore, 73.5% of the participants reported damage on their pastures in the 2011 flood. On average, 61.5% of the participants' pasture lands were damaged. The maximum flooding period was 120 days and the maximum water depth was 4.0m.

(2) Group Discussion on Countermeasures

During the training session, group discussions were conducted to understand the problems of pasture management and animal raising during the 2011 flood, and participants discussed flood countermeasures based on their lessons learned in the previous year. The result of the group discussions in eight sites are shown in Appendix I-B-9. The major problem with animal raising was the lack of feed. The countermeasure for it was to keep feed, such as hay and silage, in storage. Another problem was that they did not have shelter for livestock on ground higher than flood water levels. The countermeasure for it was to look for higher ground, to where animals could be moved. Some groups mentioned that they needed governmental support for constructing shelters. The major problem for pastures was that soil and crops were damaged or destroyed completely during the flood. The countermeasures for this were to stock forage seeds and fertilizers, and to have available pumps to drain water from flooded pasture land. Farmers can also use forage varieties with a higher plant height than the flood level. In addition, some groups mentioned that the government should establish an early warning system for floods so that farmers can be prepared.

(3) Evaluation of the training by participants

Halfway through the training sessions, participants evaluated various aspects of the training, such as the topics covered in the lectures, equipment, the presentations. All items were evaluated on a five point scale from excellent to very poor. The results are shown in Figure 2.7.1. The participants mostly gave high ratings, which appear consistent between all four sites where the evaluations were conducted.



Key: The area rated and the corresponding number on the graph.
1. Overall content and quality of the training material
2. Overall content of the presentations
3. Overall explanation by the lecturers
4. Content and quality of the module “Pasture development and fodder needs for ruminant production in Thailand”
5. Content and quality of the module “Breeding, selection, and management of beef cattle for small farm holders”

6. Content and quality of the module "Pasture establishment and management"
7. Content and quality of the module "Intensive pasture production, paddy pasture production, backyard pasture production, fodder preservation, hay making and silage making"
8. Content and quality of the module "Practice on pasture establishment, management and utilization "
9. Content and quality of the module "Animal health and health care during flood and drought situations "
10. Content and quality of the module "Prevention, countermeasures and disaster risk management"

Figure 2.7.1 Results of Evaluation at four Training Sites

As shown in Appendix I-B-10, most of participants mentioned that this kind of training is required at least once a year and if possible more often. Another important point raised by the farmers was that they needed much more urea than compound fertilizer.

2.8. Recommendations

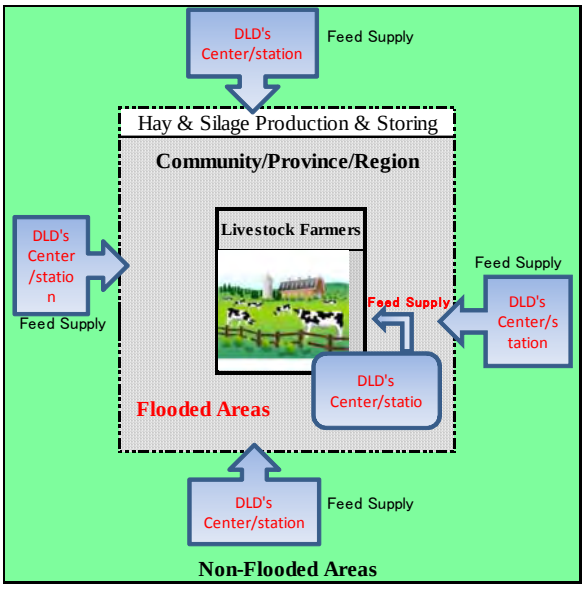
(1) Strengthening Forage Production and Storing at Community Level

It was confirmed through the monitoring survey conducted in 2012 in the Component-1 that the most serious issue on livestock sub-sector during and after the flooding in 2011 was shortage in animal feed. Any kind of livestock need to have feed every day to maintain their body and to produce animal products such as meat and milk.

As to forage production, it will be necessary to promote cultivation of Pangola grass and Pakchong-1 (Giant Napier grass) containing higher nutrition values in order to cope with likely flood disaster. DLD recommends Pangola grass for low land and Pakchong-1 for upland respectively increase livestock productivity and to secure feed storing. It is known that the profitability of Pangola grass per rai (1,600m^2) is higher than that of paddy, and farmers also recognize this. Pangola grass is able to increase its yield by proper fertilizing (basal and top dressing), cutting and irrigation (much better if a water source is available) and surplus production can be sold by THB 100 per bale because of high demand for it for cattle, horses, rabbits and elephants etc. For Pakchong-1, silage can be sold at THB 54 per 20 kg bag. Taking into consideration the probability of future flooding, it is recommended to make hay bales and silage to store before the flood occurs.

(2) The Role of ANRDCs under DLD

In the 2011 flood disaster, ANRDCs (so called DLD center) deployed in 29 provinces in the country supported livestock farmers by distributing stored hay bales in their storages. Considering the number of livestock, magnitude of flooding areas and also flooding period, huge amount of forage has to be stored not only in ANRDC level but also in community and individual livestock farmers targeting mainly cattle and goats/sheep. Especially feed storing at a community level is considered to be weak because livestock farmers have not so serious flood damage as the 2011 flood in the past.



Feed supply system in the time of emergency should consider at national level so that the non-flooded areas can support the flooded areas in supplying stored feed (refer to the Figure).

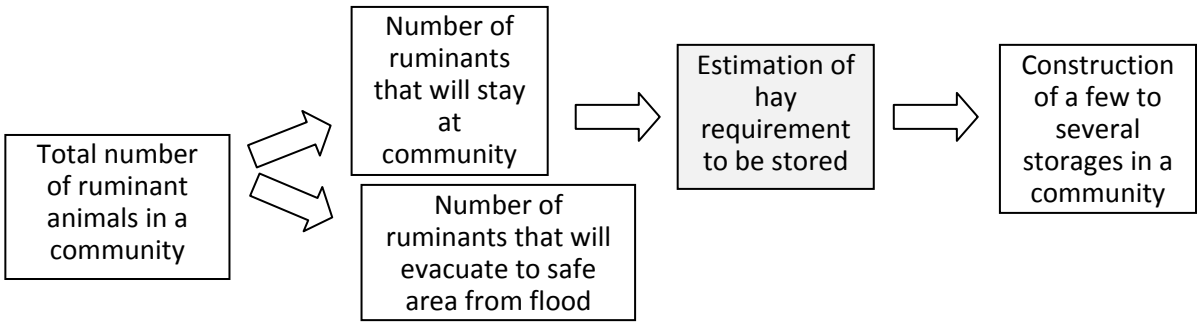
According to the above mentioned concept, JICA's Componenet-1 Team proposes strengthening feed production and storing in the DLD level, Community level and individual farmer level respectively, and implemented proposed pilot projects in the selected areas of Tambon Wang Man in Chainat province and Tambon Singhanat in Ayutthaya province. To be more precise, JICA Team provided livestock farmer in the two sites with 2-wheel mowers, grass choppers and constructed feed storages to strengthen feed production and storing as a model at community level. For the ANRDC (Animal Nutrition and Research Development Center) under DLD in Chainat, JICA Team provided two local-made balers and constructed two silage storages at the Sub-Center under ANRDC as a model at DLD level.

(3) Planning Feed Storing

1) Identification of the Flooding Area and Non-Flooding Area based on Simulation Study

In order to realize the national-level feed supplying system in a time of disaster, identification of the flooding area is necessary as the first step based on simulation analysis on map. By doing so, all the 77 provinces, districts and sub-districts (Tambons) of the country can be divided into two categories, flooding area and non-flooding area on maps.

At each community level where the area may be affected by flood, mapping by people/farmers under control of TAO will be necessary to identify: 1) location of livestock farmers by animal type, 2) livestock farmers who will not be affected by flood, 3) the higher areas being not affected by flood in the community etc.



2) Procedure to Estimate Feed Requirement during Flood

In the area of a Tambon community predicted as a flood area based on the simulation analysis, following will be necessary to estimate number of livestock, mainly cattle and goats/sheep to be fed feed during and after flooding:

- Number of livestock and livestock farmers who will evacuate to adjacent areas/provinces located at non-flooded areas/provinces when flood comes,
- Number of livestock farmers who will stay at community because they can feed even in flooding period relying on stored feed,
- Number of cattle and goats/sheep that stay at community even in flooding period, which will be the targeted number of cattle and goats/sheep of supplying feed in a disaster,

Then, after identifying the number of targeted livestock, those number should be converted into the Livestock Unit (LU) to estimated volume of feed to be stored at each community. LU in Thailand is as follows:

Livestock	Livestock Unit (LU)	LU (FAO)
Cattle	1.00	0.65
Buffalo	1.00	0.70
Goat/sheep	0.15	0.10
Pig	0.38	0.25
Poultry	0.02	0.01

LU which will stay in a community even in a disaster can be calculated as below, and cattle, buffalo and sheep/goat shall be the target of feeding stored feed in a disaster according to their digestion system:

Livestock	No. of Livestock to stay in a community (1)	LU (2)	LU=(1)x(2)
Cattle		1.00	
Buffalo		1.00	
Goat/sheep		0.15	
Total	-	-	***A***

3) Estimation of Feed Requirement to be Stored at Community Level

Generally a cattle equivalent to one LU requires 12to 15 kg hay per day:

Items	LU=a Cattle
Assumption of body weight(kg/head)	500
Feed requirement per body weight in fresh (%)	12%
Feed requirement in fresh (kg/head/day)	60
Feed requirement in hay (kg/head/day)on average *	13.5

Based on the estimated number of LU in 4.3, hay requirement can be calculated as shown in the table below.

Estimated LU	Hay Requirement per LU (kg/LU/day)	Hay Requirement per Day B=Ax13.5	Flood Period (days) *	Hay to be Stored (ton) D=BxC/1000
A	13.5	***B***	***C***	***D***

Note: *: Flooding period shall be predicted based on lesson in 2011 or simulation analysis

4) Estimation of Hay Storage

The floor area of storage as a model for 100 LU (livestock unit) can be calculated as shown below:

Conditions	Assumption
Body weight of a cattle (1 LU)	500 kg
Intake of hay per day	13.5 kg/day/LU
Flood period	60 days (to be varied depending on areas
Number of cattle (LU)	100 LU (100 cattle)
Requirement of hay	81.0 tons
Cubic volume of hay per ton	3.9 m^3/ton
Estimated cubic volume of hay	315.9 m^3
Height of hay bale's heap	4.0m
Required floor area	79.1 m^2 (8.9x8.9 for example)

Considering the influence of flooding area, it is recommendable to construct a few to several storages scattered at the selected higher places found in a community, not in one place, which will contribute to effective and convenient transportation of stored hay bales when disaster comes into a community.

(4) Monitoring Hay Storage by the DLD HQ

DLD HQ is required to monitor status of feed storing at 29 ANRDCs in the country every month. There are 116 feed storages though the size is varied. The total storage capacity is about 100,000 m3 which is able to cover the consumption of 190,000 cows feed per day. Out of 29 ANRDCs, 28 have 1 to 7 storages with the size of 10mx20m. The Suphanburi ANRDC has 2 storages of 10mx28m size. To cope with possible flood in the foreseeable future, the role of 29 ANRDCs in a time of disaster are very important as performed in the 2011 flood because they are big producer of forage/hay with large capacity of storing (refer to the picture of a storage of ANRDC in Lampang). As well as monitoring hay storage, DLD HQ is also required to study effective transportation system of hay at the national level prior to a disaster.

The existing storing capacity of hay storages in the 29 ANRDCs in the country is as follows:

Items	Hay Storage		
	10m x 20m size	10m x 28m size	Total
Hay storage (places)*	92	24	116
Estimated capacity of storing (m^3) **	73,600	26,880	100,480

Source: *:DLD HQ
Note:**: calculated by JICA Team assuming at 4.0m for height of hay

(5) Further Capacity Building of Livestock Farmers

It is the most important things to keep livestock healthy and productive even in a disaster such as flood and drought because livestock farmers have to live on animals as an income source. People are required to have common view that they need to cope with large scale flood though it may take place or may not take place. However, in fact, they are not so aware of importance of feed storing, animal health, feeding to meet nutrient requirement not only in a peacetime but also in flood and after flood. As JICA Team trained livestock farmers in the eight sites and two model areas, trainings covering various matters on livestock management will be necessary in every area of the country. By doing so, livestock farmers, especially small scale farmers who have not enough capital and knowledge, will be strengthened, resulting to realize stable production of animal products and stable livelihood of them. The DLD HQ has enough experience for this purpose and should have initiative in this field.

(6) Necessity for Improvement of Agricultural Machinery of ANRDCs

The role of ANRDCs in a time of disaster is very important to support affected livestock farmers who are in shortage of animal feed. However, the condition of existing machinery for forage production and hay making in 29 center/station has deteriorated and in addition the number of their units is inadequate to cope with the emergent supply of hay/silage in a time of emergency (refer to the Table 2.8.1). It will be most ideal to improve and enrich machinery

necessary for forage production at the 29 centers/stations in the whole country. By doing so, forage production will be able to coordinate the supplementation between affected and unaffected centers/stations as illustrated in the paragraph 2.8.2.

Table 2.8.1 Existing Agricultural Machinery and Feed Storage in 29 ANRDCs

Center/Station		Tractor		Attachment											Hay Storage		Seed Incubator
		below 50HP	Above 50HP	Disc Plough	Trailer	Hay Spreader	Hay Raker	Disc Mower	Forage Harvestor	Drum Mower	Sickel Mower	Rope Hay Baler	Wire Hay Baler	Rotary Hoe	Hay Storage (10x20m)	Hay Storage (10x28m)	
1	Chainat	6	1	2	1	3	2	4			1	3			6		5
2	Suphanburi	2	1	1	2		2		1	3	1	2				2	2
3	Sakaeo	3		1	1	1	1		1	1	2	1	1	1	2	1	2
4	Nakhonratchasima	6		1	2	2	2	4	2	2	4		3	3	7		6
5	Roi Et	3		1	1	1	1	2	1	1	1	1	1	1	5		5
6	Yasothon	3		1				1			1	1	1		2	2	3
7	Buriram	3		1	1		1	1	1		1	2		1	4	1	4
8	Khonkaen	3	1	1	1	1		1	1	1	2	2		2	3	1	2
9	Mahasarakham	3		1	1	1	1		2	3	2	4		1	2	1	6
10	Udonthani	4			1	1	1	3	2	1	1	1	2	1	6	1	1
11	Kalasin	2									1	1			2	1	2
12	Nakhonphanom	2		1		1	1		1	1	1	1			3		3
13	Sakonnakhon	3			1		1	1	1	1		2		1	4		1
14	Nongkhai	2					1	1	1		1	1	1	1	4		1
15	Loei	3				1	1	1	1		1		1		5	1	3
16	Mukdahan	2			1			1				1			1	1	3
17	Lampang	3			1	1	1	2	1		1	3	1	1	3	1	3
18	Phrae	3		1		1	1	1	1	1	1	2			2	1	3
19	Phetchabun	3			1		1	1	1	1	1	1		1	3	1	4
20	Sukhothai	4		1	1	1	2		1	1	2	1	3	1	3	1	1
21	Phichit	2		1		1	1	1			1	2		1	1	1	2
22	Petchaburi	5	1	1	1	1	2	2			2	2	1		6		2
23	Prachuapkhirikhan	3			1	1	1		1	1	1	1	1		3	1	1
24	Chumpon	4			1		1	1	2	1	1	1	1	1	3	1	2
25	Suratthani	5			2	1		1	2	1	1	3	1		1	1	2
26	Narathiwat	2			1			2			2	1			2	1	5
27	Trang	4				1		3	2		2	2		1	2	1	3
28	Satun	3		1	1				1				1	1	5	1	3
29	Phatthalung	2		1	1		1	1	1		1	1		1	2	1	1
Total		93	4	17	24	20	26	35	28	20	36	43	19	20	92	24	81

Source: DLD

(7) Linkages with Component 3

1) Model Areas

The two following sites were selected for conducting livestock-related projects in the model areas selected for Component 3.

Province	District	Tambon	
		Name	Characteristics
1. Chainat	Wat Sing	Wang Man	1,066 households. Rain-fed, elevated area adjacent to irrigated area. Cattle are mainly raised by 103 farmer households (10% of total households)
2. Phra Nakhon Si Ayutthaya	Lat Bua Luang	Singhanat	974 households. 80% Buddhist and 20% Muslim. Cattle (70%) and goats (30%) are raised

2) Planning for Livestock Related-Pilot Projects

- Preparation of a community map using participatory approaches assuming a sudden evacuation of livestock and people: Information should be included in the map such as the distribution of livestock, location of elevated areas, evacuation routes, order of evacuation (priority to large-scale livestock farmers), location of feed, etc.
- Survey about the nearest places for evacuation of livestock in a time of emergency and preparing an agreement with those communities.
- Increase of forage production: Pakchong-1 and sweet sorghum on upland, Pangola grass on lower land using existing water sources such as farm ponds for irrigation.
- Hay/silage storage: Making hay, silage, and Urea Molasses Mineral Blocks (UMMB).
- Improving goat raising in Muslim communities.
    i) Provision of bucks to improve the productivity of existing goats.
    ii) Construction of goat houses with elevated floors considering flood water levels, goat behavior and their health.
    iii) Goat milk processing and marketing: Introduction of milk type goats, processing of cheese, yoghurt, ice cream, soap etc.

3) Training of farmers on pasture management, forage production, livestock management during and after flooding, animal health, livestock selection, etc.

4) Provision of hay making equipment and hay/silage storage: Grass cutter, hay baler, grass chopper, plastic bags for silage making, vacuum blower, hay fork, hay/silage storage etc.

5) Biogas fuel using cow/cattle dung.

CHAPTER 3. COMPONENT 2: REHABILITATION AND REINFORCEMENT OF IRRIGATION FACILITIES

3.1. Background

This chapter explains all activities and results carried out between April and October 2012 as well as conclusions and recommendations under Component 2 of this JICA Project for the rehabilitation and reinforcement of irrigation facilities in the agriculture sector.

In the original plan, Component 2 mainly focused on: 1) flood recovery and prevention works implemented by RID, 2) flood recovery of Japan-assisted facilities in past projects, and 3) technical advice and assistance on rehabilitation and improvement works for irrigation facilities through the implementation of the pilot project. However, as the implementation of pilot project was canceled after selection, the third task was not fully attained.

RID is the main agency involved in planning, design, construction, operation and maintenance on water resources management project in Thailand. Total irrigated area in 2010 was 29.3 million rai (=4.7 million ha) against irrigation potential area of 60.3 million rai (=9.6 million ha) according to RID. Of 29.3 million rai, 24.2 million rai (=3.9 million ha) are for the large and medium scale irrigation systems under O&M of RID, while 5.1 million rai (=0.8 million ha) are for small scale irrigation system including pumping irrigation under O&M of TAOs and farmer groups. Number of irrigation systems under O&M of RID in whole country is 86 for large scale (more than 80,000 rai) and 731 for medium scale (less than 80,000 rai) as of 2010.

3.2. Flood Damage, Recovery and Prevention Works on Irrigation and Drainage Facilities operated by RID

3.2.1. Flood Damage on Irrigation and Drainage Facilities

According to the World Bank assessment report (December 2011) regarding the 2011 flood damage, over 11% of the present irrigation and drainage areas were damaged. The total damage to the flood control, drainage and irrigation infrastructure under RID was estimated at 7.72 billion baht (about 260 million USD), which does not include damage to the on-farm irrigation and drainage facilities nor damage and losses of agriculture, livestock and fishery productive sub-sector.

Damages by the 2011 flood on irrigation and drainage facilities were very severe for those parts related to social, commercial and industrial infrastructure in rural and urban areas. Major facilities damaged were river / canal banks and slopes as eroded and collapsed due to overtopping of flood water, village roads and bridges as collapses and washed away due to erosion, canals / reservoirs / ponds as heavily silted due to flood water, drainage regulating gates at rivers and canals as damaged and collapsed due to flood water pressure and overtopping. For the recovery of those damages, an emergency recovery budget apart from the regular RID annual budget was created and then those projects assessed emergency with priority have been implemented.

On the other hand, flood damage on irrigation and drainage facilities related to agricultural production in the agriculture sector is observed in various structures such as canal embankment, distribution structures and regulating gates in main and lateral canals, road crossing culverts and siphons, canal bridges, tail end outlets canals and on-farm facilities. For repair and rehabilitation of such structures, RID O&M Projects and Regional Irrigation Offices carried out investigation, planning and

design. Those projects are being implemented as a routine O&M activity within RID O&M budget under the 6-year Medium-Term Expenditure Framework (MTEF). Among such repairs, in case of small and urgent works, they were executed immediately after the floods by O&M Project offices.

3.2.2. Emergency Flood Recovery and Prevention Works on Irrigation and Drainage Facilities

As explained in the previous section, flood damage was severe to social-related functions of irrigation and drainage facilities. Therefore, recovery and prevention works being implemented as emergency countermeasures also focus on these functions. In other words, current recovery projects focus on the social, commercial and industrial purposes of irrigation and drainage facilities, but not necessarily on agricultural needs such as recovery of crop production.

Figure 3.2.1 and Table 3.2.1 show the number of projects on flood recovery and prevention by facility type being implemented by RID. Regarding the number of projects by type, the most common are repair, reconstruction or heightening of river banks and canal dikes, which make up 47% of the 1,283 projects in the study area, followed by repair of drainage regulators (25%), repair or reconstruction of roads and bridges (11%), dredging of rivers and canals (7%) and distribution of pumps and generators (5%). From this, it can be seen that social-related projects account for 95% of the total projects. Most projects are planned to be completed by October 2012 before the start of the rainy, flood season.

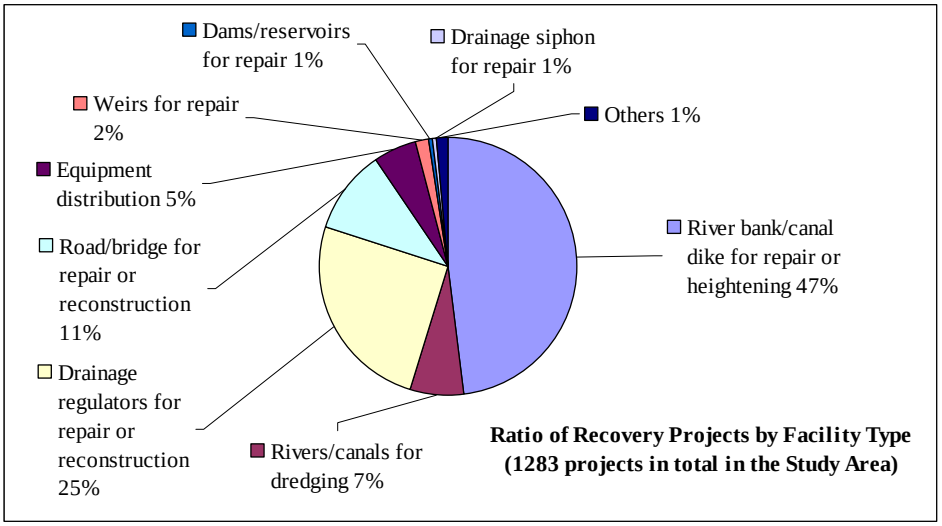


Figure 3.2.1 RID's Flood Recovery and Prevention Projects by Facility Type

Table 3.2.1 RID's Flood Recovery and Prevention Projects by Facility Type

No.	Structural category	Number of projects								
		Batch -1	Batch -2	Batch -3	Emergency	Additional -1	Additional -2	Additional -3	**Total**	
									projects	**%**
1	River banks / canal dikes for repair, reconstruction or heightening	39	364	151	41	15	3	2	**615**	**48%**
2	Rivers / drains / canals for dredging	7	8	3	39	30	0	0	**87**	**7%**
3	Drainage regulators / gates for repair or reconstruction	16	172	88	22	25	2	1	**326**	**25%**
4	Roads / bridges / culverts for repair or reconstruction	20	73	40	0	2	0	0	**135**	**11%**
5	Mechanical / electrical equipment such as pumps, generators, etc. for distibution	0	4	2	39	18	2	0	**65**	**5%**
6	River weirs for repair	6	16	0	0	0	0	0	**22**	**2%**
7	Dams / reservoirs for repair or construction	2	3	1	0	0	2	0	**8**	**1%**
8	Drainage siphons for repair	0	6	1	0	0	0	0	**7**	**1%**
9	Others	4	9	3	2	0	0	0	**18**	**1%**
	Total	**94**	**655**	**289**	**143**	**90**	**9**	**3**	**1,283**	**100%**

Note 1: Projects only in the Study Area (RID regional irrigation offices 3, 4, 10 ,11 ,12 and 13) are counted.

Current projects being implemented by RID for flood recovery and prevention are categorized into several groups depending on planning initiatives and budget approval processes. The total number of projects approved was 2,236 projects (about for 12 billion baht) nationwide as of August 2012. The project team conducted the field observation and confirmed their construction work and construction drawings at the sites. They had been implemented according to the drawings and observed in good progress with the commendable efforts of RID as summarized in Table 3.2.2. Construction drawings for typical prevention works and structures are presented in the Appendix I-C-1.

2012/8/9, Reconstruction of Chao Phraya River bank along national road 304 in Chainat Province

2012/5/20, Reconstruction of drainage regulator and river bank connected to Tha Chin River in Suphan Buri Province

i) Batch-1 (555 sites in the country)

This project group was the first one approved with budget and covers the entire country. About 40% of the projects in this group are located in the middle and lower Chao Phraya River basin. Projects are mostly small repair and rehabilitation works with the 2011/12 budget to prevent flood disasters in the 2012 wet season and are presently nearly completed. Overall work progress was 96.5% as of September 2012.

Table 3.2.2 Progress of RID Rehabilitation Projects for Flood Recovery (September 24, 2012)

Project category	Unit	Chaophraya river basin area			Other areas in the country	Total	Remark
		Upper basin	Middle basin	Lower basin			
1. Total of Batch-1 to 3 & Emergency-SCWRM							
1) No. of sites	site	302	325	903	590	2120	
2) Budget approved	million baht	681.71	1,559.13	6,351.62	2,571.60	11,164.06	
	(million yen)	(1,840.61)	(4,209.66)	(17,149.37)	(6,943.32)	(30,142.95)	
3) Disbursement status	%	98.69%	87.32%	82.14%	75.27%	82.32%	
1-1. Batch-1							For small repair but most urgent with completion target of August 2012
1) No. of sites	site	167	45	69	274	555	
2) Budget approved	million baht	307.91	105.79	69.26	635.98	1,118.94	
	(million yen)	(831.36)	(285.63)	(187.00)	(1,717.15)	(3,021.14)	
3) Disbursement status	%	99.50%	68.97%	99.39%	99.32%	96.51%	
1-2. Batch-2							For small repair but most urgent with completion target of October 2012
1) No. of sites	site	74	212	483	186	955	
2) Budget approved	million baht	203.40	657.86	1,421.08	422.82	2,705.16	
	(million yen)	(549.18)	(1,776.22)	(3,836.92)	(1,141.61)	(7,303.93)	
3) Disbursement status	%	98.86%	98.00%	97.23%	99.08%	97.83%	
1-3. Batch-3							For small repair but most urgent with completion target of October 2012
1) No. of sites	site	60	48	248	125	481	
2) Budget approved	million baht	138.86	165.00	784.44	378.67	1,466.98	
	(million yen)	(374.93)	(445.51)	(2,117.98)	(1,022.42)	(3,960.84)	
3) Disbursement status	%	99.88%	98.94%	91.83%	96.44%	94.58%	
1-4. Emergency-SCWRM							For big repair programmed by SCWRM. 2 years implementation - 2011/12 and 2012/13 budget.
1) No. of sites	site	1	20	103	5	129	
2) Budget approved	million baht	31.53	630.48	4,076.84	1,134.13	5,872.98	
	(million yen)	(85.14)	(1,702.29)	(11,007.47)	(3,062.14)	(15,857.04)	
3) Disbursement status	%	84.47%	76.22%	74.73%	45.85%	69.36%	
2. Additional sites No.1							Approved on May 15, 2012 with focus on urban area to protect from flood in 2012. Completion target is October 2012
1) No. of sites	site	0	0	116	0	116	
2) Budget approved	million baht			1,051.04		1,051.04	
	(million yen)			(2,837.80)		(2,837.80)	
3) Disbursement status	%			14.92%		14.92%	
3. Additional sites No.2							Under approval process. This includes 2 dam projects in Chiang Mai & Nakhon Sawan. Budget is up to year 2019.
1) No. of sites	site	2	3	6	0	11	
2) Budget approved	million baht	17,635.00	13,635.45	1,045.00		32,315.45	
	(million yen)	(47,614.50)	(36,815.70)	(2,821.50)		(87,251.70)	
3) Disbursement status	%					N.A	
4. Additional sites No.3							Under approval process. This is to supplement the Emergency-SCWRM listed above.
1) No. of sites	site	0	0	3	0	3	
2) Budget approved	million baht			498.92		498.92	
	(million yen)			(1,347.09)		(1,347.09)	
3) Disbursement status	%					N.A	

ii) Batch-2 (955 projects in the country)

This project group was the second one approved with budget and the area focuses on the middle and lower Chao Phraya River basin where the floods damage was most serious. As with Batch-1 above, projects are mostly small repair and rehabilitation works and are also being implemented rapidly with the 2011/12 budget to prevent flood disasters in 2012. Overall work progress was

97.8% as of September 2012.

iii) Batch-3 (481 projects in the country)

Similar to Batch-1 and Batch-2 above, projects in this group are also mostly small repair and rehabilitation works and were implemented with 2011/12 budget to ensure completion before the 2012 flood season. The area particularly focuses on the lower Chao Phraya River basin where flood damage was the worst in the 2011 flood. Overall work progress was 94.6% as of September 2012.

iv) Emergency - SCWRM (129 projects in the country)

In contrast to Batches-1-3 above, this project group is for big rehabilitation works programmed by the Strategic Committee for Water Resources Management (SCWRM). They are presently implemented under a two-year implementation plan with 2011/12 and 2012/13 budgets. Construction of the concrete wall along the Chinat- Pasak canal is included in this group. These projects are located in the lower Chao Phraya River basin. Overall work progress was 69.4% as of September 2012.

	
2012/8/9, Concrete wall (H=1.0m) constructed along Chainat – Pasak Canal. Bank crest revel is heightened by 0.6m.	2012/5/16, Driving concrete piles for the construction of concrete flood walls at C-22 irrigation canal, branch of Chainat – Pasak Canal

v) Additional Sites No. 1 (116 projects in the country)

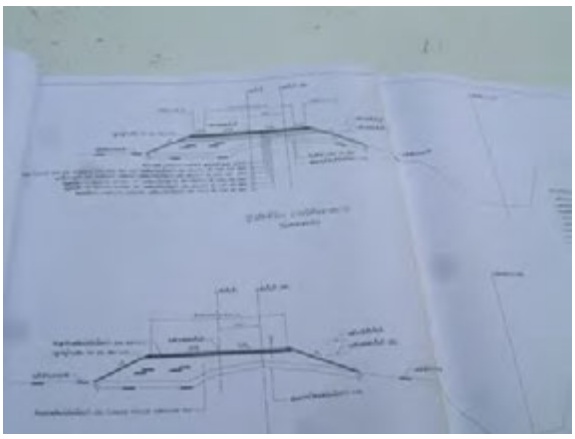
This group was programmed late, and was approved in May 2012, with particular focus on urban areas in the lower Chao Phraya River basin to protect them from flood disasters in 2012. Completion target of this group was October 2012. Overall work progress was 14.9% as of September 2012.

vi) Additional Sites No. 2 (11 projects in the country)

This group is under approval process. The projects include two dam projects with an implementation schedule up to the year 2019, therefore a relatively large budget is proposed. The two dams are Mae Kung Udom Tara Dam (existing) in Chiang Mai and Mae Wong Dam (new) in Nakhon Sawan Province.

vii) Additional Sites No. 3 (3 projects in the country)

This group was proposed in late May 2012 to supplement the Emergency–SCWRM group listed above. Therefore, the project scale is quite small.

	
2012/5/17, Construction drawing for rehabilitation of irrigation canal dike in Lop Buri Province	2012/5/17, Observing river/canal network map under Khok Ka Teim O&M Project in Region 10, Lop Buri Province

3.2.3. MTEF Plan and Emergency Recovery and Prevention Works

RID annually formulates the Medium-Term Expenditure Framework (MTEF) plan as a 6-year expenditure proposal for all RID projects/works for the operation, maintenance and improvement of irrigation systems and integrated water resources management. The MTEF is divided into four categories as follows:

C-1: Improvement and management of irrigation system for existing O&M projects,

C-2: Development of water resources and increase of irrigation areas through new medium scale irrigation projects, water resources and small scale irrigation projects,

C-3: Water hazard prevention and mitigation through dam improvement, monkey cheeks and drainage systems.

C-4: Construction of large scale projects for dams, reservoirs, river basin development, drainage system and others.

Table 3.2.3 gives the number of projects/works, as 3,521 projects in total, under the MTEF plan for the year 2012 – 2017 for six RID regions in the middle and lower Chao Phraya River basin in the study area by project category. RID's budget for 2013 is about 35.5 billion baht, and category C-1 (1,180 projects) and C-2 (1,400 projects) each are allocated about 36% of the budget.

In the case of the 2011 flood, however, the special emergency budget was appropriated for recovery and prevention of the flood damage, separate from the MTEF. The emergency budget projects were categorized into several groups such as Batch-1, Batch-2 and Batch-3 as described above.

Table 3.2.3 Number of Projects in MTEF Plan 2012-2017 by Category

Category of projects		RIO-3	RIO-4	RIO-10	RIO-11	RIO-12	RIO-13	Total
C-1	Improvement and management of existing O&M Project	275	38	234	92	280	261	**1180**
	(1) Improvement of whole system	106	0	25	42	5	0	178
	(2) Repair of selected facilities	169	38	209	50	275	261	1002
C-2	Development of water resources and increase of irrigation areas	332	321	212	9	168	358	**1400**
	(1) Medium scale construction projects	34	45	36	0	20	35	170
	(2) Small scale construction projects	298	276	176	9	148	323	1230
C-3	Water hazard prevention and mitigation	214	117	163	136	205	105	**940**
C-4	Large scale projects	0	0	1	0	0	0	**1**
Total		**821**	**476**	**610**	**237**	**653**	**724**	**3521**

MTEF: Medium Term Expenditure Framework RIO: Regional Irrigation Office
Source: RID

3.3. Confirmation of Flood Damage and Recovery of Projects Assisted by Japan in the Past

A number of aid projects assisted by Japan have been implemented during the past several decades. Among these, projects located in the area affected by the Chao Phraya River flood were selected and the flood damages were studied to identify suitable rehabilitation pilot projects for this Project. The candidate projects are listed in the following table. (Refer to Figure3.3.1 for the location)

Table 3.3.1 Projects Implemented through the Assistance of Japanese Funding Agencies

Projects Implemented by the Assistance of Japanese Funding Agency

No.	Name of Project	Location Changwat	Asisting agecy of Japan side	Executing agency of Thai side	Fund	Date of commencement	Date of completion
1	Chao Phrya Irrigation Project	Ayuttaya	JICA/OECF	ALRO	Loan	1980/5	1985/3
2	Pasak Irrigation Project (Kaeng Khoi-Ban Mo Pumping Irrigation	Saraburi	JICA/OECF	RID	Loan	1981/7	2004/1
3	Small Scale Irrigation Program (SSIP)	Phitsanulok Uttaradit Phichit Nakhon Sawan Kamphaeng Phet Sukhothai Lopburi Phechabun Saraburi Nonthaburi Chinat Uthai Thani Suphanburi	OECF	RID	Loan	1978/1	1989/1
	Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP)					1998/4	2003/4
4	Large Swamp Inland Fishery Project (LSIFP)	Nakhon Sawan	OECF	DOF	Loan	1985/5	1993/9
5	Small Swamp Inland Fishery Project (SSIFP)	Phitsanulok Phechabun Phichit Nakhon Sawan Kamphaeng Phet Sukhothai	OECF	DOF	Loan	1982/6	1988/1

Figure 3.3.1 Location Map of Projects Assisted by Japan

3.3.1. Chao Phraya Irrigation Project by the Agricultural Land Reform Office (ALRO)

(1) Project Area

The project area of about 12,620 ha is located in Lad Bua Luang District (A*mphoe*), Ayutthaya Province (*Changwat*), 70 km north of Bangkok, and lies on the right side of the Chao Phraya River. The topography of the project area is very flat with an average slope of about 1/20,000 from the northwest to the southeast. The elevation ranges from 1.75 m to 2.25 m above mean sea level. The average annual rainfall is 1,300 mm. The main crop is paddy for wet and dry seasons (2 times a year). The average flood water level was 2.60 m during the flood in September – December, and the maximum flood water level before the project was 3.10 m, which was recorded in 1975.

(2) Project History

JICA carried out the feasibility study for "the Irrigated Agricultural Development Project in the West Bank Tract of the Greater Chao Phraya" during October 1976 – May 1977. The detailed design was completed in February 1982 and the Government of Thailand secured the project implementation with OECF loan of the total amount of 2,650 million yen in July 1982. The project was completed in 1988.

(3) Project Facilities

The total gross area of 12,620 ha is divided into 10 Farm Blocks and these Farm Blocks are protected by 6 polder dikes with an embankment crest elevation of 3.5 m above mean sea level, i.e. an average height of about 1.5 m from the ground surface. The crest width of the dike is mostly 4 m. However, dikes used as provincial roads have 8 m wide. The pumping stations were constructed with 2 sets of pumps with a diameter of 700 mm and total head of 4 m and capacity of 36 m^3/min in each Farm Block 1 – 10.

(4) 2011 Flood Damage

Since the completion of the project in 1988, the project area had been protected by polder dikes with crest elevation of 3.5 m above mean sea level. The flood water level exceeded the crest level of the polder dike by 50 cm for the first time in 2006. However, the farmlands were protected from inundation in Farm Blocks 1 – 4, because the polder dikes were temporarily raised by 50 cm. These temporary dikes were later removed because the dikes were used as rural roads and temporary embankments were an obstacle for smooth traffic.

In the 2011 flood, the water level went up as high as 5 m above mean sea level, which is 1.5 m higher than the polder dikes. Again, temporary dikes were constructed in Farm Blocks 1 – 4. The farmlands in these blocks were protected and paddy rice was harvested successfully. The flood continued for about 2 months from November to December and the paddy rice in Farm Blocks 5 – 10 were completely damaged. The damage to the irrigation facilities was not serious.

The pumping stations had no direct damage from the flood. Major damages were erosion and sliding of the slope of the dikes. Although there were serious damages on the agriculture crop (paddy) especially in Blocks 5-10, and sliding of the embankment slope of the canals was seen in some places, no critical damage to the major irrigation facilities were reported.

	
2011/10/23, Temporary dikes were constructed to raise the crest of the 1-4 farm block	2011/10/27, The farm block 5-10 were totally inundated because of no temporary dikes

3.3.2. Pasak Irrigation Project by RID (Kaeng Khoi-Ban Mo Pumping Irrigation Project)

(1) Project Area

The project area extends across two districts, District Kaeng Khoi and District Ban Mo, in Sara Buri Province. The area is located on the right bank of the Pasak River and the left bank of the Chainat-Pasak Canal. The soil and the topography are suitable for paddy cultivation. However, due to the higher elevation of the land, the area cannot be irrigated by gravity flow from either the Pasak river or the Chainat-Pasak Canal.

(2) Project History

RID proposed the Pumping Irrigation Scheme and requested JICA to conduct the feasibility study through the technical cooperation program. The feasibility study of the project was completed in 1981 followed by a detailed design carried out under E/S loan from OECF in 1985. Due to the social and economic situation prevailing in the country in the subsequent period, the proposed project could not be implemented for a long time.

In 1994, RID decided to apply for a project loan from OECF in order to speed up implementation of the project. The loan amount of 3,038 million yen was approved and agreed between RID and OECF. The detailed design was carried out in 1998 and 1999. The construction work was started in 2001 and was completed in 2005.

(3) Project Facilities

The project facilities are as follows;

a. Pumping Station
   6 unit + 1 spare, 2.44 m^3/sec/unit Total Max. Capacity 17.08 m^3/sec

b. Irrigation Canal System
   1 Main canal of 34.145 km
   11 Lateral canals and 19 Sub-lateral canals of 104.885 km
   Irrigation structures along the canal 834 units

c. Drainage Canal System
   14 Drainage canals of 83.409 km
   Control unit of 159 units

d. Irrigation Area
Construction stage 86,700 rai
After a change in land use due to the expansion of community, economy, and manufacturing enterprise;
At present 67,356 rai

(4) 2011 Flood Damage

The pumping station is located at the right bank of Pasak River. However, the maximum water level of the Pasak River in 2011 did not reach the floor level of the pumping house. The 2011 flood did not cause any damage to the pumping station. As the project area is located in a rather elevated area, no damages were caused to the irrigation canals and drainage canals. The low lying area of 1,000 rai was affected by inundation caused by hillside runoff and the backwater of the Pasak River when the Rama VI barrage gates were closed. This phenomenon is very common.

3.3.3. Small Scale Irrigation Program (SSIP) and Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP) by RID

(1) Project History

The objective of the SSIP was to provide water sources for irrigation and domestic use to those areas where the people lacked access to a water source. The project has constructed reservoirs, weirs and head regulators and no water distribution canals were incorporated. SSIP was implemented by the OECF yen loan of 6 stages from Stage I to Stage VI in 1977 to 1985.The project has constructed more than 4,000 facilities in these areas remote from water sources especially in the Northeastern Region 50%, in the Northern Region 20%, and 10% each in the Central, Eastern and Southern Regions.

Approximately 30 years have passed since the completion of the project facilities. The documents concerning the project have been scattered or lost in this time. The number of projects is huge and it is very difficult to grasp the present condition of every project and the effect of the 2011 Chao Phraya River flood.

Recently, RID had an opportunity to avail of a JBIC (Japan Bank for International Cooperation) yen loan to rehabilitate small scale irrigation facilities as a part of a Social Investment Project. RID has selected a number of major SSIP project facilities for SSIRP. In line with the above, RID prepared the Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP) for JBIC assistance under the Loan Agreement No. TXXIII-1.

(2) SSIRP Objectives

The objectives of Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP) are as follows;

i. To rehabilitate and improve existing small scale irrigation projects, especially those implemented by SSIP,
ii. To increase job creation and raise income for rural people, particularly to increase employment during the economic recession
iii. To extend distribution systems in existing projects of SSIP
iv. To improve the quality of life of rural people by supplying both domestic and irrigation water.

(3) Project Implementation

RID decided the implementation plan consisted of 570 sub-projects with a total budget of 1,597.702 million baht in1998 and completed in 2003

(4) 2011 Flood Damage

1) Method of SSIRP Inventory Survey

The project team conducted the inventory survey of 106 facilities in the study area which were repaired or improved under the SSIRP project. Result of Inventory survey is listed in Appendix I-C-2-5. Detail information (Such as project location or repaired period) is shown in Appendix I-C-2-6. The survey was carried out from 14th June 2011 to 31st August 2011 in cooperation with RID Bangkok Headquarters, RID Regional Office, Province Office and TAO. The degree of damage was assessed according to following category. The questionnaire used in the survey is shown in Appendix I-C-2-7.

- No damage: The facility has no or slightly damaged by 2011 flood. Repairmen for the felicities are unnecessary and can use for irrigation.
- Slightly damaged: The facility has damaged by 2011 flood and need to be repaired in prompt.
- Seriously damaged: The facility has damaged by 2011 flood and need to be repaired or new construction

2) Analysis on SSIRP Inventory Survey Result

After the SSIP project, the operation and maintenance (O&M) of almost all facilities were transferred to TAO. But some projects, such as those constructed under the King's Project or those with a large beneficiary area (more than 4,000 rai according to interview in the field), are still under RID O&M. Among the 106 facilities, 7 facilities are still under RID O&M, and for the remaining facilities O&M have been handed over to TAO. The number of damaged facilities and the extent of damage is shown in Figure 3.3.2 and Table 3.3.2. Details are given in Appendix I-C-2.

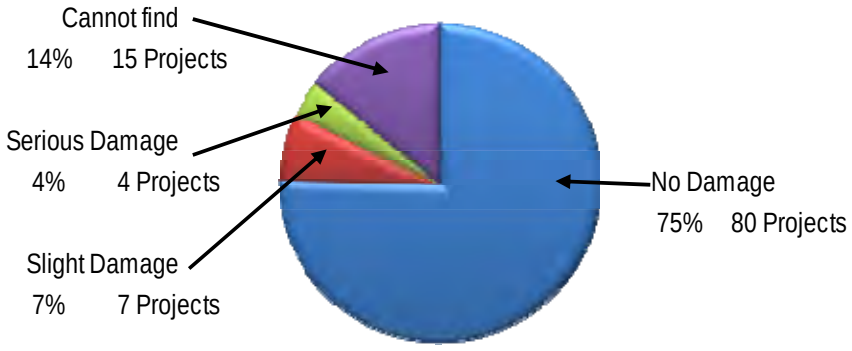


Figure 3.3.2 Rate of damaged degree by 2011 flood

Table 3.3.2 Result of SSIRP Inventory Survey by Province

Regional Office No.	Province		No. of Project	Not Damaged	Slightly Damaged	Seriously Damaged	Cannot Find
3	1	Phisanulok	14	7	6	1	
	2	Uttaradit	7	4			3
	3	Phichit	20	15	1		4
	4	Nakhon Sawan	8	8			
		Sub-total	49	34	7	1	7
4	5	KamphaengPhet	4	3		1	
	6	Sukhothai	3	3			
		Sub-total	7	6		1	

10	7	LopBuri	2	1			1
	8	Phetchabun	15	12		2	1
	9	Saraburi	11	11			
		Sub-total	28	24		2	2
11	10	Nonthaburi	1	1			
		Sub-total	1	1			
12	11	Chainat	5	4			1
	12	UthaiThani	8	5			3
	13	Suphanburi	8	6			2
		Sub-total	21	15			6
Total			106	80	7	4	15

2012/7/10, No.66, Bueng Sakae Weir at Phetchabun Province under O&M of TAO. River revetment was heavily collapsed.

2012/7/10, No.69, Bung Sam Phan Weir at Phetchabun Province under O&M of TAO. Downstream of weir body was heavily scored.

3) Current Status of Recovery for Damaged Facilities by RID or TAO

- Current status of recovery for seriously damaged facilities.

i) No10 Ban Hin Lat Reservoir (Phitsanulok Province)

RID is in charge of O&M. The facilities were already repaired (It cost 2 million baht according interviews) and they are used for irrigation.

ii) No.52 Ban Dan Yai Weir (Kamphaeng Phet Province)

RID is in charge of O&M. The RID plan was to start the survey in October 2011 to repair the facility.

iii) No.66 Bueng Sakae Weir（Phetchabun Province)

TAO is in charge of O&M. The facility is not expected to be repaired because the TAO has given priority to use the budget for repairing infrastructure such as roads.

iv) No.69 Bung Sam Phan Weir（Phetchabun Province)

This facility is also not expected to be repaired forthe same reason as iii)

- Current status of recovery for slightly damaged facilities

Water Users Group (WUG) is dredging and repairing the facilities with their own labor. When machines are required, TAO provides support.

3.3.4. Large Swamp Inland Fishery Project (LSIFP) by the Department of Fisheries (DOF) (Bung Boraped Sub-project)

(1) Project Area

In Thailand, there are 48 large swamps, of which Bung Boraped Nong, situated in Nakon Sawan (Central Thailand), is one of the largest. It has been contributing a sustainable amount of fish

production to the people residing in the area, but has also been suffering from problems such as sedimentation, accumulation of aquatic weed, illegal encroachment, over fishing, pollution, upstream development, etc. The dimension of the swamp is as follows;

- Reservoir Area at Retention WL	138.53	km^2
- Active Storage Capacity	109.9	MCM
- Effective Water Depth	1.0	m

(2) Project History

In 1985, the Thai Government decided to apply for a project loan of 2,651 million yen from OECF for the Large Swamp Inland Fisheries Project including Nong Han Sub-project and Kwan Phayao Sub-project, with the Department of Fisheries (DOF) as the executing agency. The feasibility study was conducted in 1985. Upon the completion of the feasibility study, the detailed design was started to prepare construction drawings, cost estimates, construction schedule, technical specifications and tender documents, and was completed in August 1986. The construction work was started in 1991 and completed in 1993.

(3) Project Objectives

The objectives of the project are as follows;

- To rehabilitate the swamps so that they are more suitable for increasing fish production.
- To increase the fisheries stations facilities and capabilities sufficient to serve the local need regarding aquaculture training and extension as well as supplying seeds.
- To increase the storage capacity of the swamps so that the domestic water supply, both in quality and quantity, be can assured. The surplus water can be used for irrigation through provision of distribution systems.
- To minimize flood damages to the areas along the periphery of the swamps.
- To improve or maintain quality of the swamp water at the level which is suitable for both domestic water supply and fish production by proposing proper waste treatment and sanitation facilities.

(4) Project Facilities

The major facilities constructed in the project are as follows;

- Construction and rehabilitation of weirs and gates	4	sites
- Construction of dike and dirt road	30	km
- Construction of drainage canal and dredging	13	km
- Construction of irrigation system	1,120	ha

- Construction of fishery station and procurement of laboratory equipment
- Procurement of O&M equipment

(5) 2011 Flood Damage

This swamp area was totally inundated for 3 months and a large amount of sedimentation has been left. Offices and hatchery ponds were also inundated. Buildings, facilities, laboratory equipment and O&M mechanical equipment, including dredging boats, bulldozers, backhoes and tracks, were seriously damaged. Usually, there are small floods every year in November when the Chao Phraya River water levels become high and flood water flows into the swamp. But unlike the huge flood in 2011, these small floods do not cause damage to facilities. A list of equipment and facilities damaged by the 2011 flood that need repair or replacement is attached (See Table 3.3.3 for the list of flood

damaged equipment).

This swamp and the fishery station are operated by DOF, and is one of the main inland fishery development centers in Thailand. The annual volume of dredging for maintenance of the swamp is usually 500,000 m^3. However, as the flood in 2011 has brought a huge amount of sediment, dredging of Bung Boraped Swamp (V=4 MCM) has just been commenced by DOF, hired contractors and the military. The work is set to be completed in 4 months before the start of 2012 flood season. Rehabilitation of concrete structures such as offices, laboratories, workshops, storages, hatcheries and ponds is on-going with the 2012/2013 budget. On the other hand, the extent of damage to laboratory/ office equipment, aquarium operation system, O&M equipment, water tanks, etc. has not yet been determined. A detailed assessment on such electrical / mechanical equipment will be needed.

	
2012/5/25, Main regulating dam for Bung Boraped built in 1994. Left side is inside swamp, right side is water way to Chaophraya River.	2012/5/25, Just commenced dredging heavy silt caused by floods. Target volume is 4 MCM in 4 months.

Table 3.3.3 List of Flood-Damaged Equipment (Nakhon Sawan Freshwater Fishery Development Center)

Nakhon Sawan Freshwater Fishery Development Center

Priority	Items	Pattern of Damage	Photo	Location	Damaged cost (Baht)	Rehabilitation Approach (repair/ construct/ others)	Estimated budget (Baht) for repair
1	Hatchery air control unit	Intergrated circuit was damaged, causing the system cannot work properly		Tambon Kwai Yai, Muang District, Nakhon Sawan	40,000	repair as a damaged condition that was found at that time	40,000
2	Air generator	Engine could not work fully during floods occur due to the blackout, affecting the fingerling in the nursery house		Tambon Kwai Yai, Muang District, Nakhon Sawan	10,000	repair as a damaged condition that was found at that time	10,000
3	Water pump	Motor did not work properly, causing water was pumped into the pond slowly, affecting a change of water for fish breeders and fingerling		Tambon Kwai Yai, Muang District, Nakhon Sawan	5,000	repair as a damaged condition that was found at that time	5,000
4	Plumbing system	Plumbing system beneath the ground was damaged since there is a water leak from the dike construction for flood protection and waste electricity for pumping water out		Tambon Kwai Yai, Muang District, Nakhon Sawan	5,000	repair as a damaged condition that was found at that time	5,000
5	Aquarium water filter	Filter system could not work properly, causing water filter has low quality affecting water condition in the aquarium		Tambon Kwai Yai, Muang District, Nakhon Sawan	200,000	repair as a damaged condition that was found at that time	200,000
6	Microscope	Electrical circuit system could not work properly, microscope lens have a fungus and be unusable		Tambon Kwai Yai, Muang District, Nakhon Sawan	20,000	not repaired yet	20,000
7	Vehicle	Engine & electrical system were damaged affecting fingerling removal, damaged vehicle i.e. pick-up truck and 6 wheels truck		Tambon Kwai Yai, Muang District, Nakhon Sawan	200,000	not repaired yet	200,000
8	Incubator	It was unusable.		Tambon Kwai Yai, Muang District, Nakhon Sawan	50,000	not repaired yet	50,000
9	Oven	It was unusable		Tambon Kwai Yai, Muang District, Nakhon Sawan	50,000	not repaired yet	50,000
10	Air Conditioner	8 air conditioners were damaged by flood		Tambon Kwai Yai, Muang District, Nakhon Sawan	240,000	unable to repair, need to buy a new one	240,000
11	Computer (PC)	It was damaged from moisture because of flood		Tambon Kwai Yai, Muang District, Nakhon Sawan	10,000	repair as a damaged condition	10,000
	Total						830,000

3.3.5. Small Swamp Inland Fisheries Project (SSIFP) by DOF

(1) Project Area

Thailand has about 6,000 natural water bodies or swamps with a total area of more than 1 million rai (1,600 km^2). However, these swamps are currently in a state of deterioration. DOF has attempted to rehabilitate the deteriorated natural swamps through efforts on water resources cum fishing development.

The proposed swamps for rehabilitation are located in three separate regions, namely Upper Northern, Lower Northern, and Eastern. Among the three regions, the area affected by the flood of the Chao Phraya River in 2011 is the Lower Northern Region.

(2) Project History

The rehabilitation of natural swamps was initiated in 1979. A major boom in swamp rehabilitation emerged in 1982, when the Thai government received a yen loan for the rehabilitation of 100 small swamps together with the development of fish seed centers and equipment centers in the Northern and Eastern Regions. Subsequently, there was another yen loan for the rehabilitation of three large swamps in the Northern and Northeastern Regions, together with the implementation of the small swamp project. An OECF loan of 4,900 million yen was given to the project and the work commenced in 1983.

(3) Major Facilities

The Number of Rehabilitated Swamps is shown below:

Province (*changwat*)	**Phase I**	**Phase II**	**Total**
Nakhon Sawan,	4	8	12
Kamphaeng Phet,	8	4	12
Phichit,	13	10	23
Phisanulok,	5	9	14
Sukhouthai	11	5	16
Phechabun,	8	6	14
Total	49	42	91

(4) 2011 Flood Damage

According to the survey conducted by DOF, damages or impact reported for the small swamps of SSIFP are as follows;

Province	**District**	**Project Name**	**Damage/Impact**
Nakonsawan	Klok Pra	Nong Plong	shallow by sediment
	Nong Bua	Nong Krub	flooded
Phitsanulok	Muang	Nong Kradan	shallow by sediment, dike damaged
	Ban Ra Kam	Nong Ma Khang	shallow by sediment, gate damaged
Uttaradit	Muang	Bung Pa Sao	shallow by sediment
Sukhothai	Muang	Bung Noi	flooded
	Muang	Nong Huai Raab	flooded

3.4. The Pilot Project

3.4.1. Objective of the Pilot Project

The implementation of this pilot project was designed to support RID's rehabilitation works for flood recovery, prevention and improvement of irrigation facilities in the Chao Phraya River basin. The support was planned as technical assistance for the design and construction for the reinforcement of irrigation facilities through pilot implementation in cooperation with RID.

3.4.2. First Selection of the Pilot Project

Projects initially considered for the pilot project can be categorized into the following three groups. Their project content, current situation and the rationale for the first selection are explained below. (Refer to Table 3.4.1)

i) Flood Recovery and Prevention Projects being implemented by RID

ii) Flood Recovery and Improvement Projects requested by RID for JICA Support

iii) Projects Assisted by Japan in the Past

(1) Flood Recovery and Prevention Projects being implemented by RID

As explained above, projects for emergency flood recovery and prevention that have been identified and implemented by RID have focused on rural and urban residential areas as well as industrial and commercial areas in and around cities. Therefore, most projects are related to social and industrial infrastructures, such as rehabilitation and reconstruction of roads and bridges, dredging of rivers and canals, heightening of river and canal banks with soil embankment or concrete floodwall, drainage regulators, and procurement and distribution of drainage pumps.

These projects were initially considered as possible candidates for the pilot project, however it was realized that they had been implemented in line with government emergency recovery and prevention plans and schedule at the cabinet council level. Therefore, they were excluded from the list of candidates for the pilot project.

(2) Flood Recovery and Improvement Projects requested by RID for JICA Support

In response to the inquiry by the Project Team, RID presented the following projects for possible JICA support in the agriculture sector.

i) Naresuan Dam O&M Project: This irrigation system built in 1982 is located in Phitsanulok Province under RID Regional Office 3 in the middle Chao Phraya River basin. Irrigation water is taken from the Naresuan barrage built on the Nan River. The project covers an irrigation service area of 91,000 rai (=14,560 ha) which spreads on the left bank of the Nan River down to the Kwai Noi River, a tributary of the Nan River.

During the 2011 flood, irrigation facilities such as canal banks, roads and drainage culverts were damaged. The central part of the irrigation area, where natural drain flows from the north to the south, is inundated every year. Moreover, in April 2012, one of five radial gates at Naresuan barrage was washed away. Upon the request of RID, the Project Team conducted a field visit and held meetings and discussions with the O&M project office on 18 May 2012.

Through the discussions, it was clarified that small repair and rehabilitation of canal facilities had been mostly completed. The issues of frequent inundation of the central lowland in the project area will need further study in the future in view of drainage improvement. The radial gate that had

been washed away in April was under fabrication in the workshop.

As a result, the Project Team concluded that there was no particular unrepaired structure suitable for the pilot project.

ii) Phlai Chumphon O&M Project: This irrigation system, also built in 1985, is located in Phitsanulok Province under RID Regional Office 3 in the middle Chao Phraya River basin. Irrigation water is taken from Naresuan barrage, similar to the Naresuan Dam O&M Project described above. The project covers an irrigation service area of 218,000 rai (=34,880 ha) which lies between the Nan River and the Yom River, an area which suffers from frequent flooding.

The feasibility study for the improvement of irrigation and drainage facilities was made in 2007. The detailed design was completed and approved by RID last year, in 2011. Upon the request of RID, the Project Team conducted a field visit and held meetings and discussions with the O&M project office in May and June 2012. Among 98 sub-projects in the improvement plan, two priority sub-projects, namely construction of outlet drainage structures on the main canal and construction of drainage pumping stations, were discussed and studied. (Refer to Table 3.5.1 for the list of 98 sub-projects)

As a result and as detailed below, the construction of the main canal outlet drainage structure was selected as the pilot project to be supported by the Project Team.

	
2012/5/28, Phlai Chumphon, proposed site for drainage pumping station along drainage canal and dike. Yom river is just 50 m away on right side.	2012/8/9, Phlai Chumphon, proposed site for outlet drainage structure at C-1 main canal.

(3) Projects Assisted by Japan in the Past

Projects assisted by Japan were also reviewed for identifying potential candidates for the pilot project. The flood damage and current situation of these projects are described earlier in this chapter.

i) Chao Phraya Irrigation Project (ALRO): Among 10 pumping irrigation blocks, 5 blocks are operated by TAOs while 5 other blocks are managed by individual farmers using small portable pumps due to the deterioration of project-provided pumps. Flood damage in 2011 was mainly for polder dikes built in 1982-1987. However, it is judged that there is no particular irrigation facility suitable for the pilot project to be carried out by this Project Team.

ii) Pasak Irrigation Project (RID): Flood damage in 2011 was minimal because of its hilly topographic condition. Therefore, it was decided that there is no particular damaged irrigation facility to be urgently repaired with the support of this Project Team.

iii) SSIP / SSIRP (RID): It is generally observed that most sub-project sites are located in hilly and mountainous areas, and not in the lowland areas which is the focus of this Project Team. Most sub-projects have been transferred to respective TAOs. According to the results of the inventory survey for the 106 sub-projects listed under SSIRP within the study area, structural damage was observed at many sub-projects but they are mostly due to the operation of many years not due to the flood in 2011, except a few cases. Four sub-projects with river weir structure were found seriously damaged that will need reconstruction. They are either repaired or underway for investigation and survey, thus the team concluded that there is no possible facility to be supported as a pilot project by this JICA project.

iv) LSIFP (DOF): As the project area for Bung Boraped Swamp under LSIFP is situated right beside the Chao Phraya River in Nakhon Sawan Province, flood damage in 2011 was serious for many facilities. Dredging of the swamp is being executed with a target volume of 4.0 million m^3. Various equipment such as for research, extension, facility operation, dredging and office use was also seriously damaged. However, although the need and demand for equipment support are high, equipment support would not be appropriate for pilot implementation under this JICA project.

v) SSIFP (DOF): It was observed that 91 sub-project sites in the study area were inundated mostly due to their lowland locations. Dredging of such small swamps / ponds will be needed to restore their storage capacity. However, such work would not be suitable for the pilot project under this JICA project as they have been operated by their respective TAOs.

(4) First Selection of the Pilot Project

The first selection of the pilot project was made by considering the following criteria;

i) To support flood recovery and prevention works in the agriculture sector.

ii) To be able to implement within the JICA project period up to May 2013.

iii) To correspond to the requests from the C/P agencies, particularly RID.

Current conditions, issues and necessity of projects / project groups were studied and assessed for the selection. The projects / project groups being implemented by RID under the emergency recovery and prevention program were excluded. Project suitability, as pilot implementation by the Project Team in terms of study concept, was also taken into consideration.

As a result of this review, the improvement of the Phlai Chumphon O&M Project in Phitsanulok Province was identified as a potential pilot project. Subsequently, additional field work was conducted, and detailed discussions were held between the Project Team and the Phlai Chumphon O&M Project office as described in the next section.

Table 3.4.1 Candidates for Pilot Project

Project category / group	Description	Current status / Flood damage	Actions taken by study team	For JICA support			Remark
				Necessity	Possible for pilot project	Tentative cost	
1. RID flood recovery & protection work (nation-wide)		Progress as of June 30, 2012					
1) Batch-1 (555 sites)	For the recovery and protection of urban and rural residential and industrial areas	86%	Conducted site visit on May 16-20 & follow-up the progress	None	---	---	
2) Batch-2 (955 sites)		80%					
3) Batch-3 (481 sites)		79%					
4) Emergency SCWRM (129 sites)		19%					
5) Additional No.1 (119 sites)		-					
6) Additional No.2 (11 sites)	Included 2 dam projects & program is up to year 2019	-					
7) Aditional No.3 (3 sites)	To suppliment SCWRM above	-					
2. RID's request for JICA support		Flood recovery					
1) Naresuan Dam O&M Project	Gravity irrigation system for 91,000 rai taking water at Naresuan Dam from Nam River at Phitsanulok	Budget for equipment (radial gate, wire, electrical) was approved then procurement is underway.	Conducted site visit and discussion on May 18	None	---	---	
2) Phlai Chumphon O&M Project	Gravity irrigation system for 218,000 rai taking water at Naresuan Dam at Phitsanulok	Seeking JICA support for 1) main canal spillway, 2) drainage pumping station.	Conducted site visit & discussion on May, June & July	Very high	Priority 1 is spillway, Priority 2 is drainage pumping station	40 million baht	D/D was made by RID in 2011.
3. Japan assisted projects in the past		Flood damage					
1) Chao Phya Irrigated Project (ALRO)	Polder dike & 10 pump stations for 10,000 ha irrigation at Ayutthaya	4 blocks were protected during flood but 6 were totally inundated. 5 pump stations are operational.	Conducted site visit on May 10	None	---	---	
2) Pasak Irrigation Project (RID)	Pump irrigation system for 67,356 rai at Sara Buri	Not flooded nor damage to facilities / structures.	Conducted site visit on May 16	None	---	---	
3) SSIP / SSIRP (RID)	106 sites in the study area under SSIRP, Sites of SSIP are not clarified.	Damage depends on location. Most sites are located at hilly area free from flood.	Conducted site visit on May 16-20, & inventory of 106 sites is on-going.	To clarify after inventory	---	---	Wait for result of inventory.
4) LSIFP (DOF)	Bung Boraped Swamp at Nakhon Sawan	Totally inundated, need dredging, rehab of facilities, ponds, roads & equipment. Recovery is in progress but equipment recovery not yet.	Conducted site visit on May 25	High for equipment supply	Equipment supply is not suitable to pilot project	---	Obtained the equipment list
5) SSIFP (DOF)	49 small swamps in the study area	Totally inundated with much sedimentation to ponds managed by TAOs	Conducted site visit on May 25	None		---	

3.4.3. Final Selection of the Pilot Project

(1) Overview of the Phlai Chumphon Irrigation System Improvement Project

General features: The Phlai Chumphon irrigation system, built 30 years ago, is located in Phitsanulok Province under RID Regional Office 3 in the middle Chao Phraya River basin with an irrigation service area of 218,000 rai (34,880 ha). This area, together with two interconnected irrigation systems, namely the Dongsethi and Tabua O&M Projects, covers a total irrigation services area of 572,400 rai (92,000 ha), and is one of the largest irrigated agricultural areas in the country. The project area is situated in lowland between the Nan River and the Yom River where floods occur frequently every year. Both the Nan River and the Yom River are among the four biggest tributaries of the Chao Phraya River. The Nan River is frequently flooded and causes extensive damage to the urban areas of Phitsanulok. The Yom River also floods between August and October every year to the urban areas of Sukhothai and the surrounding agricultural land. (Refer to Figure 3.5.1)

Irrigation system: Irrigation water with design capacity of 141.68 m^3/sec is diverted from the Nan River at Naresuan barrage. The main canal for the Phlai Chumphon irrigation system extends to the Dongsethi and Tabua irrigation systems, which are interconnected immediately downstream of the Phlai Chumphon irrigation system. This 80 km-long main canal system has regulators for water distribution control at six places in the main canal, but canal outlet drainages structures are attached at only two places, namely at the upper-reach and the canal end.

Drainage system: The drainage system of the irrigation service area is very poor due to its topography. The area borders on the Yom River and the old Yom River, thus drainage is made through drainage gates directly into the rivers. However, water levels of both rivers are so high during the wet season that drainage from the irrigation area becomes difficult and consequently standing crops and farmland are

damaged by long periods of inundation. Currently, there exist only two pumping stations built in 2006 and 2007 facing onto the old Yom River.

Flood damage and recovery: In the 2011 flood, this area between the Yom River and the Nan River was the most damaged area in the middle Chao Phraya River area. It has been reported that 120,400 rai (19,200 ha) of farmland, or about 55% of the total irrigation service area, were inundated for three months from July to September. Wet season paddy of 16,920 rai (2,700 ha) were totally lost due to inundation. Presently in this area, many works for flood recovery and prevention have been implemented, such as repair and heightening of river banks, repair of village roads and bridges, dredging of rivers and canals, and repair of social infrastructures.

Issues and countermeasures: Major issues on this irrigation system, including the surrounding area, can be summarized as: 1) shortage of irrigation water in the dry season, 2) poor drainage condition in the wet season in half of the project area because it is low-lying, and 3) frequent flood damage in the Phitsanulok area which is situated by the Nan River downstream from the Naresuan barrage. On the other hand, countermeasures to solve these issues, according to the detailed design approved by RID, are: 1) improvement of irrigation canals with concrete lining and canal structures, 2) construction of drainage pumping stations along the Yom River and river bank improvement, and 3) construction of outlet drainages structures on the main canal to use as a floodway or bypass canal for the prevention of flooding in the Phitsanulok area. Particularly for 3) above, during heavy floods, the Nan River water is diverted into the main canal at Naresuan barrage as an emergency measure to reduce river discharge to the Phitsanulok urban areas. The diverted water is inevitably discharged to the irrigation area due to the lack of outlet drainage structures on the main canal, and consequently farmland, standing paddy, farmers' houses and rural infrastructures are damaged. As such damage increases, induced by climate change and farmers' claims in recent years particularly in the 2011 flood, construction of outlet drainage structures on the main canal has become a strong and serious social demand.

Phlai Chumphon Irrigation System Improvement Project: The feasibility study for the improvement of the Phlai Chumphon irrigation system was conducted by Thai consultants in 2006 – 2007. The detailed design was completed and approved by RID in July 2011. The improvement project is composed of 98 sub-projects, and as a result of the experience of the 2011 flood, construction of outlet drainage structures has become priority. However, its budget has not been secured because of the large number of works for emergency recovery and prevention being implemented throughout the country by the government.

Priority sub-projects: Among 98 sub-projects for improvement in the Medium-Term Expenditure Framework (MTEF) (2011/12 – 2016/17), 5 sub-projects, which are urgently required for flood recovery, have had their budget approved for 2012/13 implementation. Among others, according to the O&M project office and RID approval documents, two categories, namely 1) construction of outlet drainage structures for the safety of the main canal as well as prevention of flooding in the Phitsanulok urban area, and 2) construction of drainage pumping stations for the improvement of drainage conditions along the Yom River, are considered priority. Therefore, these two types of sub-projects were selected for further study and final selection of the pilot project.

i) Candidate 1: Construction of outlet drainage structures for flood waterway on the main canal (2 places)

ii) Candidate 2: Construction of drainage pumping stations for inundation prevention along the Yom River (15 places)

(2) Candidate 1: Construction of Outlet Drainage Structures on the Main Canal

During floods, the main canal of the Phlai Chumphon irrigation system is often used as a bypass canal of the Nan River to prevent flooding in Phitsanulok city. Although this happens only in cases of emergency, and the flood water comes into the main canal, diverted water is discharged to the project area through lateral canals resulting in serious inundation and damage in lower areas along the Yom River, as explained above.

The purpose of constructing outlet drainage structures is to allow the main canal to be used safely as a floodway / bypass canal when the Nan River is severely flooded. Diverted flood water will be conveyed downstream by the main canal then spilled back into the Nan River at a point downstream of the Phitsanulok urban area.

According to the improvement project, two outlet drainage structures are planned and the upper one (at km 56+151) is priority. Therefore, the upper outlet drainage structure is selected as candidate 1 for the pilot project. (Refer to Figure 3.4.2)

i) New outlet drainage structure at km 56+151 on C-1 main canal, estimated project cost = 39.5 million baht. To drain to DR 15.8.

ii) New outlet drainage structure at km 63+240 on C-1 main canal, estimated project cost = 37.8 million baht. To drain to DR 2.8.

The pilot project for the selected outlet drainage structure (at km 56+151) for new construction are composed of a vertical gate type outlet drainage structure (3 sets of steel roller gates) with a design discharge of 49.50 m^3/sec, concrete culvert box, and protection work.

(3) Candidate 2: Construction of Drainage Pumping Stations along the Yom River

Drainage improvement is a long-term issue for the Phlai Chumphon irrigation system (irrigation service area of 218,000 rai or 34,880 ha) that is characterized by lowland geography with widespread inundation when there is heavy rain. The purpose of the construction of drainage pumping stations is to drain inundated water mechanically to the Yom River and the old Yom River. The pumping stations are located at the end of the lateral drainage canals along these rivers.

According to the improvement plan, 15 pumping stations have been planned for new construction. Among them, the one with highest priority (No. 11 Khlong Go regulator and pumping station) is selected as candidate 2 for the pilot project. The 15 pumping stations are as listed below. (Refer to Figure 3.5.2)

The pilot project for the selected drainage pumping station (No. 11 Khlong Go regulator and pumping station) will consist of rehabilitation of an existing drainage gate (steel slide gate) and new construction of a pumping station. The type of pump is a water submerged pump for three sets with a diameter of 800 mm. There is a suction pit but no discharge pit. An extension of the electric transmission line from the existing line is needed.

(4) Final Selection of the Pilot Project

The pilot project was finally selected among two candidate projects, i.e. the construction of outlet drainage structure and the construction of drainage pumping station, taking into consideration the following factors;

i) Appropriateness to agriculture sector
ii) Applicability to other irrigation systems
iii) Viability in terms of construction period
iv) Necessity of JICA support in view of urgency
v) Priority by Phlai Chumphon O&M Project

i)Appropriateness to agriculture sector: The projects currently implemented by RID for flood recovery and prevention have focused on the social infrastructure, particularly for the protection of rural and urban residential areas as well as commercial and industrial areas. Hence, projects for the recovery of agricultural production as well as for the prevention of flood damage in the agriculture sector through rehabilitation and improvement of irrigation facilities have not been observed.

Considering the above, both candidates are appropriate to agriculture sector as they could bring benefits through the recovery of agricultural production and/or reduction of flood damage to crops and irrigation facilities.

ii)Applicability to other irrigation systems: The concept of candidate 1 “the construction of outlet drainage structures on the main canal” is to use the irrigation canal as a floodway. In other words, an irrigation system can be used not only as agricultural infrastructure to supply water for irrigation, but also as social infrastructure to prevent flooding in the surrounding residential areas. In the case of Phlai Chumphon where the Phitsanulok city area is spread out, the need to use the main canal of the irrigation system as floodways of the Nan River becomes a high social demand. In planning such floodways, discharge capacity, structure type and locations of outlet drainage structures are the key engineering points that need to be properly designed.

The above concept for candidate 1 could be applied both to the neighboring irrigation systems and to those systems in the middle Chao Phraya River basin where similar issues are observed. This is particularly so, due to frequent unusual rainfall patterns induced by climate change. Moreover, this can be a model for future irrigation development together with flood prevention measures for the Yom River, where irrigation development has not yet progressed and areas that experience severe flooding, such as Sukhothai city, are situated. This measure would be named the “flood waterway model for irrigation system”.

The concept of candidate 2, “the construction of drainage pumping stations”, is to drain inundated flood water by using pumps. The current drainage system in this area is to drain flood water naturally through small drainage gates built 30 years ago along the Yom River, but natural drainage does not function well in the wet season because of high water levels of the Yom River. In the 2011 flood, almost 50% of the project area was inundated for three months, causing huge losses of standing paddy of about 2,700 ha.

Candidate 2 could be executed as a pilot implementation of 15 drainage pumping stations to be constructed for drainage improvement. In addition, this could be a model of inundation prevention for irrigation systems in the middle to lower Chao Phraya River basin. This would be named the “inundation prevention model for irrigation system”.

In conclusion, both candidates could be applied to other areas for the improvement of existing systems as well as for new development. However, it is further evaluated that candidate 1 would be more suitable to this JICA project because it has more potential for replication.

iii)Viability in terms of construction period: Both candidate projects could be completed within this JICA project period up to May 2013. Six months in the dry season, possibly from November to April, could be secured for construction, provided that the work is done by private contractors. However, there will be some risks, critical to the construction period, as pointed out below, and such risks will be properly analyzed and reviewed.

For candidate 1, civil work volume is estimated at 40,000 m^3 for earth work and 2,600 m^3 for concrete work according to the detailed design. Major work including the cofferdam and gate fabrication and installation will require about 4 - 5 months. The steel roller gate can be fabricated in Phitsanulok but this is subject to confirmation.

For candidate 2, the work consists of civil work and pump mechanical work. Major work including the cofferdam will require about 4 – 5 months as above. The critical factor will be the manufacture of pumps which may need to be procured from other countries.

iv)Necessity of JICA support in view of urgency: According to RID, both candidate projects are considered high priority in terms of urgency for flood reduction and prevention. The project area is located in the middle Chao Phraya River basin, right in the central area of this JICA project.

Therefore, in terms of the purpose and necessity of this JICA project support, both projects would be equally highly prioritized.

v)Priority by Phlai Chumphon O&M Project and RID: Priority given by the Phlai Chumphon O&M Project and RID was also taken into consideration. According to the six-year Medium-Term Expenditure Framework (MTEF) (2011/12 – 2016/17) for the improvement of the Phlai Chumphon Irrigation System, candidate 1 “the construction of outlet drainage structure on the main canal” is ranked higher in priority than candidate 2 “the construction of drainage pumping station.”

The result of the priority study described above is summarized in the table below. From this, it was proposed that candidate 1 “the construction of outlet drainage structure on the main canal” of the Phlai Chumphon irrigation system be the first priority for the pilot project to be implemented by the Project Team.

Table 3.4.2 Results of Priority Study for Selection of Pilot Project

Criteria	1. Construction of outlet drainage structure	2. Construction of drainage pumping station
1) Appropriateness to agriculture sector	◎	◎
2) Applicability to other irrigation systems	◎	○
3) Viability in terms of construction period	◎	○
4) Necessity of JICA support in view of urgency	◎	○
5) Priority by Phlai Chumphon O&M Project	◎	○

	
2012/8/9, Phlai Chumphon, proposed site for outlet drainage structure at km 56+151 at C-1 main canal	2012/8/9, Phlai Chumphon, natural drain (DR 15.8) to discharge water from proposed outlet drainage structure.

3.4.4. Design of the Pilot Project

(1) Overview of the Pilot Project

1) General

For the Pilot Project of this component, one of the 98 sub-projects under the Improvement of Phlai Chumphon O & M Project, "Construction of Outlet Drainage Structure on Main Canal C-1" was selected taking into account the urgency and importance of the project, the strong request by RID for assistance, as well as its suitability for the purpose of the present project. The pilot project was designed to demonstrate how a drainage function could be added into the irrigation canal. In other words, the pilot project will be an example of how an irrigation system can be utilized not only to provide water for irrigated agriculture but also to protect neighboring areas during peak flood times through using the facility as social infrastructure, i.e. drainage. Due to urbanization, the city of Phitsanulok is expanding along the Nan River. Therefore there is a need to improve the drainage function of the Phlai Chumphon irrigation system. If the system is to have a dual purpose of irrigation and drainage, an outlet drainage structure needs to be constructed to secure the safety of the irrigation canal. When planning the outlet drainage structure, the most important design-related issues are location, scale and the discharge amount . (Refer toAppendix I-C-3 for the details of the design)

2) Location of the facility

The detailed design works for the construction of the outlet drainage structure on the main canal C-1 was prepared by RID. Out of the two outlet drainage structures, the upper stream outlet drainage structure, as specified below, was reviewed.

Km 56+151.898: Located at about the 56 km point of C-1 main canal extending from the Naresuan intake to the south along the Nan River

3) Scale of facility and drainage capacity

As per the detailed design made by RID, the present C-1 main canal is an earthen canal but is planned to be concrete-lined in the near future. So, the detailed design was made on the assumption that the main canal has been improved and is already concrete-lined. Accordingly, if the pilot project was implemented prior to the concrete-lining improvement, it would be necessary to review the capacity of the outlet drainage structure on the basis of the present earthen canal condition.

For the capacity of outlet drainage, the plan assumed that half each of the maximum irrigation supply (90 cum/s, present/after improvement) would be drained at two outlets: 50% would be drained at the upstream outlet and the remaining 50% would flow down through the main canal. In order to drain out all the remaining 50% at the downstream outlet, it would, theoretically, be necessary to block the flow by having agate in the canal to prevent the water from flowing downstream. Nevertheless, no design for a closure gate was included in the detailed design works for the downstream outlet drainage structure.

Similar to RID's practice, the scope of work for this pilot project did not include construction, but covers the design and cost estimate on the outlet drainage structure..

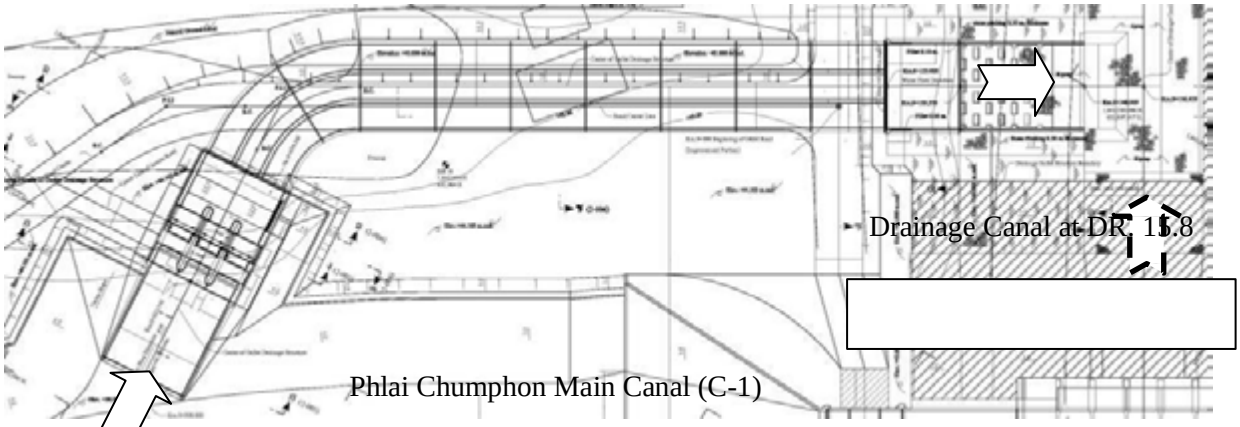
The design outlet drainage discharge by RID is 50% of the flow capacity of the main canal (90 cum/s) and an additional 10% should be added as an allowance.

Design outlet drainage discharge = 90.0 x 0.5 x (1.0+0.1) = 49.5 cum/s

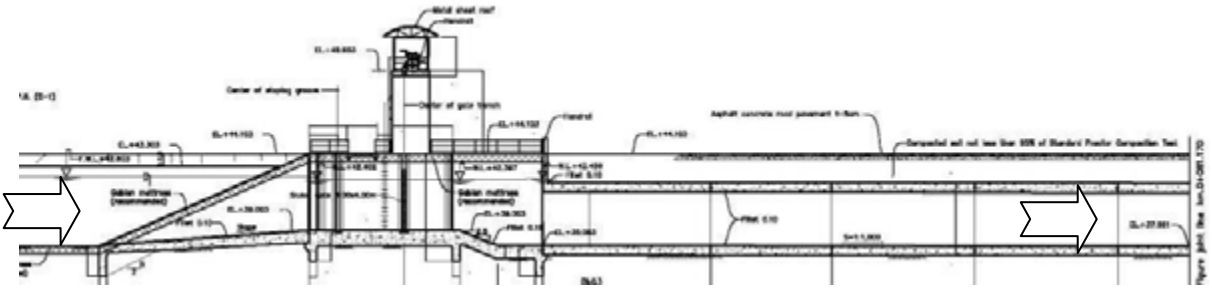
Main Canal (C-1) ⇒ Outlet Drainage Structure ⇒ Drainage Canal DR.15.8

PLAN of Outlet Drainage Structure

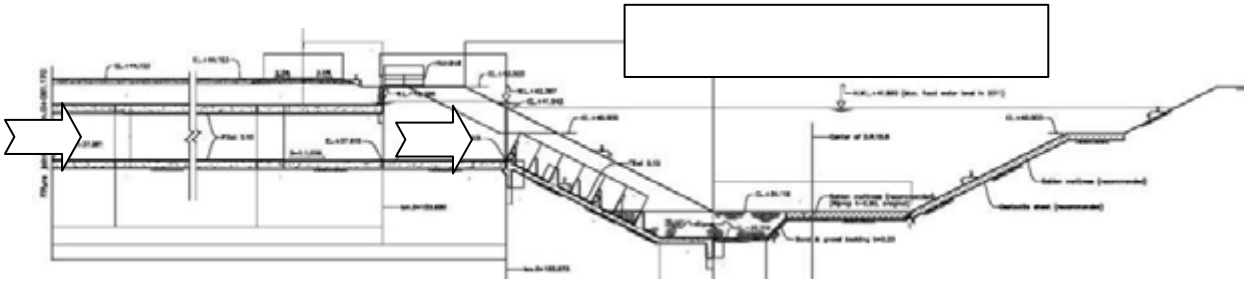
Outlet Drainage Structure



PROFILE of Outlet Drainage Structure



Drainage Canal at DR. 15.8



(2) Review of RID's Detailed Design

RID's design for the outlet drainage structure assumed that the main Phlai Chumphon canal would be concrete lined. Therefore, it was necessary to examine the drainage capacity for the scenario of the earthen and un-lined canal as well. Furthermore, there are plans to increase the intake amount at Naresuan by 10 cum/s after the improvement of Phlai Chumphon main canal by concrete lining. However, the increased amount will affect only the upstream section from the beginning to the 25 km point, so there will be no change in the required capacity in the lower stream portion. The planned water requirement, the planned canal capacity as well as the existing capacity are as presented in the following table.

Phlai Chumphon Main Canal Capacity (cum/s)

Canal Interval Point			Canal Plan(Concrete Lining)		Existing Capacity		Outlet Concept
Beginning km.	~	Ending km.	Requirement	Available			
0+0.000	~	10+608	150.532	153.351	>	140	
10+608	~	24+920	128.375	152.516	>	140	
24+920	~	40+760	102.298	137.214	=	100	
40+760	~	52+63.628	90.000	94.958	=	90	
52+63.628	~	58+718.042	90.000	93.561	=	90	
km. 56+151.898 (Proposed Drainage)			90.000	93.561	=	90	⇒49.5cum/s
58+718.042	~	63+360	60.730	93.863	=	60	
km. 63+240.740 (Proposed Drainage)			60.730	93.863	=	60	⇒49.5cum/s
63+360	~	72+351.008	60.730	136.896	=	60	
72+351.008	~	79+873.186	60.730	127.571	=	60	

(3) Hydraulic Design （km. 56+151.898: Outlet Drainage Structure）

1) General

In the rehabilitation works of the Phlai Chumphon canal by RID Regional Office 3, the outlet drainage structure works were planned and detailed designs were completed for construction.

The hydraulic conditions of the outlet drainage structure are as follows:

Top elevation of wall at gate portion	EL.	44.103 m
Top elevation of canal bank	EL.	43.303 m
Water level at km 56+151.898 Main Canal (C-1)	WL.	42.603 m
Water level of 2011 flood in drainage canal DR. 15.8	HWL.	41.880 m
Discharge capacity in outlet drainage structure	49.5 cum/sec	

(Based on RID Design Criteria for Survey-Design of the Improvement of Phlai Chumphon O&M Project)

2) Discharge sections of Irrigation canal at Station 56 + 151.898 (km. 56+100)

i) RID: Concrete lining Cross Section (km. 56+100 Upstream of Outlet Drainage Structure)

Depth of flow H=4.603m (Discharge 90.000 cum/s), Bottom width B=15.000m, Side slope m=1:2.0, Bed slope I=1/20,000, Roughness coefficient n=0.018 (Concrete lining), Top of bank EL=44.106m,

Improvement of Phlai Chumphon O&M Project

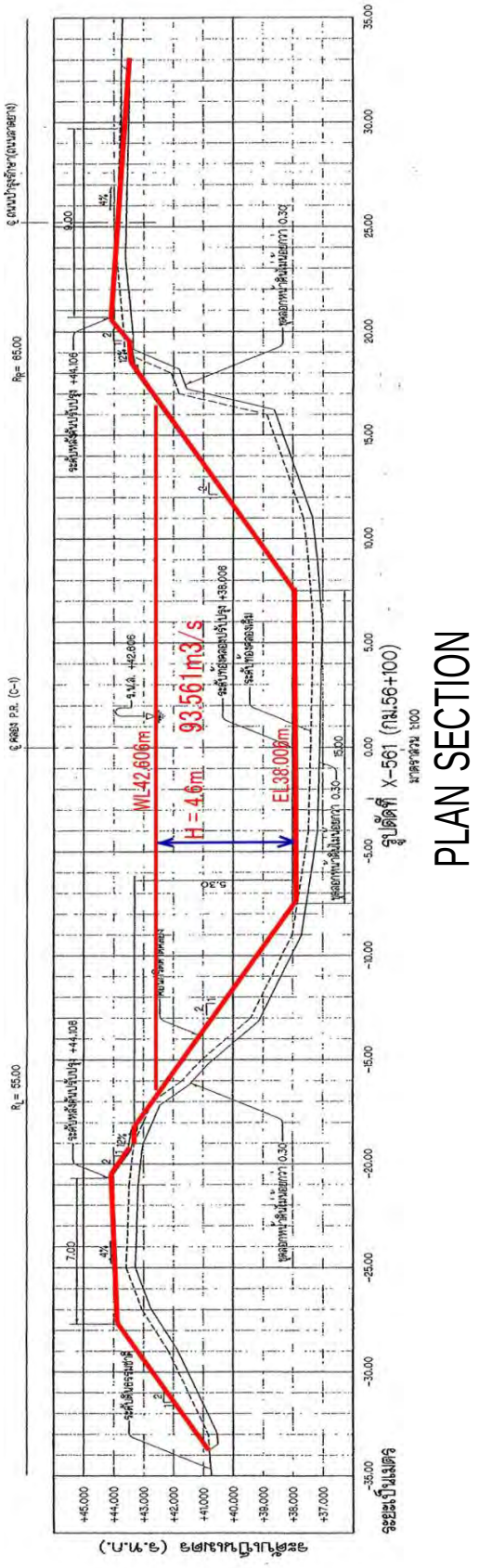
Main Canal C-1

· km 56 + 100 UNIFLOW of Planned Canal Section

Discharge (m3/s)	Q=	93.561	Area of Cross (m2)	A=	111.320
Bed Slope (1/I)	I=	20000.0	Wetted Perimeter (m)	S=	35.572
Roughness Coef.	n=	0.018	Hydraulic Radius (m)	R=	3.129
Bottom Width (m)	B=	15.000	Velocity (m/s)	V=	0.840
Side Slope	m=	2.000	Depth of Flow (m)	H=	4.600
Trial Start Depth	H1=	3.000	Diff. (Q-q)	GS=	0.00000
Bottom Elevation (m)	El=	38.006	Critical Depth(m)	Hc=	1.478
Water Surface (m)	WI=	42.606			

Estm. Hc

FX1=	0.00000
C1=	19.56
C2=	-19.26
FX2=	1941.10
Gs=	0.00000

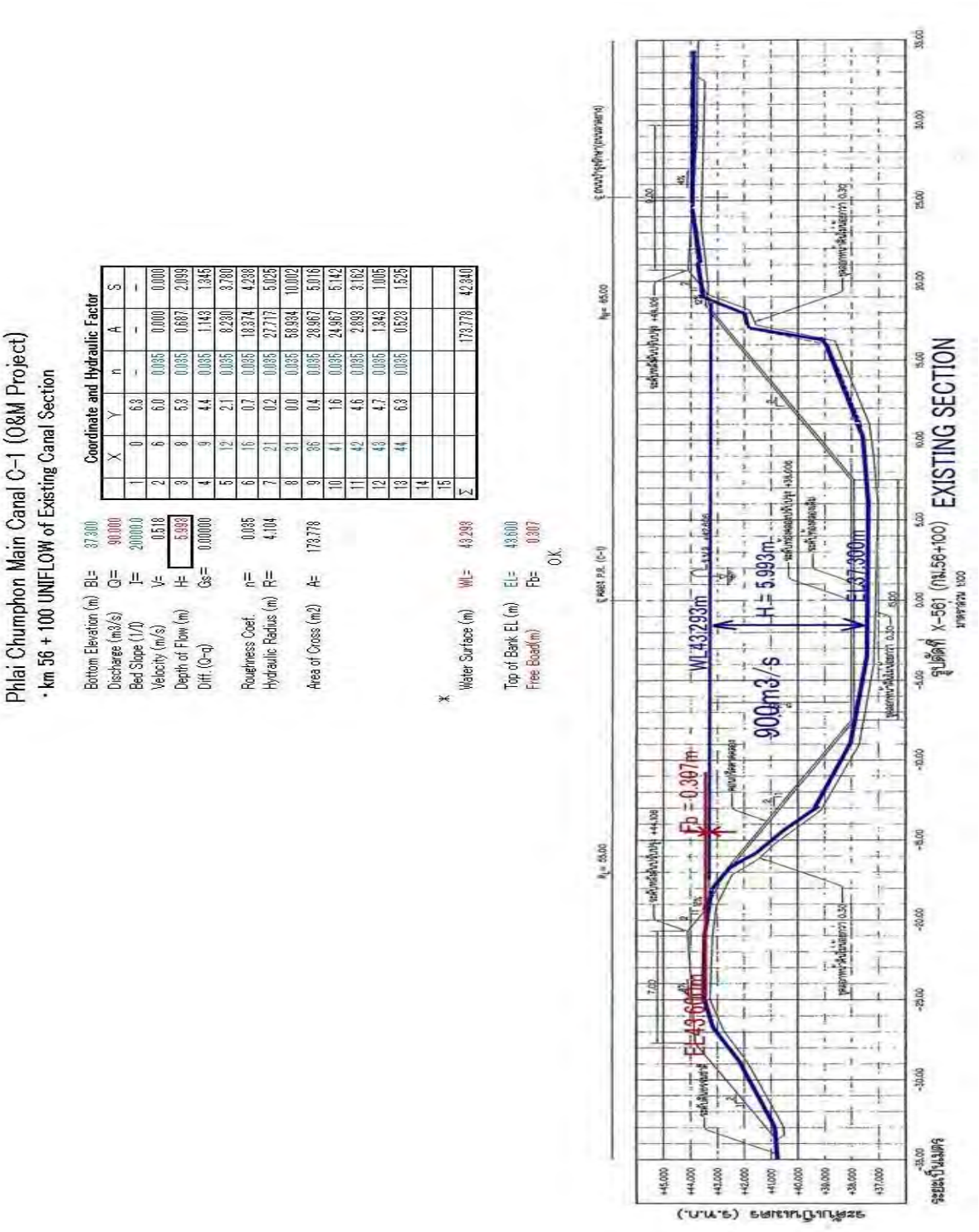


Discharge Q = 93.561 cum/s > 90.000 cum/s ----------O.K.

Free board = EL 44.106- WL 42.606 = 1.5m

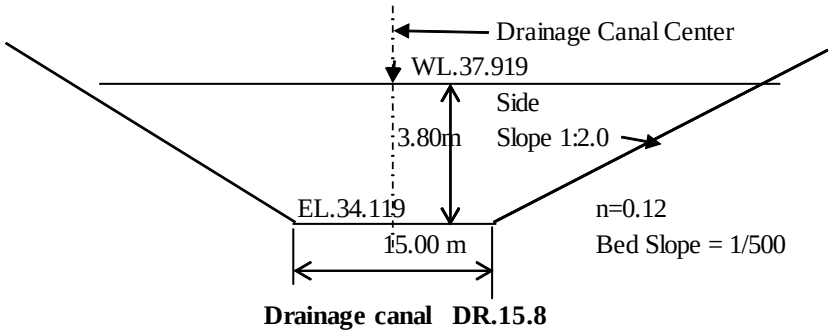
ii) Existing Un-lined Survey Cross Section (Upstream of Outlet Drainage Structure)

Required discharge= 90.000 cum/s, Roughness coefficient n=0.035 (Un-lined), Bed slope I=1/20,000, Bottom elevation EL=37.300m, Top of bank EL=43.600m



Results, discharge Q=90.000 cum/s ⇒ Depth of flow H=5.993m, Water surface WL=43.293m, Free board fb=EL 43.600m – WL 43.293m = 0.307m > 0.0m----O.K.

3) Discharge Sections of Drainage canal at DR. 15.8 (Downstream Water Surface EL. of Outlet Drainage Structure)



Drainage canal DR.15.8

Depth m	WL in m	Area sq.m	Premeter m	Slope 1 / 500	n 0.12	Velocity m / sec	Diachrge cum/sec	Remark
0.000	34.119	0.000	15.000	0.002	0.12	0.000	0.000	
0.500	34.619	8.000	17.236	0.002	0.12	0.223	1.787	
1.000	35.119	17.000	19.472	0.002	0.12	0.340	5.787	
1.500	35.619	27.000	21.708	0.002	0.12	0.431	11.637	
2.000	36.119	38.000	23.944	0.002	0.12	0.507	19.268	
2.500	36.619	50.000	26.180	0.002	0.12	0.574	28.684	
3.000	37.119	63.000	28.416	0.002	0.12	0.634	39.920	
3.500	37.619	77.000	30.652	0.002	0.12	0.689	53.028	
3.800	37.919	85.880	31.994	0.0002	0.12	0.720	61.817	Design WL37.919
4.000	38.119	92.000	32.889	0.002	0.12	0.740	68.069	
4.500	38.619	108.000	35.125	0.002	0.12	0.788	85.107	
5.000	39.119	125.000	37.361	0.002	0.12	0.834	104.209	
5.173	39.119	131.119	38.135	0.002	0.12	0.849	111.317	Design+49.5cum/s
5.500	39.619	143.000	39.597	0.002	0.12	0.877	125.445	
6.000	40.119	163.071	50.833	0.002	0.12	0.811	132.190	
6.500	40.619	187.571	53.069	0.002	0.12	0.865	162.200	
7.000	41.119	213.071	55.305	0.002	0.12	0.916	195.148	
7.500	41.619	239.571	57.541	0.002	0.12	0.965	231.068	
7.761	41.880	253.801	58.708	0.002	0.12	0.989	251.010	2011 Max
8.000	42.119	267.071	59.777	0.002	0.12	1.011	269.995	
8.367	42.619	287.8958	61.419	0.002	0.12	1.044	300.510	2011Max.+49.5cum/s
8.500	42.619	295.571	62.013	0.002	0.12	1.055	311.971	
9.000	43.119	325.071	64.249	0.002	0.12	1.098	357.042	
9.381	43.500	348.221	65.953	0.002	0.12	1.130	393.492	Bank Top

Drainage Canal Discharge and Water Level (Downstream Water Surface EL. of Outlet Drainage)

[1] Drainage Design + 49.5 = WL. 37.919m (Q=61.817 cum/s) + 49.5 cum/s = 111.317 cum/s ⇒WL. 39.119m

WL. 37.919 m is almost the same as the outlet flume level of the outlet drainage structure. Therefore, there will be no problems regarding the outlet discharge capacity from the outlet drainage structure.

WL. 39.119 m is lower than the center elevation of the box culvert. This will affect the open flow water level in the box culvert, and will raise the water level a little, but will not affect the capacity of 49.5 cum/s.

[2] Drainage Canal 2011 Max + 49.5 = WL. 41.88m (Q=251.010 cum/s) + 49.5 cum/s = 300.510 cum/s ⇒WL. 42.619m

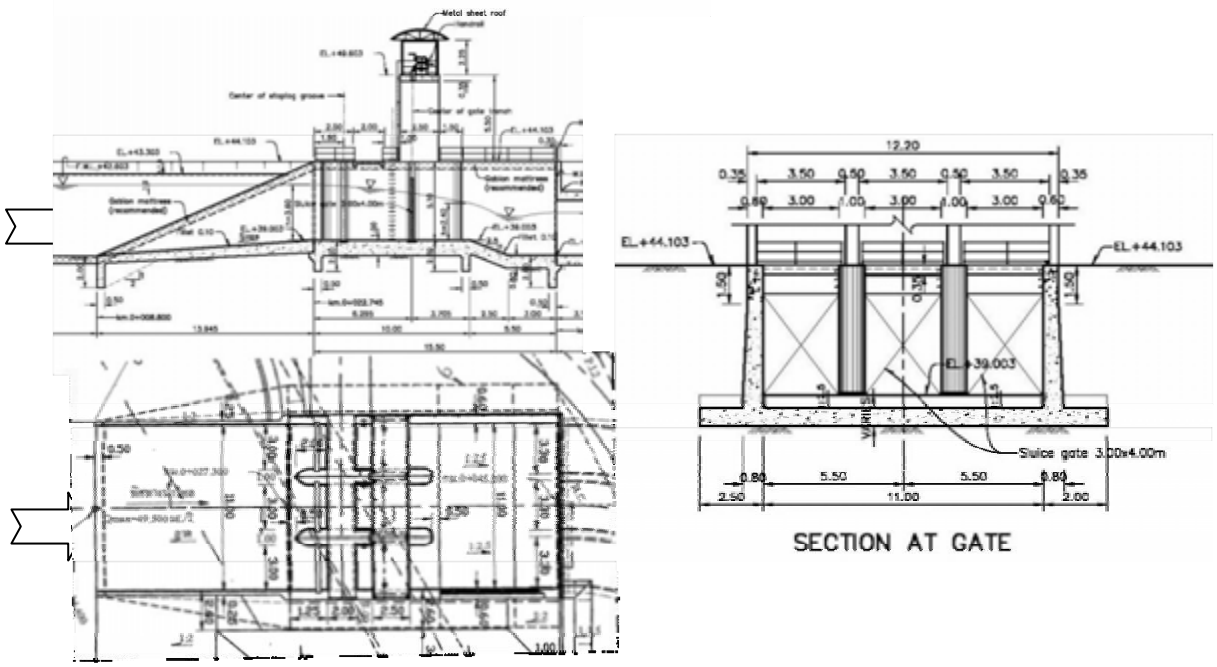
When water levels at the drainage canal are either at the highest levels of the 2011 flood or at the higher level caused by the additional discharge of 49.5 cum/s, they are higher than the inside top

elevation (EL. 41.518m) of the box culvert. Therefore, the water level in the main canal (concrete-lined and WL. 42.603m – 90 cum/s) is lower than the water level of the drainage canal (WL. 42.619m). So not only will 49.5 m3/s not be able to flow down, but an adverse flow may also occur resulting in the outlet gate to close fully, although the discharge itself is rather limited. By contrast, for the present un-lined main canal with WL. 43.293m (90 cum/s), the water level difference between the drainage canal and the main canal is 0.674m, allowing 49.5 cum/s to flow down.

4) Hydraulic Estimation for Inlet of Outlet Drainage Structure (Function as Weir)

Gate: Full Opened

WL_1	h_1 =	h_1/L =	Formula	C =	Q	WL_0	WL_1	WL_2	Index
39.003	0	0	a	0.000	0.000				
39.500	0.497	0.0497	b	1.556	4.907	39.592	39.500	39.488	
40.000	0.997	0.0997	b	1.560	13.979	40.186	40.000	39.986	
40.500	1.497	0.1497	b	1.564	25.789	40.780	40.500	40.485	
41.000	1.997	0.1997	b	1.569	39.840	41.376	41.000	40.984	
41.309	2.3055	0.23055	b	1.571	49.500	41.744	41.3085	41.293	Outlet discharge 49.5 cum/s
41.500	2.497	0.2497	b	1.573	55.850	41.973	41.500	41.483	
42.000	2.997	0.2997	b	1.577	73.633	42.570	42.000	41.981	
42.027	3.024	0.3024	b	1.577	74.640	42.603	42.027	42.007	Concrete Canal WL.42.603 (90cum/s)
42.6035	3.6005	0.36005	b	1.582	97.266	43.293	42.604	42.582	Existing Canal WL.43.293 (90cum/s)



Overflow Water Depth and Discharge

$$Q = C \cdot N \cdot B_0 \cdot h_1^{3/2}$$

where, Q : discharge capacity (m^3/sec)

C : discharge coefficient

Formula : $0 < h_1/L \leq 0.1$ $\quad C = 1.624\,(h_1/L)^{0.022}$

Formula : $0.1 \leq h_1/L \leq 0.4$ $\quad C = 1.552 + 0.083\,(h_1/L)$

Formula : $0.4 \leq h_1/L \leq$ (1.5 to 1.9) $\quad C = 1.444 + 0.352\,(h_1/L)$

Formula : (1.5 to 1.9) $\leq h_1/L$ $\quad C = 1.785 + 0.237\,(h_1/D)$

h_1 : overflow water depth $\quad h_1 = WL_0 - EL_1$ (m)

m_0 : side slope of overflow dike $\quad m_0 =$ 0.0

B_0 : average width of flow area $\quad B_0 = (B_1 + B_2)/2$ (m)

B_1 : crest width of overflow dike $\quad B_1 =$ 3.00 m

B_2 : width of overflow water surf: $B_2 = B_1 + 2\,m_0 \cdot h_1$ (m)

L : Crest length to flow direction $\quad L =$ 10.00 m

D : height of overflow weir $\quad D =$ 1.00 m

5) Confirmation of Outlet Drainage Structure Capacity

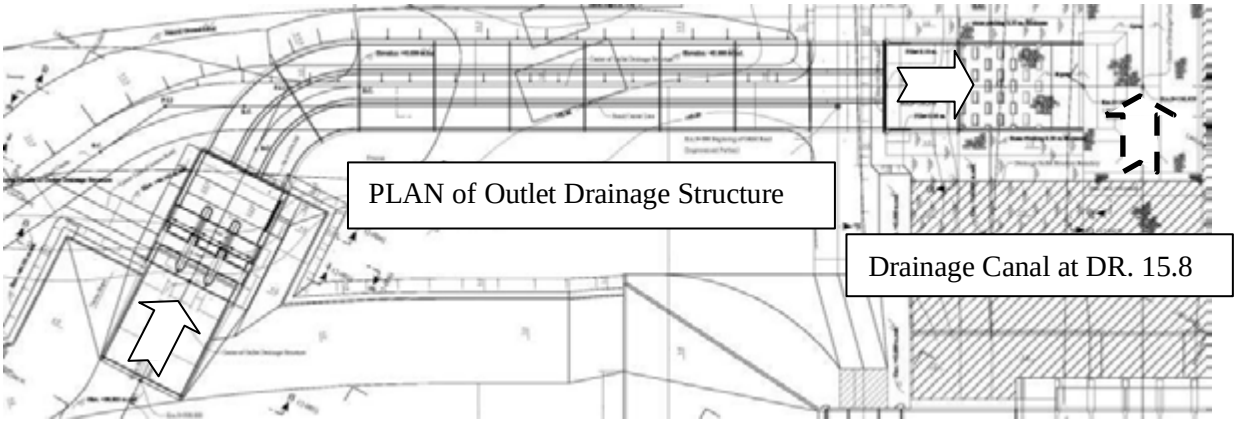
Result of Hydraulics Estimation for Confirmation of Outlet Drainage Structure Capacity

Case	Main Canal Condition	Main Canal WL (90cum/s)	WL	Main Canal WL (Outlet 45.9cum/s)	Upstream WL.	WL	Drainage Canal WL	Drainage Canal Discharge
a-1)	Concrete Lining	**WL.42.603 m**	>> OK	WL.41.744 m	**WL.42.603 m**	**>> OK**	WL.39.119 m	111.3 cum/s
a-2)	Concrete Lining	WL.42.603 m	>> OK	WL.41.744 m	WL.42.603 m	<< NG	WL.42.619 m	300.5 cum/s
b-1)	Existing	**WL.43.293 m**	>> OK	WL.41.744 m	**WL.43.293 m**	**>> OK**	WL.39.119 m	111.3 cum/s
b-2)	Existing	**WL.43.293 m**	>> OK	WL.41.744 m	**WL.43.293 m**	**> OK**	WL.42.619 m	300.5 cum/s

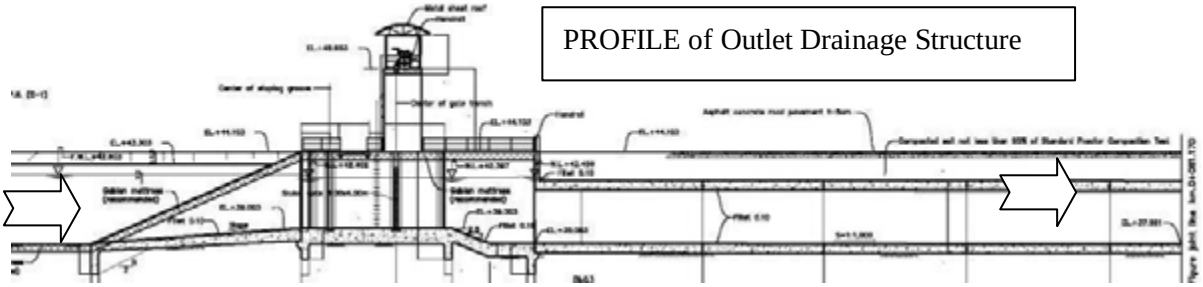
Case *-1) : Design Water Level on Drainage Canal = Design Flood Discharge 61.817cum/s + Outlet Discharge

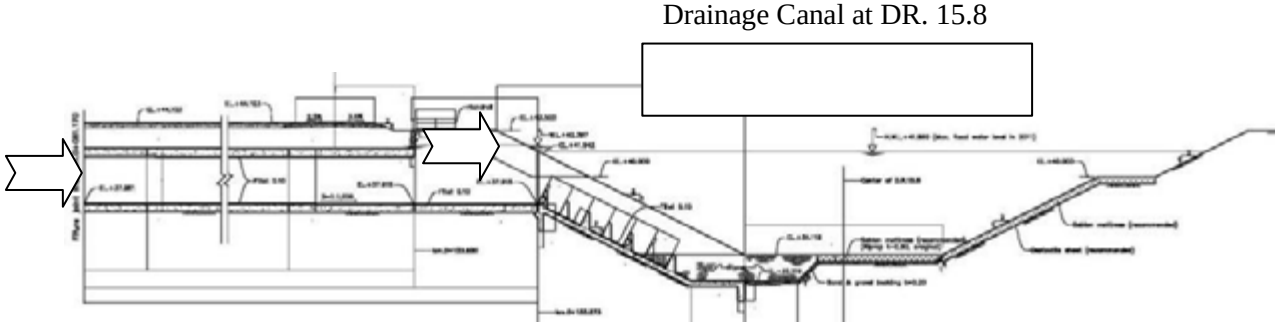
Case *-2) : 2011Max. Water Level on Drainage Canal = 2011Max. Discharge 251.010cum/s + Outlet Discharge

RID's detailed designs correspond to Case a-1), which does not take into consideration the discharge from the outlet drainage structure at Drainage Canal DR. 15.8.



Main Canal (C-1) ⇒ Outlet Drainage Structure ⇒ Drainage Canal DR.15.8





6) Recommendations for the Hydraulic Design

Countermeasures for Outlet Drainage Structure based on Hydraulic Review

Item	Findings	Countermeasures
1. Hydraulic calculation at gate	(1) Discharge at gate is considered as submerged flow and is calculated by using the submerged flow formula. This formula was taken from the RID Design Criteria for the Survey-Design of the Improvement of Phlai Chumphon O&M Project. The formula, however, seems to be misprinted and the discharge appears to be too high (Too small head loss).	(1) The formula in the RID Design Criteria should be corrected as below: From; 2*g0.5 = 6.264 To: (2*)0.5 = 4.427 →However, there is a need to establish an O&M standard through observation of discharges following the completion of construction works. This will be done by measuring and observing the relationship between the upstream water level, gate openings, the downstream water level and discharge quantities.
	(2) Regarding the computation of flow capacity, the water level at the drainage canal DR 15.8 downstream is not considered in examining the outlet drainage discharge.	(2) The flow capacity can be confirmed by taking into consideration the water level at the lower stream drainage canal and the outlet drainage discharge. Accordingly, for the design drainage water level, the effect by the 49.5 cum/s must be added, even in the case where the maximum level reached by the 2011 flood is used..
2. Hydraulic calculation between inlet and outlet of outlet drainage structure	(1) Free flow is prevailing in the box culvert and a uniform flow can be calculated by adjusting for critical depth. This calculation will determine the bed slope. However, if the water level of the outlet reaches levels as high as during the 2011 flood, there will be a submerged flow in the box culvert. There has been no examination of this possibility.	(1) It is necessary to prove that the outlet water level would not be lower than that of the designed lower stream, by calculating the head losses from the inlet down to the lower stream based on the designed upstream water level and the design discharge.
3. Baffle apron drops	(1) The design of the baffle apron drops is adequately done based on the RID Design Criteria, provided that the dissipation effect by this baffle can be obtained only when the water level in lower stream is lower.	(1) In case the water level downstream is raised, dissipation effects by water cushion can be expected and there is no need for provision of dissipating facility for the higher water level downstream. If low water level at DR 15.8 in the dry season is assumed, the desired water level can be secured by adjusting the gate facility, which can be used as a countermeasure.
	(2) It is possible that the right side bank slope of the connecting drainage canal might be scoured by the jet flow of the drained water. As a protection measure, the riprap as designed at present may be insufficient.	(2) To ensure protection against scouring, filter mats should be placed on the side slope and canal bed of the connecting canal on which gabion mattress will be placed. Through an on-site survey, it was confirmed that the rock/stone block is 50 cm and there is no problem to withstand the velocity. It is, therefore, recommended that the filter mats be placed under the riprap.

(4) Design of Structure (km. 56+151.898: Outlet Drainage Structure)

1) General

In the rehabilitation works of the Phlai Chumphon canal by RID Regional Office 3, two outlet drainage structure works were planned and detailed designs were completed for the construction.

The designs of the outlet drainage structures were based on RID Design Criteria for Survey-Design of the Improvement of Phlai Chumphon O&M Project.

2) Comparative Design for Box Culvert

For the structural design, a stress analysis and calculations for requirements of reinforcing bars were conducted. The RID design, in general, is deemed to be on the safe side. For example, the RID design applies members with enough thickness and provides for more reinforcement bars than required. The following table shows the results of a structural computation with the reduced member thickness. It is possible to reduce the thickness of the member, but taking into account the potential uplifting force, the designed thickness shall remain unchanged.

Comparison between Original Design and Recommended Design of Box Culvert Section

Design Item		Original Design	Recommended Design
1. Design Criteria		RID, Design Criteria for Survey-Design of the Improvement of Phlai Chumphon O&M Project	Same Design Criteria as left
2. Design Section and Dimensions			
Whole width of culvert		B = 11.50 m	B = 11.50 m (same as left)
Unit length of culvert		L = 1.00 m	L = 1.00 m (same as left)
Internal width per barrel		b = 3.30 m	B1 = 3.30 m (same as left)
Internal height		h = 3.60 m	H1 = 3.60 m (same as left)
Covering depth of soil		**Hs = 1.90 m**	**Hs = 2.10 m**
Thickness of top slab		**tt = 0.60 m**	**tt = 0.40 m**
Thickness of bottom slab		**tb = 0.60 m**	**tb = 0.45 m**
Thickness of side wall		ts = 0.40 m	ts = 0.40 m (same as left)
Thickness of partition wall		tp = 0.40 m	tp = 0.40 m (same as left)
3. Bar Arrangement (dia.-spacing)			
(1) Main Bars			
Top slab	**upper edge joint**	**D20@0.10, As = 31.42 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
	upper mid. joint	**D20@0.10, As = 31.42 cm²/m**	**D16@0.10, As = 20.11 cm²/m**
	Lower	**D20@0.20, As = 15.71 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
Bottom slab	**lower edge joint**	**D20@0.10, As = 31.42 cm²/m**	**D20@0.20, As = 15.71 cm²/m**
	lower mid. joint	**D20@0.10, As = 31.42 cm²/m**	**D20@0.20, As = 15.71 cm²/m**
	Upper	**D20@0.20, As = 15.71 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
Side wall	**upper outside**	**D20@0.10, As = 31.42 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
	lower outside	**D20@0.10, As = 31.42 cm²/m**	**D20@0.20, As = 15.71 cm²/m**
	Inside	**D20@0.20, As = 15.71 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
Partition wall	**both sides**	**D20@0.20, As = 15.71 cm²/m**	**D16@0.20, As = 10.05 cm²/m**
(2) Distribution bars (flow direction)		D16@0.20, As = 10.05 cm²/m	D16@0.20, As = 10.05 cm²/m
4. Principal Quantities		Total length of box culvert: L= 86 m	Total length: same as left
Concrete, fc'=210 kg/cm²		**1,690 m³**	**1,350 m³ (-340 m³, -20%)**
Form work		**2,960 m²**	**2,870 m² (-90 m², -3%)**
Reinforcement bar, SD30		**160 ton**	**119 ton (-41 ton, -26%)**

3) Examination on Uplifting Force

The RID design did not appear to include a study on the uplifting force. Depending on the site conditions, studies on uplifting force may not always be required. However, in this case, there was a possibility of an empty condition, so the following examination was made. The study concludes that safety against a potential uplifting force can be secured by the present member thickness, and that it is not necessary to modify the member thickness.

i) Case 1 Box portion: Gate closed and empty condition

For case 1 when the water level at lower stream is raised, then water flows into the box freely and the water levels inside the box and ground water levels are assumed to be the same. In this case, there is no need for analyzing uplift action. Below, analyses were made for cases where the box is empty and the ground water level reaches up to the crest of the box culvert.

Case 1-1: Original Design Section (GWL---42.003m = Crest surface)

Concrete Section	11.5*4.8*-3.3*3.6*3	19.56	m^2
C weight	19.56*2.4	46.944	t
Uplifting force	11.5*4.60	52.9	t
Required overburden	(52.9*1.2-46.944)/11.5/1.8=0.799 m		
Design minimum Overburden	0.800 m (Minimum embankment within boundary)		
Weight of sand/earth	11.5*1.8*0.8	16.56	t
Examination	(46.944+16.56)/52.9=1.20	= 1.2	OK

Case 1-2: Recommended Design Section (GWL---42.003m = Crest surface)

C weight	15.535*2.4	37.284	t
Uplifting force	11.5*4.45	51.175	t
Required overburden	(51.175*1.2-37.284)/11.5/1.8	1.166	m
Design minimum Overburden		1.000	m
Weight of sand/earth	11.5*1.8*1.0	20.7	t
Examination	(37.284+20.7)/51.175=1.13	< 1.2	NG

ii) Case 2: Gate portion - Gate & stop log closed/empty

Under case 2, an analysis of the uplifting force is needed only when both the gate and the stop log are closed during the flood and there is no water inside the structure. The analysis was made on the case where the water level in the main canal is the same level as the ground water. (WL 43.293 m, un-lined at present and 90.0 cum/s)

Case 2-1: Original Design Section (43.293m = Main canal present highest water level)

Gate portion (h)	43.293 – 39.003 + 1.00	5.29	m	
Section of uplifting force	5.29*12.6	66.65	t	
Self-weight, invert	12.6*1.0	12.60	m^2	
Self-weight, side wall	(0.6 + 9.8)*5.1	7.14	m^2	
Self-weight, pier	1.0*5.1*2	10.20	m^2	
Total m^2		29.94	m^2	
Total weight	29.94*2.4	71.856	t	
Weight in short	Uplift force*1.2 – Self-weight	8.124	t > 0	N.G.
Overhanging	1.7*1.0*2*1.4	4.76	t	
Sand/earth on overhanging	1.7*1.0*(5.1+2.6)	13.09	t	
Total		17.85	t	
Safety factor	(17.85 + 71.856)/66.65	1.35	> 1.2	OK
(No problem considering the gate operation deck and lifting device)				
Only concrete self-weight	(71.856 + 4.76)/66.65	1.15	> 1.1	OK

Case2-2: Proposed Design Section (Without cantilever at footing) (GWL---43.293m = Main canal present highest water level)

Gate portion (h)	43.293 – 39.003 + 1.00	5.29	m	
Section of uplifting force	5.29*12.6	66.65	t	
Self-weight, invert	12.6*1.0	12.60	m^2	
Self-weight, side wall	(0.6 + 0.8)*5.1	7.14	m^2	
Self-weight, pier	1.0*5.1*2	10.20	m^2	
Total m^2		29.94	m^2	
Total weight	29.92*2.4	71.856	t	
Weight in short	Uplift force * 1.2 – Self-weight	8.124	t > 0	N.G.
Overhanging	1.7*1.0*2*1.4	4.76	t	
Sand/earth on overhanging	1.7*1.0*(5.1 + 2.6)	13.09	t	
Total		17.85	t	
Safety factor with invert overhanging	(17.85+71.865)/66.65	1.35	> 1.2	OK
(In case of without overhanging, the safety factor is lower than 1.1.)				
Without invert overhanging	71.856/66.65	1.08	< 1.1	N.G.

iii) Case 3 Flume at immediate upstream of box, gate closed/empty condition

Similar to case 1, case 3 is the scenario of free flow into the box from the lower stream making the water levels the same between the groundwater and inside the flume immediately upstream. Also in this case, there is no need for further examination on uplifting action. The following is for reference only, and calculations were made for the condition of: the groundwater levels are as shown below, empty condition in the flume and without invert overhanging, but with the vertical loads by wall friction by earth pressure on both sides. There were some safety problems with the groundwater level at the main canal water level of 43.293 (90.0 cum/s) and it is considered necessary to lower the groundwater level down to 41.88 m.

Case 3-1: Original Design Section

Under case 3, the lower stream box shall be re-filled by sand and gravel so as to lower the ground water level HWL 41.88 (maximum level in the 2011 flood)

Max height (h)	41.88 – 38.003 + 0.8	4.677	m	
Section of uplifting force	4.677*12.6	58.9302	t	
Self-weight, invert	12.6*08	10.08	m^2	
Self-weight, side wall	(0.6 + 0.8)*6.1	8.54	m^2	
Total		18.62	m^2	
Cut off	12.6*0.5*1.2	7.56	t	
Total weight	18.62*2.4 + 7.56*1.4	55.272	t	
Weight in short	Uplifting force *1.2 – Self-weight	15.44	t > 0	
Weight in short	Uplifting force *1.1 –Self-weight	9.55	t > 0	
Overhanging	1.7*1.0*2*1.4	4.76	t	
San/earth on overhanging	1.7*2.0*6.1*1.0	20.74	t	
Total (Counter-measures)		25.5	t	
Safety factor	(25.5 + 55.272)/58.9302	1.37 > 1.2		OK
Concrete self-weight	(55.272 + 4.76)/58.9302	1.02 = 1.0		OK

Case 3-2: Recommended Design Section

Without invert overhanging, on both sides of side walls 50 % of vertical pressure due to friction by earth pressure shall be considered. GWL: HWL of 41.88 (maximum level in the 2011 flood)

Max height (h)	41.88 – 38.003 + 0.8	4.677	m
Section of uplifting force	4.677*12.6	58.930	t
Self-weight, invert	12.6*0.8	10.08	m^2
Self-weight, side wall	(0.6 + 0.8)*6.1	8.54	m^2
Total		18.62	m^2
Cut-off	12.6*0.5*1.2	7.56	t

Total weight	18.62*2.4 + 7.56*1.4	55.272	t	
Combined force of main earth pressure	0.333*1.8*6.9^2/2	14.269	t	
Friction angle with wall	30*2/3	20	deg.	
50 % of vertical earth pressu e	14.269*sin(20 deg.)/2	2.440	T	
Weight in short Uplifting force *1.2 – (Self-weight + Vertical earth pressure)		10.564	t > 0	
Weight in short Uplifting force *1.1 – (Self weight + Vertical earth Pressure)		4.671	t > 0	
Weight in short Uplifting force *1.0 – (Self-weight + Vertical earth pressure)		- 1.222	t < 0	
Overhanging	1.7*1.0*2*1.4	4.76	t	
Sand/earth on overhanging	1.7*2.0*6.1*1.0	20.74	t	
Total (Counter-measures)		25.5	t	
Safety factor With overhanging	(25.5 + 55.272)/58.930	1.37 > 1.2		OK
Without overhanging	(55.272 + 2.44*2)/58.930	1.02 = 1.0		OK

4) Recommendations on the Structural Design

Recently in Japan, more emphasis is placed on workability or ease of construction when preparing a structural design. This is different from the conventional approach that gives the highest priority to the economical aspect. In this respect, RID may wish to consider adjusting their Design Standard in the future. At present, however, the RID design for this pilot project is found quite justifiable and no modifications of the Standard has been made, though recommended.

Countermeasures for the Outlet Drainage Structure based on the Structural Review

Structure	Findings	Countermeasures
1. Inlet transition	(1)Analysis was made of a single body of flume structure consisting of side wall and invert. Though the thickness of the member and the diameter and bar arrangement of the reinforcement bars are found adequately designed, the invert width is too wide (B/H=2.2), causing the bending moment at the center of invert to be quite large requiring more reinforcement bars.	(1) When applying the L-shaped structure with provision of joints on the invert, the quantity of reinforcement bars can be minimized. However, it may lead to dissymmetry on the left and right banks, causing un-uniform bearing as well as horizontal forces. To this end, the single body flume structure is reasonable.
	(2) The edge of invert is designed to have an overhanging of 0.0 m – 1.70 m. If the foundation could be substituted, enough bearing capacity can be secured even without the overhanging.	(2) The overhanging of the invert shall be removed, though it is a reasonable countermeasure for soft foundations, which could not be confirmed by a boring survey. In other words, it is reasonable to have an overhanging to deal with the inadequacy of a geological investigation.
	(3) The side wall is designed with a taper. However, the height of the side wall varies from 0.0 m to 5.10 m, and the thickness of the lower end of the side wall also varies. These may cause difficulties in construction works including installation of formworks, bar arrangement and assembly.	(3) The length of the transition is rather short at about 14 m only and construction difficulties can be avoided if the thickness of the side wall (from the lower to the upper end) could be uniform, without tapering.
2. Operation deck for stop-log	(1) For the slab,the thickness of the member, the diameter of the reinforcement bars, as well as their arrangement are adequately designed.	

Structure	Findings	Countermeasures
3. Gate hoist section	(1) Except for the lower part of the partition wall, the member thickness and the diameter and the arrangement are adequately designed.	
	(2) The edge of the invert is an overhanging structure, but if the basic foundation could be substituted, enough bearing capacity could be secured even without the overhanging. This is similar to the case of the inlet transition above.	(2) The overhanging of the invert should be deleted, though it is reasonable as a countermeasure for the soft foundation which could not be determined by the boring survey. In other words, it is reasonable to have an overhanging to deal with the insufficiency of geological investigation.
	(3) Tapering is designed for the partition wall below the planned ground surface and this causes difficulties in construction works like formwork installation, reinforcement bar arrangement and assembly.	(3) The length of this section is short at 10 m only and tapering can be deleted so as to secure easier construction by applying the uniform thickness of side wall. However, the uniform thickness may result in higher cost, so the original design is reasonable.
	(4) For the partition wall below the ground surface, a considerably larger quantity of reinforcement bars is planned when compared with the requirements from a stress point of view.	(4) It is possible to modify the bar arrangement to a minimum for the lower part of the partition wall, or a bar arrangement based on shear force safety can be acceptable.
	(5) The gate is designed to be 3.0 m (W) x 4.0 m (H) with a freeboard of 0.4 m with the designed water depth. The freeboard can be made smaller.	(5) If the freeboard can be 0.2 m only with the gate height at 3.8 m, then the manufacturing cost of the gate could be reduced by about 5%. However, when the RID standard is strictly followed, the freeboard is calculated to be 0.28 m and the gate height is 3.88 m, justifying the original design.
4. Inlet of box culvert	(1) See section on inlet transition	(1) See section on inlet transition
5. Box culvert	(1)The invert and the crest are designed to be thicker than the required thickness of the member, and the quantity of reinforcement bars is also higher than the quantity required to withstand stress.	(1) The loads and stress resultants may be re-calculated, by applying thinner members of invert and crest so as to minimize the quantity of reinforcement bars needed to meet the stress requirement. With these countermeasures, the quantities of concrete and reinforcement bars for the box culvert could be reduced by 20%. (It is necessary to pay due consideration to the analysis on uplift force.)
	(2) A water stop is provided for the joint portion but no dowel bar is provided.	(2) Although it is confirmed that the bearing capacity is adequate, the provision of dowel bars is preferred to avoid uneven subsidence.

Structure	Findings	Countermeasures
6. Outlet transition	(1)An analysis was made on the uniformed flume structure consisting of side walls and invert as a single body. The member thickness of the side walls and the diameter and arrangement of reinforcement bars are adequately designed.	
7. Inclined drop with baffle apron	(1) Similar to the outlet transition, an analysis was made on the uniform structure of side walls and invert. Though the member thickness and bar arrangement are adequately designed, the inclined invert and the tapering on the side walls, make the construction work difficult.	(1) If uniform thickness is applied to the side walls, without tapering, the construction would be easier. However, as this is not economically justifiable, the original design is appropriate.
8. Others	(1) In order to make formwork installation and bar assembly easier in construction work, lean concrete (10 cm thick) is required. However, no indication of lean concrete was found in the drawings.	(1) It is better to indicate the lines of lean concrete. By RID practice, lean concrete is included in the construction cost estimate, and this is acceptable.
	(2) As per the boring survey results, soft foundation with N value 3 has been confirmed at BH-18 with the elevation 37-38 m. This zone is located at the bottom of structures crossed over by inlet transition and gate section, so the foundation needs to be strengthened adequately.	(2) This soft foundation zone is only1 m thick and positioned at the bottom of the structure. In this case, substitution by sand and gravel is required. (Under this design review, estimation is made for excavation and substitution.)
	(3)The slope of the side excavation is gentle at 1:1 and the foundation is of clayey nature. Accordingly, 1:0.5 slope is judged to be adequately safe, even considering the height of excavation.	(3) By modifying the excavation slope to 1:0.5, the quantities for excavation and re-filling can be reduced. This is acceptable if it follows the construction requirements.
	(4) There is a concern that the right bank side slope and invert of the connecting canal may be scoured by the jet flow of the outlet drains and that the riprap work as presently designed may not provide enough protection.	(4)To ensure that the structures are adequately protected against scouring, filter mats will be placed on the side slope and invert of the connecting canal and the ripraps will be placed on top. Ripraps in and around the project site is larger than 50 cm and found to be large enough and acceptable.
	(5) During construction work, water flow in the main canal cannot be suspended and dry condition cannot be secured for construction.	(5) Temporary closure by sheet piling and large sand bags is necessary. In the project area, temporary closure by providing coffer dams in the canal is also practiced in some cases.
	(6)In the drawings, there is no indication of a clear boundary between the beginning of the main canal and the construction site.	(6) It is necessary to clearly indicate the boundary. This can be done by highlighting the extent of the concrete lining and slope protection works under this project, or indicating only the outlet drainage structure.

Note: Bold face indicates high priority for implementation.

(5) Construction Plan and Schedule（km. 56+151.898: Outlet Drainage Structure

Outlet Drainage Structure Works: Detailed Construction Schedule

No.	Description	QBQ	Unit	2012		2013				Remarks
				November	December	January	Feburary	March	April	
				Dry Season				Wet Season		
1.	**Preparation Works**	1	LS							
	Site office & camp	1	LS							
	Mobilization	1	LS							
2.	**Temporary Works**									
	Dewatering at inlet portion	1	LS							
	Dewatering at outlet portion	1	LS							
3	**Earth Works**									
	Cleaning works by machine	7,370	sqm							
	Stripping works by machine	2,210	cum							
	Earth excavation by machine	11,590	cum							
	Earth excavation by hand	1,540	cum							
	Earth filling by machine	10,490	cum							
	Earth filling by light weight machine	1,400	cum							
	Gravel & sand bedding	540	cum							
4.	**Concrete works**									
	Lean (Leveling) concrete	170	cum							
	Structural concrete	2,650	cum							
	Formworks and Support	5,620	sqm							
	Steel bar for reinforcement D12	860	kg							
	Steel bar for reinforcement D16	64,300	kg							
	Steel bar for reinforcement D20	114,680	kg							
	Steel bar for reinforcement D25	27,220	kg							
5	**Miscellaneous Works**									
	Hand rail works	95	m							
	Rubber water stop A type	150	m							
	Rubber water stop C type	160	m							
	Elastic filer 1 cm thick	90	sqm							
	Sealing compound	130	sqm							
	Joint sealant 1 x 3 cm	420	m							
6	**Gate Works**									
	Shop drawing preparation	1	LS							
	Steel gate 3.0m x 3.6m with Lift	3	set							
	Bulk gate 3.00 m x 0.90 m x4	1	LS							
	Gate and Lifting Equipment insulation	3	set							
	Bulk gate installation	1	LS							
	Final Painting & testing	1	LS							
7	**Steel Works**									
	Roof works	1	place							
	Ladder to operation floor	2	place							
	L-steel bar works	2	place							
8	**Road Works**									
	Asphalt pavement	1,180	sqm							
	Sodding	2,160	sqm							
9	**Cleaning works for Handover**									
	Site cleaning	1	LS							
	Mobilization of equipment/tools	1	LS							
10	**Inspection for Hand over**									
	Training for O&M	1	LS							
	Inspection for Hand over	1	LS							

(6) Construction Cost (Outlet Drainage Structure at Sta. 56+151.898)

Table-2 Revised Project Cost of Outlet Drainage Structure at Main Canal (C-1) km. 56+151.898

Note: Factor "F" means percentage of indirect cost against direct cost which include management cost, bank interest, profile and VAT.

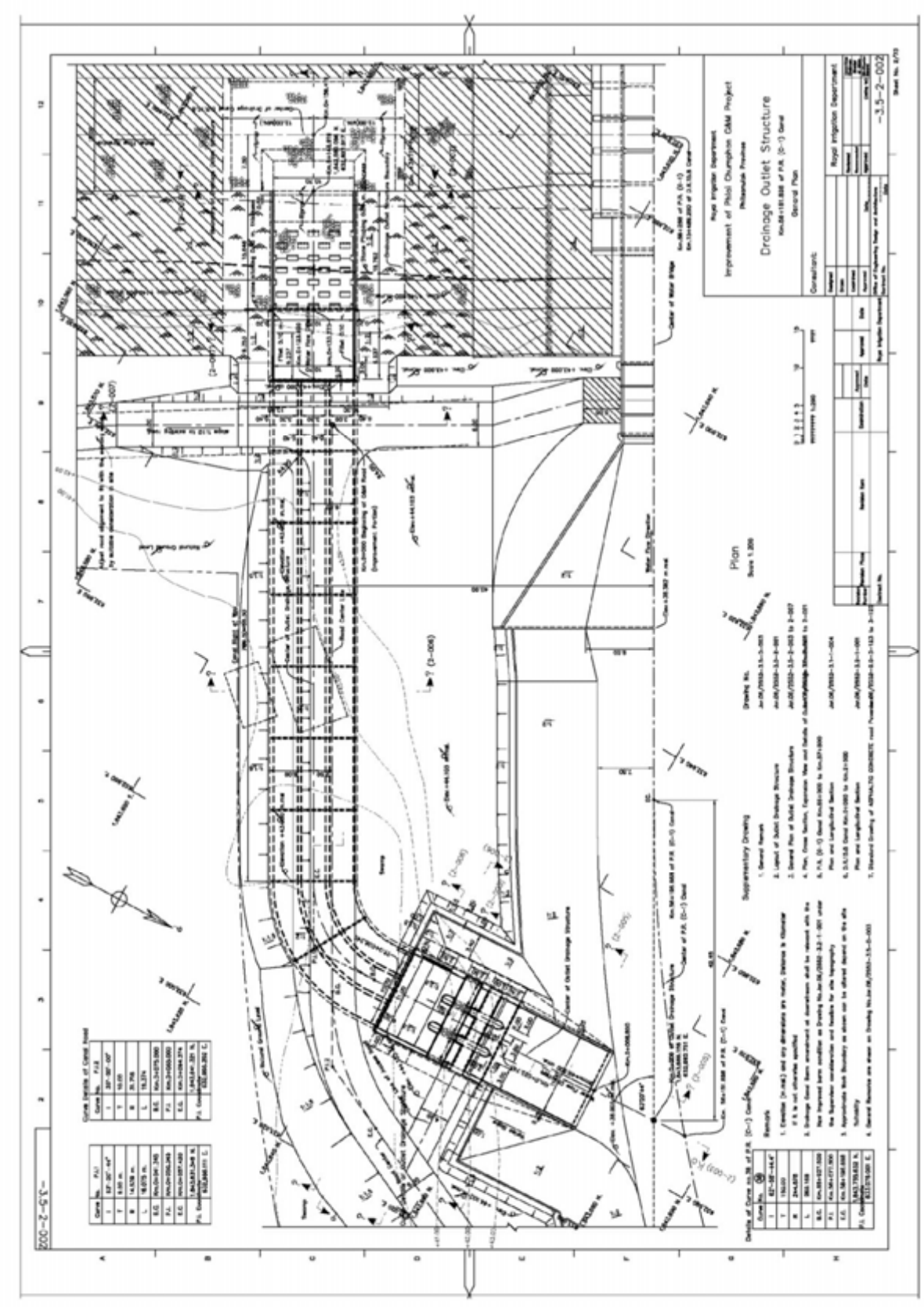
Item	Description	Unit	Quantity	Unit Cost	Total Cost	Sum
	Side Drainage Regulator Sta. 56+151.898 of PR.(C-1) Canal					
1.	Earth Work					
1.1	- Clearing work by machine	sq.m.	7,365.00	18.25	134,411.25	
1.2	- Striping work by machine	cu.m.	2,210.00	17.06	37,702.60	
1.3	- Earth excavation work by machine	cu.m.	11,590.00	53.06	614,965.40	
1.4	- Earth excavation work by hand	cu.m.	1,543.70	113.50	175,209.95	
1.5	- Earth filling and compacting 95 % by machine	cu.m.	10,490.00	159.86	1,676,931.40	
1.6	- Earth filling and compacting by light weight machine	cu.m.	1,400.00	113.57	158,998.00	
2.	Gravel and sand bedding 0.20 m. thick	cu.m.	535.70	1,137.35	609,278.40	
3.	Lean concrete	cu.m.	174.00	2,003.42	348,595.08	
4.	Structural concrete	cu.m.	2,645.00	2,852.19	7,544,042.55	
5.	Concrete lining for canal	cu.m.	46.00	2,551.01	117,346.46	
6.	WIRE MESH 5 mm. @ 0.20 m.	sq.m.	456.00	62.51	28,504.56	
7.	Plastic work 0.50 mm. thick	sq.m.	456.00	45.50	20,748.00	
8.	Form work	sq.m.	5,616.00	582.77	3,272,836.32	
9.	Steel Reinforcement					
9.1	- DB.12 mm.	kg.	863.00	30.84	26,614.92	
9.2	- DB.16 mm.	kg.	64,300.00	30.73	1,975,939.00	
9.3	- DB.20 mm.	kg.	114,700.00	30.53	3,501,791.00	
9.4	- DB.25 mm.	kg.	27,220.00	30.53	831,026.60	
10	Hand rail	m.	95.00	1,235.72	117,393.40	
11	Rubber Water Stop Type "A"	m.	151.00	598.00	90,298.00	
12	Rubber Water Stop Type "C"	m.	159.00	230.00	36,570.00	
13	Elastic filler 0.01 m. thick	sq.m.	94.00	360.00	33,840.00	
14	Sealing compound	sq.m.	129.00	46.92	6,052.68	
15	Joint sealant 1x3 cm.	m.	416.00	528.00	219,648.00	
16	Drainage gate 3.00x4.00 m. with lifting equipment +Blockout	set	3.00	1,050,000.00	3,150,000.00	
17	Bulkhead gate 3.00m.x0.90 m.x4set + Blockout x 3set	L.S.	1.00	1,350,000.00	1,350,000.00	
18	Roof work with steel structure for gate lifting equipment including other accessories	place	1.00	100,000.00	100,000.00	
19	Ladder to operation floor	place	2.00	50,000.00	100,000.00	
20	Ladder rung	place	3.00	33,000.00	99,000.00	
21	Placed riprap 0.50 m. thick	cu.m.	449.00	1,085.95	487,591.55	
22	Drump riprap 0.50 m. thick	cu.m.	230.00	760.20	174,846.00	
23	L-steel bar 100x100x12 mm. (17.8 kg./m. weight) for peir protection	place	2.00	10,000.00	20,000.00	
24	Asphaltic pavement road work for operation & maintenance	sq.m.	1,175.00	274.21	322,196.75	
25	Sodding	sq.m.	2,163.00	23.23	50,246.49	
	Sub-Total (A)				27,432,624.36	
	Temporary work	%	5%		1,371,631.22	
	Sub-Total (B)				28,804,255.57	
	Contingency	%	10%		2,880,425.56	
	Total of Direct Cost				31,684,681.13	
	Factor "F"		1.2223		7,043,182.23	
	Contract cost include Factor "F"				38,727,863.36	
	Construction supervision cost by Local Consultant					
	- Senior Engineer	L.S.			950,400.00	
	- Junior Engineer	L.S.			396,000.00	
	Sub-Total (C)				1,346,400.00	
	Total Budget				40,074,263.36	Say 40,100,000

(7) Quantity (Outlet Drainage Structure at Sta.56+151.898)

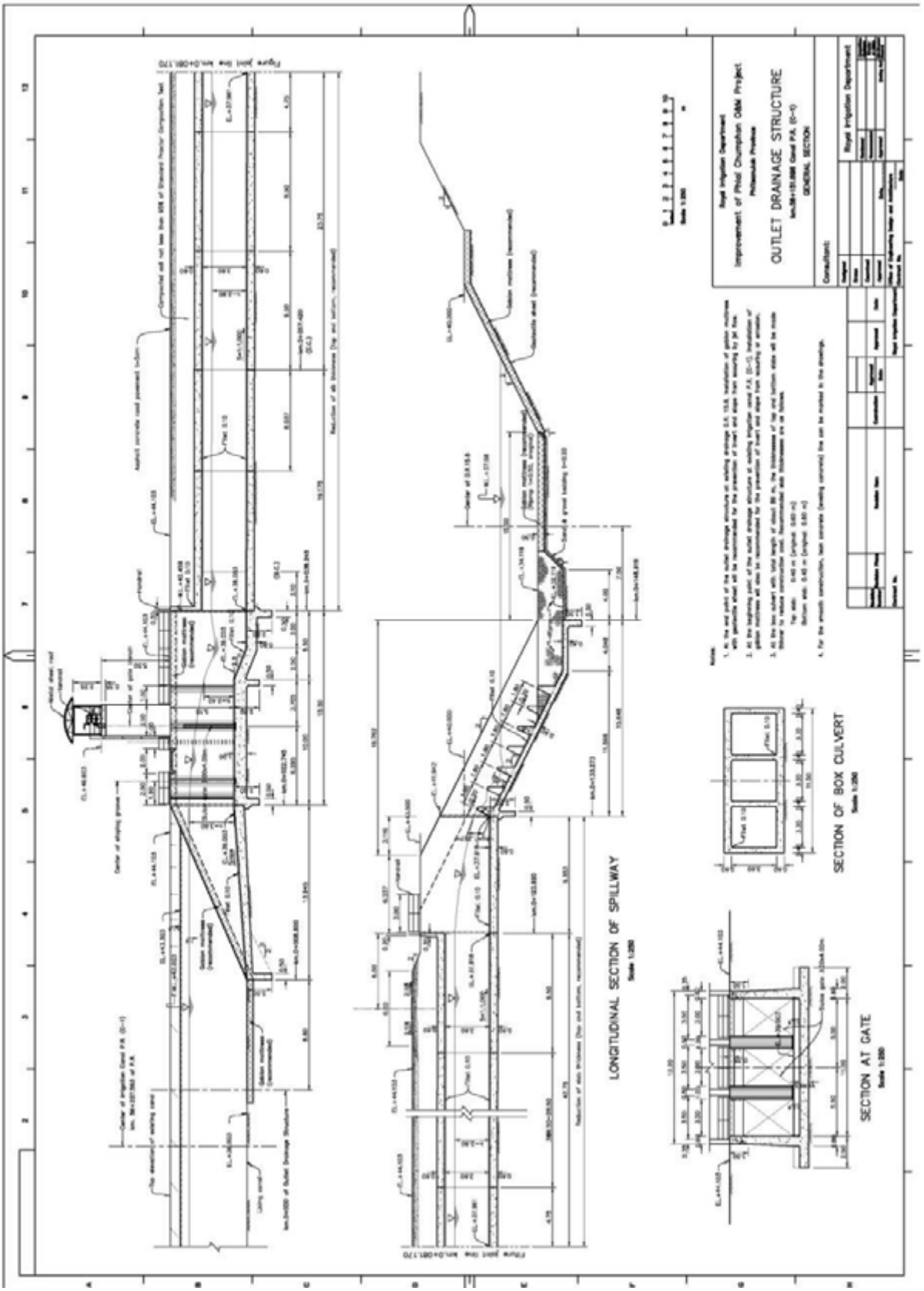
Revised Quantity Calculation of Outlet Drainage Structure at km. 56+151.898

Item	Description	Unit	Original Quantity	Revised Quantity
	Side Drainage Regulator Sta. 56+151.898 of PR.(C-1) Canal			
1.	Earth Work			
1.1	- Clearing work by machine	sq.m.	7,300.00	7,365.00
1.2	- Striping work by machine	cu.m.	2,725.00	2,210.00
1.3	- Earth excavation work by machine	cu.m.	28,650.00	11,590.00
1.4	- Earth excavation work by hand	cu.m.	300.00	1,543.70
1.5	- Earth filling and compacting 95 % by machine	cu.m.	31,150.00	10,490.00
1.6	- Earth filling and compacting by light weight machine	cu.m.	7,270.00	1,400.00
2.	Gravel and sand bedding 0.20 m. thick	cu.m.	390.00	535.70
3.	Lean concrete	cu.m.	195.00	174.00
4.	Structural concrete	cu.m.	2,605.00	2,645.00
5.	Concrete lining for canal	cu.m.	90.00	46.00
6.	WIRE MESH 5 mm. @ 0.20 m.	sq.m.	925.00	456.00
7.	Plastic work 0.50 mm. thick	sq.m.	925.00	456.00
8.	Form work	sq.m.	5,340.00	5,616.00
9.	Steel Reinforcement			
9.1	- DB.12 mm.	kg.	863.30	863.00
9.2	- DB.16 mm.	kg.	64,306.00	64,300.00
9.3	- DB.20 mm.	kg.	114,682.10	114,700.00
9.4	- DB.25 mm.	kg.	27,219.50	27,220.00
10	Hand rail	m.	105.00	95.00
11	Rubber Water Stop Type "A"	m.	170.00	151.00
12	Rubber Water Stop Type "C"	m.	205.00	159.00
13	Elastic filler 0.01 m. thick	sq.m.	130.00	94.00
14	Sealing compound	sq.m.	110.00	129.00
15	Joint sealant 1x3 cm.	m.	20.00	416.00
16	Drainage gate 3.00x4.00 m. with lifting equipment	set	3.00	3.00
17	Bulkhead gate 3.00x0.90 m.	set	3.00	3.00
18	Roof work with steel structure for gate lifting equipment	place	1.00	1.00
19	Ladder to operation floor	place	2.00	2.00
20	Ladder rung	place	3.00	3.00
21	Placed riprap 0.50 m. thick	cu.m.	1,355.00	449.00
22	Dump riprap 0.50 m. thick	cu.m.	630.00	230.00
23	L-steel bar 100x100x12 mm. (17.8 kg./m. weight) for peir protection	place	2.00	2.00
24	Asphaltic pavement road work for operation & maintenance	sq.m.	625.00	1,175.00
25	Sodding	sq.m.	1,220.00	2,163.00

(8) Revised Plan and Profile Drawings (Outlet Drainage Structure at Sta. 56+151.898)



Design of Plan



Plan of longitudinal section

3.4.5. Implementation Plan of the Pilot Project

(1) Implementation Method

Although the Pilot Project was cancelled, the original plan was for it to be implemented by the Project Team in cooperation with RID. Construction work was to be done by contractors hired through local bidding. Construction supervision was to be done by locally-hired consultants, together with the Project Team in cooperation with RID. Expenses necessary for the construction of the pilot project was to be borne by the Project Team.

(2) Implementation Schedule

- Mid-August to end-September 2012: Preparation of tender documents.
- October 2012: Execution of tender for the selection of contractors and conclusion of the contract.
- November 2012 to April 2013: Construction of the outlet drainage structure in six months.

(3) Implementation Organization

The Project Team was the implementing body for overall operation, management and supervision. Related organizations were RID with the central office, Regional Office 3 and Phlai Chumphon O&M Office for the support in management and technical supervision as a C/P agency, local consultants for construction supervision, and contractors for construction work.

3.5. Conclusions and Recommendations

3.5.1. Conclusions

(1) Flood Recovery and Prevention Projects by RID

i) Project Content: The total number of projects implemented by RID nationwide for flood emergency recovery and prevention are 2,236. Projects under Batch-1, Batch-2, Batch-3, Emergency- SCWRM, and Additional-1 are implemented under the special emergency budget, not under RID's regular annual budget. These projects are directly related to recovery and protection of social, commercial and industrial infrastructure in rural and urban areas.

The 1,283 projects in the study area under the special emergency budget can be categorized into; 1) repair, reconstruction or heightening of river and canal dikes (47%), 2) repair of drainage regulators (25%), 3) repair or reconstruction of roads and bridges (11%), 4) dredging of rivers and canals (7%) and 5) distribution of pumps and generators (5%). Most of the work was to be completed by October 2012 before the wet season. Except for the construction of dams, RID did not formulate medium to long-term recovery and prevention plans for existing irrigation facilities damaged by the 2011 flood.

On the other hand, flood recovery of irrigation facilities related to agricultural production are part of the regular O&M works by O&M Project Offices (86 offices nationwide and 49 offices in the study area for large-scale irrigation systems) and RID Regional Irrigation Offices (731 systems nationwide and 151 systems in the study area for medium-scale irrigation). They are formulated as part of the 6-year MTEF plan (2012-2017) in which 1,180 O&M projects are listed in the study area..

ii) Project Costs: The total number of RID projects approved as of August 2012 was 2,236 with a total budget of 12 billion baht for the entire country. Proposals for dam construction which require longer implementation periods are still under the approval process.

iii) Engineering Aspects: The type of engineering involved in the emergency recovery projects are earth work, concrete work, stone work, pile driving, slope protection, cofferdam work, dredging,

pump and generator supply, etc. For the design of those works, RID can generally handle the work required, such as damage investigation, topographic and geological survey, detailed design, and construction supervision. For the design of mechanical gates and electrical equipment for dams or drainage regulators, support of Thai local consultants may be needed.

As for routine O&M work of existing facilities, there will not be any technical engineering difficulties for RID since it has extensive experience in this area of work.

iv) Implementation Schedule: The RID had planned to complete most emergency recovery projects by October 2012. However, as the project volume is substantial, it is uncertain if they can be completed within the scheduled period even if urgently implemented. Progress will depend on the scale and timing of the flood in 2012.

(2) Projects Assisted by Japan in the Past:

i) The Chao Phraya Irrigation Project: Rehabilitation work will not be required for the Chao Phraya Irrigation Project although agriculture land was inundated in the 2011 flood.

ii) The Pasak Irrigation Project: There was no significant damage in the Pasak Irrigation Project. No recovery work will be needed.

iii) The Small Scale Irrigation Program (SSIP) and the Small Scale Irrigation Improvement and Rehabilitation Project (SSIRP): Some damages were reported in SSIRP. However, TAOs have commenced the recovery work. Some works are already completed and others are underway.

iv) The Large Swamp Inland Fishery Project: The Bung Boraped Sub-Project of LSIFP suffered flood damage of sedimentation and loss of equipment in the fishery center. DOF received the budget for dredging 4 MCM of sediment, and the work is underway. Procurement of the equipment has been requested to DOF Headquarters and the budget allocation is underway.

v) The Small Swamp Inland Fisheries Project: Some damages were reported for SSIFP. They are not serious, most of them are sediment-related.

vi) Overall: Thus, most of the recovery works on projects assisted by Japan in the past are already underway by the efforts of the respective agencies concerned. The recovery works that remain are not considered to be appropriate for the pilot project nor a future Japan yen loan project.

(3) Cancellation of Pilot Project Implementation:

The Pilot Project for the support of flood recovery and prevention was identified as a result of field surveys and discussions with RID. The plan was to construct outlet drainage structures (flood waterways) at Phlai Chumphon O&M Project in Phitsanulok Province. However, shortly after the selection, JICA decided to cancel the Pilot Project. There were concerns about potential duplication or other unintended consequences related to the international bidding for the infrastructure for water resources management and flood prevention initiated by the Thai government. Nevertheless, the project team reviewed the detailed designs for these structures that had been prepared by RID..

3.5.2. Recommendations

Recommendations on countermeasures for flood recovery and prevention on irrigation facilities in the agriculture sector are as follows:

(1) Flood countermeasure by use of irrigation canals as flood waterways

It is recommended that the use of irrigation canals as floodways be promoted. This can help prevent

flood disasters in many places including residential and living areas, commercial and industrial areas, areas with public facilities, historical ruins, rural villages and farmland in local cities and towns situated along flood-prone rivers in the Chao Phraya River basin. In other words, irrigation facilities of both existing and new systems can be utilized not only for agricultural production but also as components of flood disaster prevention systems. For this flood countermeasure, the following issues need to be taken into consideration in project planning and technical design, in addition to the usual requirements when designing irrigation facilities.

i) In the feasibility study, an economic evaluation will be crucial to determine the feasibility of using irrigation canals as flood waterways. In the economic evaluation, project benefits will be the value of flood damage (as reduction of damage), while project costs include construction costs of the outlet drainage structure (floodway) and the increased cost of modifying the irrigation canal to flood waterways, as applicable. Therefore, a flood damage survey should be made in the early stages of the project.

ii) In the hydraulic design, the important issues are analysis of required discharge water from the river into the irrigation canal, hydraulic analysis of the irrigation canal during the discharge of river flood water, and hydraulic analysis of gates, floodway and drains at the outlet drainage structure.

iii) In the structural design, importance will be given to the mechanical design of gates, hoists, bulkhead gates and operation deck at outlet gates section, the structural design of floodways with box culvert or pipe culvert or concrete flume, design of baffle apron and river revetment, and design of foundation treatment.

iv) In the construction planning, cofferdam work in combination with steel sheet piles and large size sand bags will normally be required.

(2) Flood countermeasure by promotion of inundation prevention system

It is recommended that inundation prevention systems be widely promoted wherever applicable to reduce crop damage, mainly of paddy, due to long periods of inundation in irrigated farmlands in the Chao Phraya River basin. For this, the following considerations shall be taken into account.

i) In the feasibility study, an inundation analysis under flood conditions will be conducted. Then a drainage plan will be prepared and used to design drainage facilities. For this purpose, previous years' data of rainfall, catchment area, the timing and duration of inundation, inundation area, etc. are required.

Evaluation of project viability, which is the most important aspect of the inundation prevention system, will be based on environment, social, technical and economic considerations. For the economic evaluation, project benefits will be obtained from the value of crops damaged by floods (as reduction of damage), while project costs are the costs of constructing the facilities to prevent inundation. Therefore, a flood damage survey for crops needs to be conducted in the early stages of the project.

ii) In designing the facilities, two drainage methods should be considered, namely natural drainage with sluice gates and mechanical drainage using pumps. During floods, river water levels are usually higher than water levels inside inundated farmland, thus mechanical drainage by pumps will be necessary. Practically, however, a combination of sluice gates and drainage pumps is often used so that natural drainage, which is more economical, is used during periods without floods, and the more expensive pumping approach isused to prevent inundation.

Table 3.5.1 MTEF Plan for Phlai Chumphon O&M Project

No	Project/Items	Areas			Fiscal Budget Allocation Plan (Million Baht)						
		Tambon	Amphoe	Province	Total	2555 2011-12	2556 2012-13	2557 2013-14	2558 2014-15	2559 2015-16	2560 2016-17
	Regional Irrigation Office 3	*ohd1*	*ohd1*	*ohd1*	*4,089.1440*	*30.0000*	*384.9940*	*1,158.5670*	*775.6890*	*756.2280*	*983.6660*
	Phlai Chumphon O&M Project	*hd2*	*hd2*	*hd2*	*4,089.1440*	*30.0000*	*384.9940*	*1,158.5670*	*775.6890*	*756.2280*	*983.6660*
1	Improvement of water distribution system for P.R.-8.7R.canal (C-5) (km.8+270 -	Phrompiram, Tha	Phrompiram	Phitsanulok	30.0000	30.0000	-	-	-	-	-
2	Improvement of water distribution system for P.R.canal (C-1)	Nong Khaem,Yan	Phrompiram	Phitsanulok	2,200.0000	-	-	550.0000	550.0000	550.0000	550.0000
3	Improvement of water distribution system for P.R.-5.3R. canal (C-2)	Phrompiram	Phrompiram	Phitsanulok	20.0000	-	-	-	-	-	20.0000
4	Improvement of water distribution system for P.R.-5.3R.-4.2R. canal (C-3)	Phrompiram, Nong	Phrompiram	Phitsanulok	20.0000	-	-	-	-	-	20.0000
5	Improvement of water distribution system for P.R.-5.3R.-4.2R.-0.4L. canal (C-4)	Nong Khaem	Phrompiram	Phitsanulok	10.0000	-	-	-	-	-	10.0000
6	Improvement of water distribution system for P.R.-8.7R. canal (C-5) stage 2	Phrompiram, Tha	Phrompiram	Phitsanulok	119.8190	-	60.0000	59.8190	-	-	-
7	Improvement of water distribution system for P.R.-8.7R.-5.2R. canal (C-6) km.0+000 to	Tha Chang	Phrompiram	Phitsanulok	8.7000	-	-	-	-	-	8.7000
8	Improvement of water distribution system for P.R.-8.7R.-5.5L. canal (C-7) km.0+000 to	Tha Chang	Phrompiram	Phitsanulok	9.9200	-	-	-	-	-	9.9200
9	Improvement of water distribution system for P.R.-8.7R.-8.5L. canal (C-8) km. 0+000 to	Tha Chang	Phrompiram	Phitsanulok	17.4000	-	-	-	-	-	17.4000
10	Improvement of water distribution system for P.R.-10.6R. canal (C-9)	Tha Chang, Ma Tum	Phrompiram	Phitsanulok	11.3000	-	-	-	-	-	11.3000
11	Improvement of water distribution system for P.R.-17.0R. canal (C-10) km.0+000 to	Ma Tum, Phai Ko	Phrompiram,	Phitsanulok	44.1000	-	-	-	22.1000	22.0000	-
12	Improvement of water distribution system for P.R.-17.0R.-3.6R. canal (C-11)	Phai Ko Don	Mueang	Phitsanulok	20.0000	-	-	-	-	-	20.0000
13	Improvement of water distribution system for P.R.-17.0R.-3.6L. canal (C-12) km.0+000 to	Phai Ko Don	Mueang	Phitsanulok	14.3000	-	-	-	-	-	14.3000
14	Improvement of water distribution system for P.R.-22.2R canal (C-13)	Jom Thong, Ban	Mueang	Phitsanulok	20.0000	-	-	-	-	-	20.0000
15	Improvement of water distribution system for P.R.-23.7R canal (C-14)	Ban Krang, Tha Nang	Mueang	Phitsanulok	73.9000	-	-	-	48.9000	25.0000	-
16	Improvement of water distribution system for P.R.-25.0R canal (C-15)	Ban Krang, Tha Nang	Mueang, Bang	Phitsanulok	164.2110	-	84.6400	79.5710	-	-	-
17	Improvement of water distribution system for P.R.-36.9R canal (C-16) km.0+000 to	Tha Thong	Mueang	Phitsanulok	16.7400	-	-	-	-	-	16.7400
18	Improvement of water distribution system for P.R.-40.1R canal (C-17) stage 1	Tha Pho, Bang	Mueang, Bang	Phitsanulok	20.0000	-	-	-	-	-	20.0000
19	Improvement of water distribution system for P.R.-40.1R-2.8R canal (C-18) km.0+000 to	Tha Pho	Mueang	Phitsanulok	26.5000	-	-	-	-	-	26.5000
20	Improvement of water distribution system for P.R.-40.5R canal (C-19) km.0+000 to	Tha Pho	Mueang	Phitsanulok	24.2000	-	-	-	24.2000	-	-
21	Improvement of water distribution system for P.R.-40.5R - 2.6L canal (C-20) km.0+000 to	Tha Pho	Mueang	Phitsanulok	20.0000	-	-	-	-	20.0000	-
22	Improvement of water distribution system for P.R.-40.5R - 2.6L - 2.6R canal (C-21)	Tha Pho	Mueang	Phitsanulok	53.0000	-	-	26.5000	26.5000	-	-

No	Project/Items	Areas			Fiscal Budget Allocation Plan (Million Baht)						
		Tambon	Amphoe	Province	Total	2555 2011-12	2556 2012-13	2557 2013-14	2558 2014-15	2559 2015-16	2560 2016-17
45	Improvement of water drainage system for D.R.1-43L.-0L. drainage canal km.0+000 to	Tha Chang	Phrompiram	Phitsanulok	0.2540	-	-	0.2540	-	-	-
46	Improvement of water drainage system for D.R.1-41L. drainage canal km.0+000 to	Tha Chang	Phrompiram	Phitsanulok	0.0160	-	-	-	0.0160	-	-
47	Improvement of water drainage system for drainage canal of D.R.1-30L. km.0+000 to	Tha Chang	Phrompiram	Phitsanulok	4.4460	-	-	-	4.4460	-	-
48	Improvement of water drainage system for D.R.1-30L.-1R. drainage canal km.0+000	Tha Chang	Phrompiram	Phitsanulok	0.7870	-	-	-	0.7870	-	-
49	Improvement of water drainage system for D.R.1-30L.-5L. drainage canal km.0+000 to	Phai Ko Don	Mueang	Phitsanulok	0.6270	-	-	-	0.6270	-	-
50	Improvement of water drainage system for D.R.1-30L.-5R. drainage canal km.0+000	Tha Chang, Phai Ko	Phrompiram,	Phitsanulok	0.4390	-	-	-	0.4390	-	-
51	Improvement of water drainage system for D.R.1-25L. drainage canal km.0+000 to	Phai Ko Don	Mueang	Phitsanulok	0.7970	-	-	-	-	0.7970	-
52	Improvement of water drainage system for D.R.1-21L. drainage canal km.0+000 to	Ban Krang	Mueang	Phitsanulok	3.6330	-	-	-	-	3.6330	-
53	Improvement of water drainage system for D.R.1-21L.-5L. drainage canal km.0+000 to	Phai Ko Don	Mueang	Phitsanulok	0.5240	-	-	-	-	0.5240	-
54	Improvement of water drainage system for D.R.1-19L drainage canal km.0+000 to	Ban Krang	Mueang	Phitsanulok	4.7680	-	-	4.7680	-	-	-
55	Improvement of water drainage system for D.R.15.8-6L drainage canal km.0+000 to	Tha Pho	Mueang	Phitsanulok	4.4660	-	-	-	4.4660	-	-
56	Improvement of water drainage system for D.R.15.8-10L drainage canal km.0+000 to	Wat Phrik	Mueang	Phitsanulok	0.9740	-	-	-	-	0.9740	-
57	Improvement of water drainage system for D.R.1-4L drainage canal km.0+000 to	Tha Nang Ngam	Bang Rakam	Phitsanulok	1.7820	-	-	1.7820	-	-	-
58	Improvement of water drainage system for D.R.1-10L.-5R. drainage canal km.0+000 to	Tha Thong, Phlai	Mueang	Phitsanulok	1.9760	-	-	-	-	-	1.9760
59	Improvement of water drainage system for D.R.1-10L drainage canal km.0+000 to	Tha Nang Ngam, Tha	Bang Rakam,	Phitsanulok	3.6500	-	-	-	-	-	3.6500
60	Improvement of water drainage system for D.R.15.8-14L. drainage canal km.0+000 to	Ngiew Ngam	Mueang	Phitsanulok	0.7360	-	-	0.7360	-	-	-
61	Improvement of water drainage system for D.R.2.-145L. drainage canal km.0+000 to	Wang Ithok,	Bang Rakam,	Phitsanulok	0.0650	-	-	0.0650	-	-	-
62	Improvement of water drainage system for D.R.2.-138L. drainage canal km.0+000 to	Kamphaeng Din	Sam Ngam	Phichit	0.1590	-	-	-	0.1590	-	-
63	Improvement of water drainage system for D.R.2-134L. drainage canal km.0+000 to	Kamphaeng Din	Sam Ngam	Phichit	0.0070	-	-	-	0.0070	-	-
64	Improvement of water drainage system for D.R.2-129L. draingae canal km.0+000 to	Kamphaeng Din	Sam Ngam	Phichit	0.2020	-	-	-	0.2020	-	-
65	Improvement of water drainage system for D.R.2-125L. drainage canal km.0+000 to	Sam Ngam	Sam Ngam	Phichit	1.3400	-	-	-	1.3400	-	-

No	Project/Items	Areas			Fiscal Budget Allocation Plan (Million Baht)						
		Tambon	Amphoe	Province	Total	2555 2011-12	2556 2012-13	2557 2013-14	2558 2014-15	2559 2015-16	2560 2016-17
65	Improvement of water drainage system for D.R.2-103L-0R drainage canal km.0+000	Sam Ngam	Sam Ngam	Phichit	-	-	-	-	-	-	-
65	Improvement of water drainage system for D.R.2-103L-0R -3L drainage canal				-	-	-	-	-	-	-
66	Dike improvement for DK.1 km.0+000 to km .43+500	Tha Nang Ngam	Bang Rakam	Phitsanulok	41.2500	-	-	41.2500	-	-	-
67	Improvement of dike for DK.1 km.43+592 to km.62+034.731	Nong Khaem,	Phrompiram, Bang	Phitsanulok	19.5000	-	-	19.5000	-	-	-
68	Dike improvement for DK.2 km.0+000 to km .10+446	Wang Ithok, Bang	Bang Rakam	Phitsanulok	25.0000	-	-	25.0000	-	-	-
69	Dike improvement for DK.2 km.10+446 to km .59+385	Wang Ithok, Rang	Bang Rakam,	Phitsanulok	7.5000	-	-	-	-	-	7.5000
70	Construction of pumping station at drainage canal tail for D.R.1-59L.	Nong Khaem	Phrompiram	Phitsanulok	10.5000	-	-	-	-	-	10.5000
71	Construction of pumping station at drainage canal tail for D.R.1-56L.	Nong Khaem	Phrompiram	Phitsanulok	9.5000	-	-	-	-	-	9.5000
72	Construction of pumping station at drainage canal tail for D.R.1-49L.	Phrompiram	Phrompiram	Phitsanulok	10.2000	-	-	-	-	-	10.2000
73	Construction of pumping station at drainage canal tail for D.R.1-43L.	Phrompiram	Phrompiram	Phitsanulok	24.1000	-	-	24.1000	-	-	-
74	Construction of pumping station at drainage canal tail for D.R.1-41L.	Tha Chang	Phrompiram	Phitsanulok	5.5200	-	-	-	-	-	5.5200
75	Construction of pumping station at drainage canal tail for D.R.1-30L.	Tha Chang	Phrompiram	Phitsanulok	43.6000	-	-	43.6000	-	-	-
76	Construction of pumping station at drainage canal tail for D.R.1-21L.	Ban Krang	Mueang	Phitsanulok	27.9000	-	-	-	27.9000	-	-
77	Construction of pumping station at drainage canal tail for D.R.1-19L.	Ban Krang	Mueang	Phitsanulok	19.4000	-	-	19.4000	-	-	-
78	Construction of pumping station at drainage canal tail for D.R.1-10L.	Tha Nang Ngam	Bang Rakam	Phitsanulok	34.6000	-	-	34.6000	-	-	-
79	Construction of pumping station at drainage canal tail for D.R.1-4L.	Tha Nang Ngam	Bang Rakam	Phitsanulok	10.6000	-	-	-	-	-	10.6000
80	Construction of pumping station at drainage canal tail for Khlong Go	Wang Ithok	Bang Rakam	Phitsanulok	11.6200	-	-	11.6200	-	-	-
81	Construction of pumping station at drainage canal tail for D.R.2-145L.	Wang Ithok	Bang Rakam	Phitsanulok	7.9000	-	-	-	-	-	7.9000
82	Construction of pumping station at drainage canal tail for D.R.2-138L.	Kamphaeng Din	Sam Ngam	Phichit	8.1000	-	-	8.1000	-	-	-
83	Construction of pumping station at drainage canal tail for D.R.2-129L.	Kamphaeng Din	Sam Ngam	Phichit	8.9600	-	-	8.9600	-	-	-
84	Construction of pumping station at drainage canal tail for D.R.2-103L.0R.	Rang Nok	Sam Ngam	Phichit	34.9000	-	-	-	-	34.9000	-
85	Construction of gate of main irrigation canal head, right bank	Nong Khaem	Phrompiram	Phitsanulok	67.6010	-	-	-	-	67.6010	-

No	Project/Items	Areas			Fiscal Budget Allocation Plan (Million Baht)						
		Tambon	Amphoe	Province	Total	2555 2011-12	2556 2012-13	2557 2013-14	2558 2014-15	2559 2015-16	2560 2016-17
86	Improvement of gate of main irrigation canal head, right bank	Nong Khaem	Phrompiram	Phitsanulok	0.5340	-	-	0.5340	-	-	-
87	Construction of spillway km.56+151.898 for P.R. canal (C-1)	Ngiew Ngam	Mueang	Phitsanulok	39.1400	-	39.1400	-	-	-	-
88	Construction of spillway km.63+240.740 for P.R. canal (C-1)	Ban Rai	Bang Kra Thum	Phitsanulok	37.4000	-	37.4000	-	-	-	-
89	Construction of office building of Phlai Chumphon O & M Project	Tha Thong	Mueang	Phitsanulok	60.5000	-	-	-	-	-	60.5000
90	Improvement of office building of O & M branch 1	Nong Khaem	Phrompiram	Phitsanulok	17.6000	-	-	-	17.6000	-	-
91	Improvement of office building of O & M branch 2	Jom Thong	Mueang	Phitsanulok	22.0000	-	-	-	22.0000	-	-
92	Improvement of office building of O & M branch 3	Ban Rai	Bang Kra Thum	Phitsanulok	22.0000	-	-	22.0000	-	-	-
93	Improvement of bridge across main irrigation canal km. 17+240	Ma Tum	Phrompiram	Phitsanulok	7.0940	-	7.0940	-	-	-	-
94	Improvement of bridge across main irrigation canal km.49+389.36	Wat Phrik	Mueang	Phitsanulok	6.2360	-	6.2360	-	-	-	-
95	Improvement of bridge across main irrigation canal km.52+950	Wat Phrik	Mueang	Phitsanulok	5.4500	-	-	5.4500	-	-	-
96	Improvement of bridge across main irrigation canal km.62+556	Ban Rai	Bang Kra Thum	Phitsanulok	3.8800	-	-	3.8800	-	-	-
97	Improvement of bridge across main irrigation canal km.57+750	Ngiew Ngam	Mueang	Phitsanulok	6.5190	-	6.5190	-	-	-	-
98	Improvement of bridge across main irrigation canal km.70+848	Kok Salut	Bang Kra Thum	Phitsanulok	5.8550	-	5.8550	-	-	-	-

MTEF: Mid-Term Expenditure Framework

Note: Five projects (NO. 16, 93, 94, 97 &98) were approved for 2012/13 budget year to commence the work in October 2012, according to the project office.

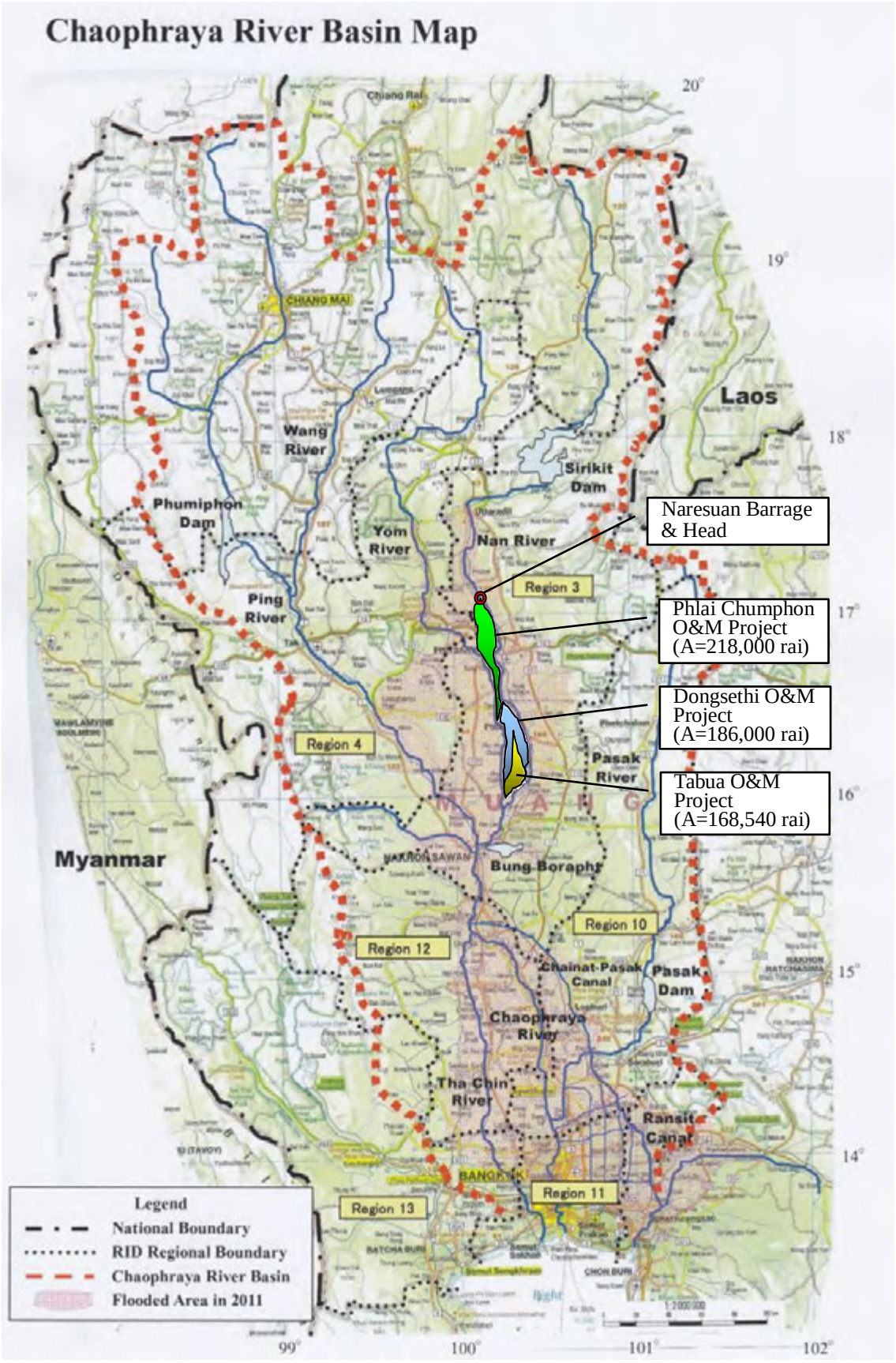


Figure 3.5.1 Location Map of Phlai Chumphon O&M Project

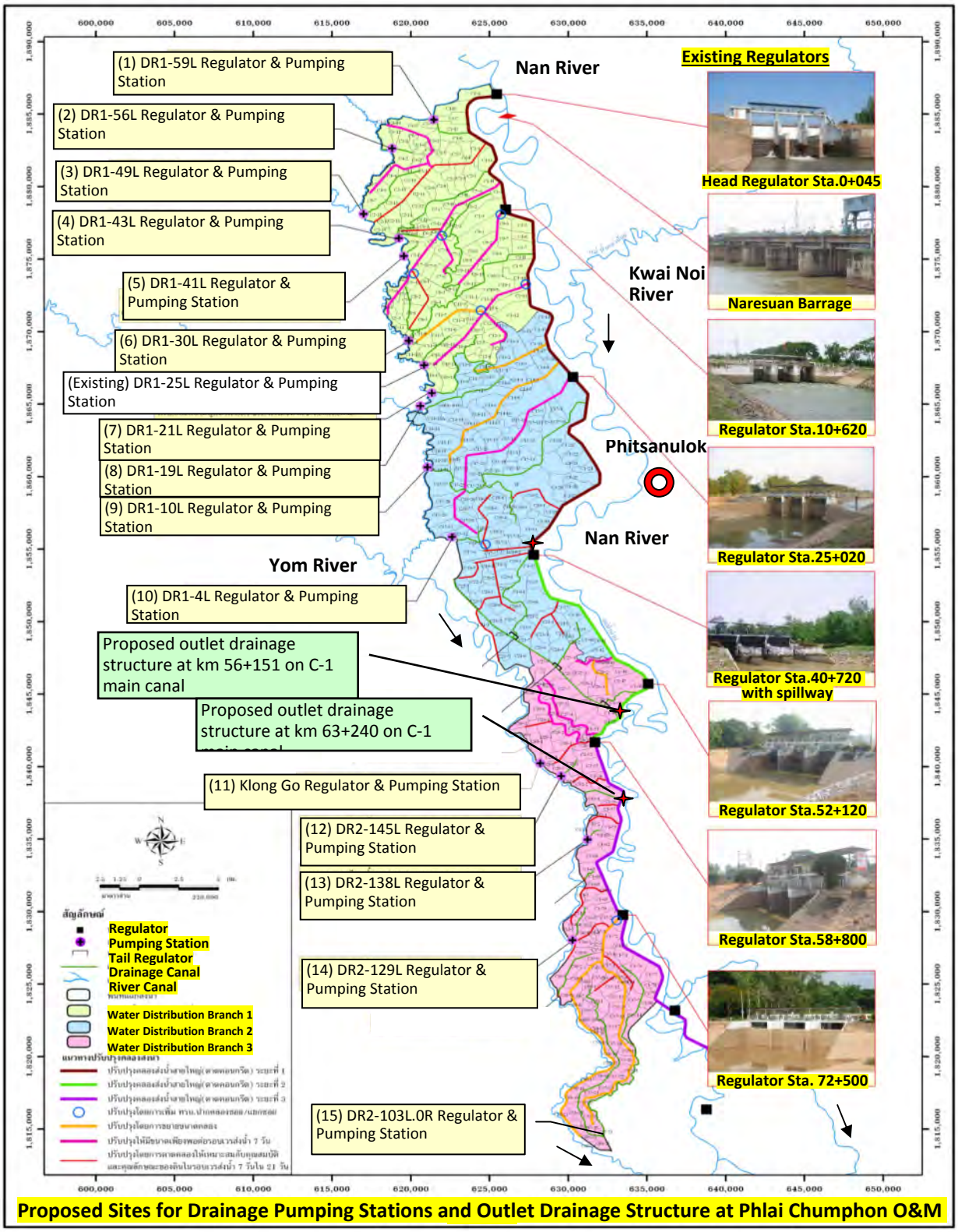


Figure 3.5.2 Proposed Sites for Drainage Pumping Stations and Outlet Drainage Structures at Phlai Chumphon O&M Project

CHAPTER 4. COMPONENT 3: GUIDELINES FOR DISASTER-RESILIENT AGRICULTURE AND AGRICULTURAL COMMUNITY

4.1. Overview of Component 3

4.1.1. Component 3 Output

The output of Component 3 is guidelines on disaster-resilient agriculture and agricultural community planning. These guidelines were designed for use in the entire Chao Phraya River basin so that rural agricultural communities in these areas will be ready and capable to cope with any future large floods.

4.1.2. Selection of Model Areas for Component 3

(1) Selection of Provinces

Five provinces (changwat) were selected to represent different areas in the Chao Phraya River Basin as follows: Phitsanulok (the upper Chao Phraya River Basin), Chainat (the upper Chao Phraya Delta), Pra Nakhon Si Ayutthaya (hereinafter Ayutthaya)(the middle Delta), Pathum Thani (the lower Delta) and Nakhon Pathom (the lower Delta).. The fifth province Nakhon Pathom was primarily selected for the orchid cultivation sub-sector.. In the kick-off meeting held on 28th March, 2012, JCC members agreed on the selection of provinces and selection criteria for model areas to be selected at provincial level (see Appendix I-A-1-2).

(2) Selection of Model Tambons

Selection of model areas were made in each province based on the following criteria: 1) a variety of farming systems is represented, 2) the community is characterized by strong social bonds, cooperative towards government agencies, and is recommended by provincial government offices, 3) the area suffered flood damage in 2011, and 4) may be affected by the government flood mitigation plans such as for water retention, including monkey cheek reservoirs, or floodways. While the Model Areas were selected at the Tambon (sub-district) level, some model pilot activities were implemented only in parts of a Tambon or covered more than one Tambon. While the Model Areas were selected at the Tambon (sub-district) level, some model pilot activities were implemented only in parts of a Tambon or covered more than one Tambon. The farming systems of the selected model areas are summarized below.

Table 4.1.1 Farming System of Selected Model Areas

Area	Province (*changwat*)	District (*amphoe*)	Tambon	River/ Irrigation	Farming System	
Upper Chao Phraya River Basin	Phitsanulok	Bang Rakam	Chum Saeng Songkhram	Yom River flood plain Rainfed Area	Paddy, Field Crop, Fish capture	1
		Bang Krathum	Nakhon Pa Mak	Kwae Wantong tributary of Nan River Rainfed Area	Paddy, Field crops Integrated Farming	2
Upper Delta	Chainat	Wat Sing	Wang Man	Wang Man Riv. tributary of Tha Chin River Rainfed	Field Crop, Paddy Cattle	3
		Sapphaya	Khao Kaeo	Manorom O&M Project Maha Raj O&M Project	Paddy only	4
Middle Delta	Phra Nakhon Si Ayutthaya	Bang Ban	Gop Chao	Bang Ban O&M Project Monkey Cheek Project	Paddy only <near Industrial Estate>	5
		Lat Bua Luang	Singhanat	Phraaya Banlue O&M Project	Paddy, Vegetable, Fruit tree, Livestock <Muslim>	6
Lower Delta	Pathum Thani	Khlong Luang	Khlong Ha	North Rangsit O&M Project	Paddy, Convert to houses <Urbanizing Area>	7
	Nakhon Pathom	Bang Len	Naraphirom	Pra Pi Mon O&M Project	Paddy, Orchid	8 *

Source: JICA Project Team

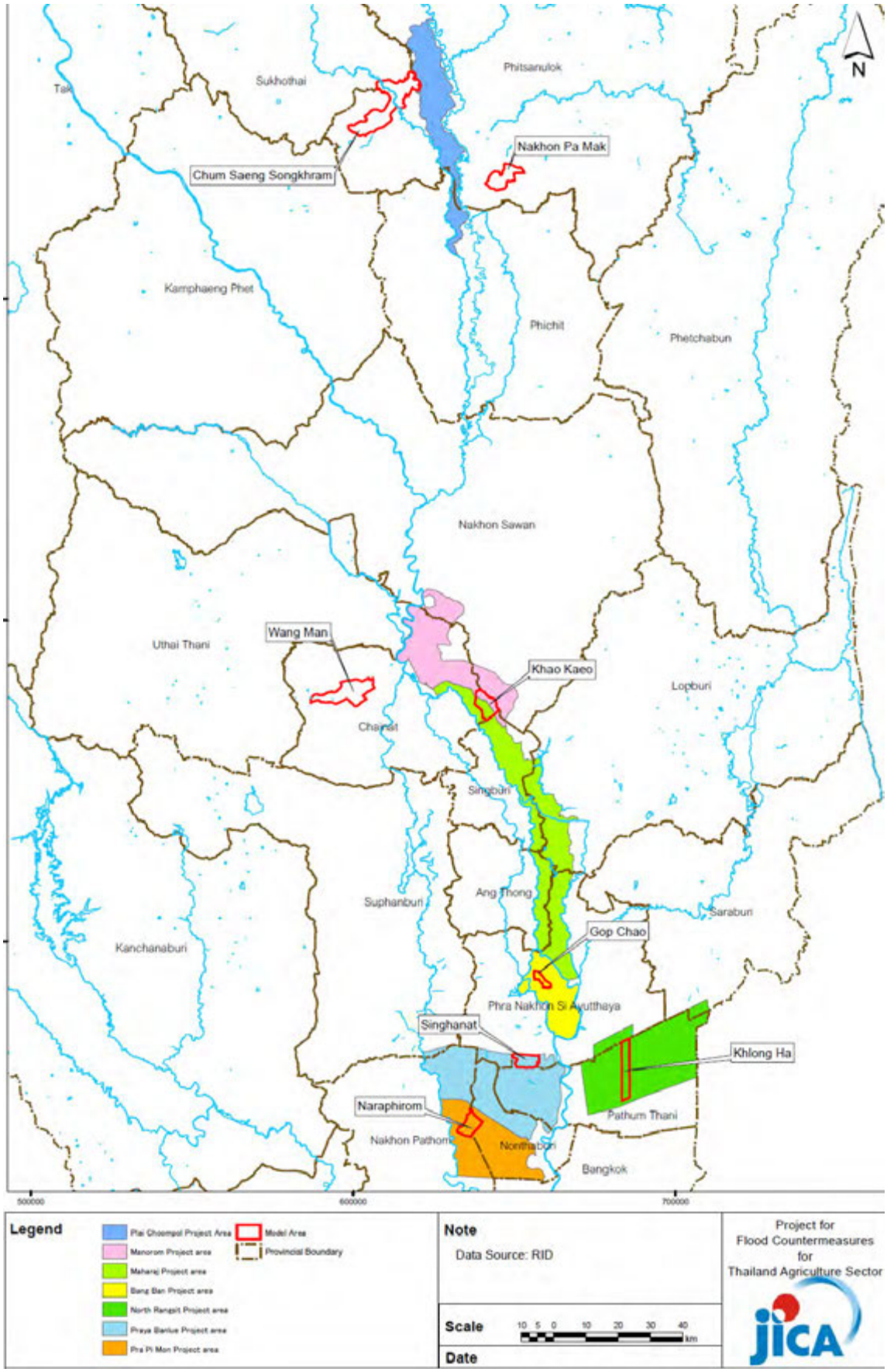


Figure 4.1.1 Location Map of Model Areas

4.1.3. Preparation Process for the Guidelines and Pilot Projects

In preparing the Guidelines, a participatory planning process was used in which communities were the main actors of the process. A "learning process approach" was taken to formulate the Guidelines based on lessons learned from pilot projects and activities by provincial task force members and villagers. This process of planning is also included in the general guidelines, after adjustments based on experience. Also included are details of the model projects/activities, the pilot initiatives with successful results and considered useful to disseminate (refer to Appendix II). In addition, information and communication materials such as leaflets, booklets and DVDs of the model activities were prepared in the Thai language.

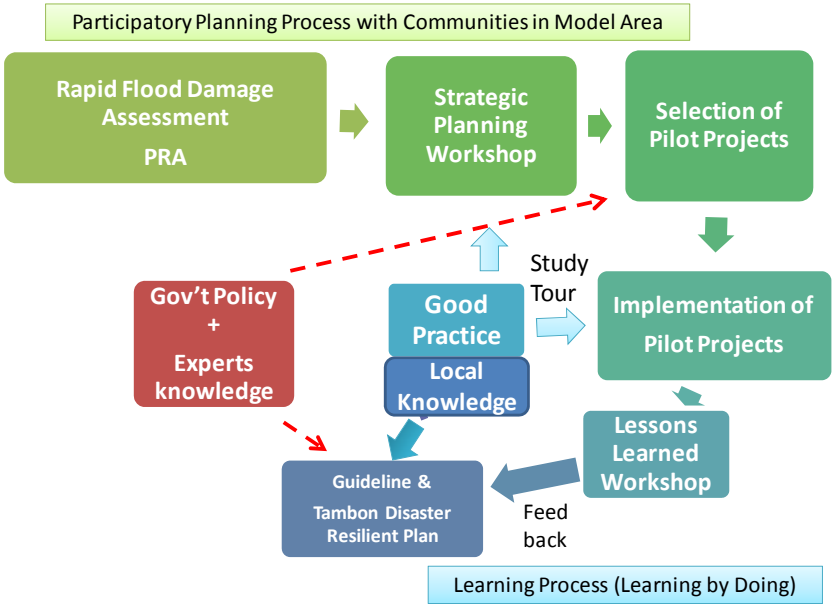
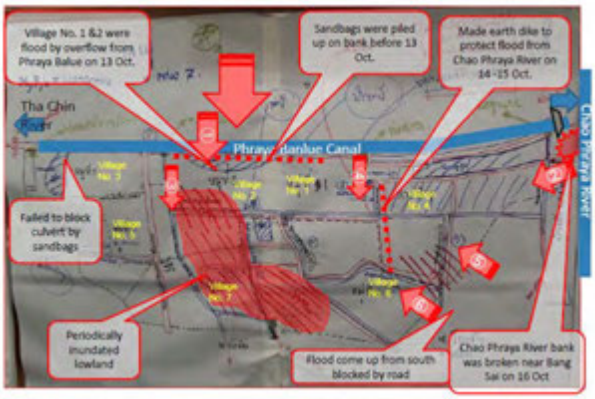


Figure 4.1.2 Implementation Process of Component 3
Source : JICA Project Team

(1) Rapid Flood Damage Assessment (PRA)

In order to understand the general condition of communities and assess the flood damage in the model Tambon areas, a rapid flood damage assessment was conducted through a workshop and walk-through survey. Using the Participatory Rural Appraisal (PRA) methodology, key informant interviews and focus group discussions were conducted. In addition to the extent of damage from the 2011 flood, the assessments collected information on how the flood occurred, how people respond to the normal, periodic floods, the current situation and issues of agriculture, and existing local resources.



It was confirmed that PRA is a useful survey method that enables outsiders to collect information about flood affected communities. With this method, it is possible, in a relatively short time, to understand the mechanism of flood occurrence at local levels and vulnerabilities of communities.

Full results of the PRA are compiled in the Community Case Studies in Appendix III. The table below summarizes the salient features of each model area and issues related to the 2011 flood (see also Appendix I-D-3).

Table 4.1.2 Salient Features of the Model Areas

Model area	Salient Feature of Model Areas		Situation in 2011 Flood and Future Government Plan for Flood Mitigation
	Location and Water Environment	Farming System and Livelihood	
1. T. Chum Saeng Songkhram A. Bang Rakam, Phitsanulok	- Flood Plain of Yum River - Floods come from Sukhothai every year - Partly upland and Water shortage in dry season	- 70% is paddy field (2-3 times/ year) - Fishing in flood season - Sugarcane	- Under water 141days - Bang Rakam - Have plan to make Water retention area 'Thung Bang Rakam'
2. T. Nakhon Pa Mak A.BangKratum Phitsanulok	- Flood Plain of Nan River basin. Flood came from Kwae Wang Tong and Nan River - Partly upland and water shortage in dry season	- 90% is paddy field (2-3 times/ year) - Some jasmine rice - 10% is sugarcane - Banana small, but common	- 65 days flooded from Aug. to Oct. - Water overflowed from Nam river (south part) - Possibility to be a water retention area
3. T. Wang Man A. Wat Sing Chainat	- Rain-fed sloped upland - Flash flood came from western mountainous area - Water shortage in dry season	- 50% is paddy (1 time/ year) - Sugarcane & cassava on upland - Migration problem	- Usually by inundation (2-3 months) but in 2011, it was flash flood (2 months)
4. T. KhaoKaeo A.Sapphaya Chainat	- Near Chao Phraya Dam - In 2 large-scale Irrigation Manorom & Maharaj Proj. - In lowland area 'Tung Chan Rak' flood came from southern area through drainage gate	- 90% is paddy field (2 times/ year) - Community rice center available	- The first flooded area with 3m depth for 3 months. - Evacuation center set up. Evacuated outside Tambon - Plan to be a Water Retention Area.
5. T.Gop Chao A.Bang Ban Ayutthaya	- Near Ayutthaya town and Industrial estates. - In the Bang Ban Polder Dike/ Pumping Project - Inundated every year, water from Noi River.	- 80% is paddy field (2-3 times/ year) - 10% is banana & field crops - 55% of people are employed (industry)	- Pilot project of Monkey cheek is under construction. Pumping water into polder dike up to 3m
6. T.Singhanat A.LatBuaLuang Ayutthaya	- Southern part of Ayutthaya adjacent to Pathumthani - Along Praya Banlue Canal connecting Chao Phraya and Tha Chin River - Partly Land Reform Area and Polder Dike of OECF loan project	- 70% is paddy field (2 times/ year) - 26% is fruit (mango) all died in 2011 - Vegetable for local and EU market - 20% are Muslim raising cattle and goat	- Flood water flow from Ayutthaya and riverbank broke of Chao Phraya River - Whole Tambon area flooded - Will be protected by elevating dike of Praya Banglue Canal
7. T. Khlong Ha A. KhlongLuang Pathumthani	- Urbanizing area near BKK and Industrial Estates. - Part of Rangsit North Large Scale Project - Rama-IX reservoir as Monkey Cheek	- 49% is paddy field (2.5 times/ year) - 70% rent land - 3% involved in fishery - Some commute to Bangkok	- Water overflowed the elevated embankment - OTOS and Volunteers - Schools as evacuation center
8. T. Naraphirom A. Bang Len Nakhon Pathom	- Near Tha Chin River and in Phra Phimon Project - Good access to irrigation water throughout year	- 80% is paddy field (3 times/ year) - 46% is farmers - 90% of orchid lost	- 3 months from Oct to Jan (1-2.5m) - Difficult to restart orchid due to high cost

Source: Extracted from PRA reports

(2) Strategic Planning Workshop

Strategic planning workshops were organized with participation of 20 representatives from each model area and some Provincial Task Force members. These four-day strategic planning workshops were held in order to draft the Disaster (Flood) Resilient Tambon Plan, a strategic plan that builds on the strengths of a community, seeks to reduce social vulnerability and describes priority activities. Utilizing the PRA survey results, visions and plans were discussed based on a SWOT analysis. A study tour to visit good practice areas was conducted during the workshop in order to understand the concept of "resilience" and to learn from local wisdom.

It should be noted that Tambon Naraphirom in Nakhon Pathom province was dropped from the

group of model Tambons for preparing Disaster Resilient Agriculture and Agricultural Community Plans at Tambon Level, but the province remained in the project because of the activities in the orchid sub-sector. A planning workshop for orchid cultivation was organized with stakeholders from government agencies, research institutes and orchid growers.

(3) Selection of Pilot Projects

Pilot projects were selected in each model Tambon according to the following criteria; 1) is considered to be high priority in the Tambon's Strategic plan, 2) is relevant to flood countermeasures and/or enhances resilience of communities, 3) will also bring benefit to the community even if there are no floods, 4) is affordable for TAO or provincial budget support, and 5) can be completed within the Project period. Pilot project were implemented after agreement of the Provincial Task Force.

In addition, proposals from JICA experts presented in the Strategic Planning Workshop were examined by each Tambon and participants. Table 4.1.3 shows the selected pilot projects in each model area. Some activities were cancelled due to low feasibility and limited time, while new activities were added during implementation.

(4) Implementation of Pilot Projects and Monitoring

In the course of implementation of the pilot projects, many study tours were organized in order to learn from good practices and from communities in the advanced stages of implementation. Training sessions on various topics, such as formulation of disaster preparedness plans, evacuation drill and small-scale livestock farming were also conducted as learning process. In some activities, experts and counterpart agencies took initiatives to set implementation procedures and to monitor results, for example in the study to compare transplanting methods of paddy.

Also, observation visits to other model areas were organized to encourage mutual learning among community members. Additional activities and follow-up activities were proposed and implemented throughout the project implementation period. In total 74 activities of 21 programs in 5 sectors were implemented as shown in the table below (see Appendix I-D-17 and Appendix III).

Monitoring activities for four Tambons in Phitsanulok and Chainat Provinces were partly conducted by an NGO hired by the Project team.

(5) Lessons Learned Workshop

Lessons learned workshops were organized in each model area at the end of the pilot project implementation period by inviting Provincial Task Force members. Moreover, continuation of activities and expansion to other areas were discussed among participants. In some cases, implementers of the pilot project were designated as "learning center," and they will help expand the activities to other farmers in their areas, and even outside the model areas.

Table 4.1.3 Number of Pilot Projects/Activities by Model Area and Sector

Sector	Program \ Model Area	Phitsanulok		Chainat		Ayutthaya		Pathum Thani	Nakhon Pathom	Others	Total
		CSS	NPM	WM	KK	GC	SHN				
Community-based Flood Disaster Risk Management (CDRM)	1. Community Flood Disaster Management Plan (CDRMP)					1	1	1			3
	2.Drinking Water Supply during Flood Period (DWS)				1	1	1	1			4
	3.Evacuation/ Rescue Center and Communication Equipment (EVC)	1				1	1				3
	4.Youth Activities to Transfer Knowledge and Lessons Learned (YALL)	1						2			3
Community Water Resources Management (WRM)	5.Preparation of Flood Hazard Map (HZDMP)	1	1		1	1					4
	6.Participatory Flood Monitoring/ Information Management (PFIM)	1	1		1	1					4
	7.Community Water Resource Management Plan (CWRMP)	1	1	1							3
	8.Water Management Facilities/ Equipment Improvements (WMFE)		1	1							2
Flood Damage Reduction in Agriculture and Livestock Sector (AGRI)	9.Paddy Cultivation Activities for Flood Adaptation(PADDY)		1		3	2					6
	10.Good Paddy Seed Production/ Seed Bank (SEED)		1		1	1	1				4
	11.Crop Diversification and Food Security (CRDV)	1	1	1	1	1	2	1			8
	12.Logistics and Market for Agro-produce (MKT)		1				1	1			3
	13.Recovery of Orchid Sub-Sector (ORCD)								2		2
	14.Small-scale Livestock and Pasture Development (LVS)			4			4				8
	15.Research on Bamboo Utilization in Flood Countermeasure (BMB)									3	3
Income Generation Activities towards Recovery of Rural Livelihood (iGEN)	16.Study on Fish Variety and Value in Flood-Prone Area (FISH)	1	1		1	1					4
	17.Income Generation utilizing Local Resources (IGLR)	1	1		1	2					5
	18.Income Diversification by Agro-processing (AGPR)							1			1
Networking, Supporting and Institution for Community Strengthening (NET)	19.OTOP/ Processing group Survey for flood countermeasure (OTOP)									1	1
	20.Networking with Neighboring TAOs (NET)			1			1				2
	21. Land Parcel Land Use GIS Database for Faster and Accurate Compensation Payment (LPGIS)				1						1
	Total	8	10	8	12	11	12	7	2	4	74

(6) Formulation of the draft Tambon Disaster-Resilient Plan and the Guidelines

Draft guidelines were prepared based on feedback and opinion from people implementing the pilot projects. The final workshop was organized in order to obtain comments from participants on the draft Guidelines presented (see Appendix I-D-18).

Each model Tambon revised their draft Disaster Resilient Agriculture and Agricultural Community plan based on experience and learning from pilot project implementation. The final versions of these plans can be found in the Appendix of this report, under community case studies. However, these should be considered as draft versions since Tambon council approval is required for this document to become an official plan. Unfortunately, it was not possible to coordinate the timing of drafting these plans with the Tambons' 3-year plan and annual budget processes because of the time frame of this project.

(7) Good Practices and Local Wisdom/ Knowledge

The 2011 flood was an exceptionally large flood which caused severe damage to industrial estates and urban residential areas. The impact on rural areas can broadly be categorized into two types. In the first type were communities that were used to flooding, and had developed coping mechanisms over time, which were adjusted to the 2011 flood of a much larger scale and longer duration. The other suffered severe damage since they had not experienced such a big flood in the last few decades.

The former are areas where there were good practices that could be replicated in other high risk areas. This project supported learning for people in the model areas through exchange of ideas, and by organizing study tours to areas where good practices were found.

In flood-prone areas in Thailand, we can find many examples of local wisdom and knowledge of how people have learned to live with floods. Even in areas that no longer experience floods as a result of constructing irrigation and drainage facilities, the know-how of living with floods can still be found. It is worthwhile collecting such knowledge and practices and introducing them to other areas. In this project, a survey was conducted to record such good practices and local knowledge so that they could be shared with people from flood risk areas (see Appendix I-D-6).

(8) Reflect Experts' Knowledge and Government Policy

Before preparing the Tambon Disaster Resilient Agriculture and Agricultural Community plans, ministry policies on disaster management, provincial agricultural development plans and directives of technical development and extension of each crop were studied. Some relevant policies, plans and directives include: paddy cultivation twice a year at most in flood-risk areas, promotion of CBDRM at Tambon level, GAP certification for vegetables and pre-GMP standards for food processing.

The planning process also incorporated technical expertise and research. By tapping into studies and research conducted by local universities and other research institutes, as well as the knowledge of Japanese experts, it was possible to include a wide range of flood countermeasures into the plans.

4.1.4. Stakeholders in Component 3

For Component 3, nine departments and offices under MOAC were involved in this Project as Joint Coordination Committee members. At the provincial level, Provincial Task Forces chaired by the Provincial Governor was organized in each province and provincial offices of DDPM and CDD under the Ministry of Interior were assigned as members, in addition to the offices under MOAC. The role of each department or office in the Project is summarized in Table 4.1.4.

Table 4.1.4 Government Agencies Involved in Component 3 and their Roles and Responsibilities

Logo	Organization	Central /JCC	Regional/ Provincial	Related Program
	Ministry of Agriculture and Cooperatives (MOAC)	Deputy Permanent Secretary is chairman , Disaster Monitoring Center in OPS	Provincial Agricultural and Cooperative Office (PACO) is secretary of Prov. Task Force.	
	Office of Agricultural Economics (OAE)	C/P coordinator of Component 3. Agro-information, statistics. Estimation crop loss by disaster	No office at province. Regional OAE 2, 7 in Phitsanulok/Chainat participate in TF. Compile crop damage	- Land Parcel GIS Database
	Royal Irrigation Department (RID)	Irrigation & Drainage. C/P of Component 2.	Prov. office care Medium scale irr. And micro watershed dev't. Large irr. by Regional	- Monkey Cheek - Particip.water measurement & website
	Department of Agricultural Extension (DOAE)	Horticulture Promotion Dept. Take lead of orchid project	District DOAE, Tambon extension farmer registration, database, damage survey, training visit	- Crop diversify - Green market - GIS Database - Orchid
	Rice Department (RD)	Rice research, policy. Flood countermeasure by Rice research center	Rice Research Centers in Prov. joined TF. Recommend variety, cultivation method	- Transplant - Cost reduction - Rice Variety
	Department of Agriculture (DOA)	JCC member	Crop research other than rice. Develop crop variety, bio-control.	- Orchid bio-control
	Department of Livestock Development (DLD)	C/P of Component 1. Animal Nutrition Dept. responsible for pasture and feed storage	Prov. and district office take part in TF. ANRDC responsible for feed production and storage	- Livestock dev't - Feed production storage - Goat raising - Bio-gas
	Department of Fishery (DOF)	JCC member	Prov. office promote fresh culture, fingering provision, processing.	- Fish pond - Fish survey
	Land Development Department (LDD)	Microorganism, Soil-water conservation. *Por dor* was used	Prov. was TF member *Por Dor* provision and water resources	- Cost reduction - Safe vegetable - Community Monkey Cheek
	Agricultural Land Reform Office (ALRO)	JCC member	Land Reform Area in Chainat Ayutthaya TF. Promote "sufficiency economy"	- Integrated Agri. - Safe vegetable - Cooling - Learning Center
	Dept. Disaster Prevention and Mitigation (DDPM)	support CBDRM Disaster warning.	Community Development Department (CDD)	Women and youth group org. OTOP and income generation project

The organization chart of the JCC, major departments under MOAC and Task Force members of the four provinces are attached in the appendix to the report.

The list of academic and training institutes involved in the pilot projects and surveys is as shown below.

Table 4.1.5 Universities and Institutes Involved in Component 3

University/ Institute	Faculty/ Department	Scope of Cooperation	Target Model Area/Province
Kasetsart University (KU)	Dept. of Civil Engineering, Faculty of Engineering	Flood hazard map	Chainat Prov. Ayutthaya Prov.
	Center of Excellence for Bamboos	Bamboo research	North, Central and Northeast
	Institute for Food Research & Production Development	Food processing	Pathum Thani
Kasetsart University Kampensaeng Campus	Department of Horticulture Faculty of Agriculture	Alternative growing media for orchid	Nakhon Pathom
King Mongkut's Institute of Technology Ladkrabang (KMITL)	Faculty of Agricultural Technology	Small scale livestock development	Chainat Prov. Ayutthaya Prov.
Naresuan University	Department of Agro-industry, Faculty of Agriculture, Natural Resources and Environment	Fish Survey and Fish Processing	Phitsanulok Prov. (Survey includes Chainat Prov. and Ayutthaya Prov.)
Khon Kaen University	Research and Development Institute	Good Practice on Flood OTOP survey	Central, North and NE case studies
Hydro and Agro Informatic Institute (HAII)		Flood hazard map Participatory water measurement	Phitsanulok

4.1.5. Composition and Structure of the Guidelines and Technical Papers

These guidelines consist of a General Guideline and 5 Thematic Guidelines, which are described in sections 4.2 and 4.3of this report. Details of all pilot projects, including their components, have been written up as Technical Papers, and have been included in the appendix to this report. Furthermore, the appendix also includes information on PRA survey results for each model area, strategic plans, pilot projects implemented during this project and community case studies describing the development of the Tambon disaster-resilient plans.

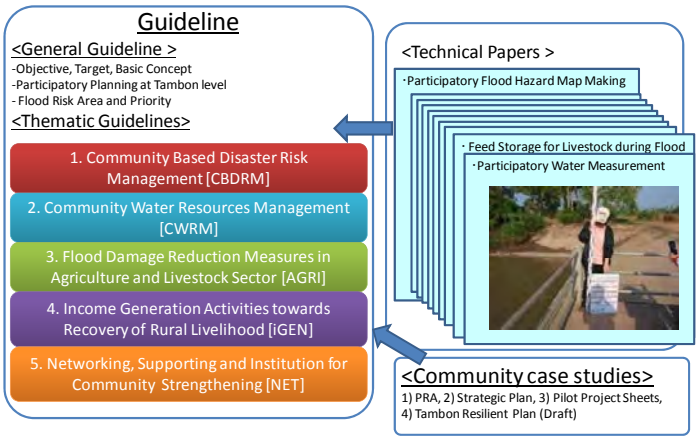


Figure 4.1.3 Structure of the Guidelines

4.2. The General Guideline

4.2.1. Objective: Why is Flood Disaster Resilient Plan Necessary?

In most rural areas within the Greater Chao Phraya basin, people have learned to live with regular flooding, particularly in areas where floods are frequent. On the other hand, many areas suffered huge economic losses in recent years. These were areas which had not experienced severe flooding after irrigation and drainage facilities were constructed. The increase in the scale of damages and losses can also be attributed to recent changes in lifestyle. After the experience of the 2011 flood which brought about enormous damages and economic losses to the country, the Government of Thailand has conceived an ambitious Master Plan on water resource management and is planning to implement a large-scale flood countermeasure project. When these countermeasures are

implemented, urban areas are expected to be protected from flood waters. However, the countermeasures do not provide any guarantees for the rural agricultural areas to be protected from flooding problems. Instead, there are plans to retain flood water in rural areas to protect urban areas and to release it after floods recede.

Under these circumstances, people in rural areas need to make all possible efforts to prepare for possible floods and to make their communities sufficiently resilient. To this end it is necessary to minimize the damage to agriculture and empower the rural communities to recover from disasters. This can be done by adapting their farming practices. It is for this purpose that these "Guidelines for Disaster-Resilient Agriculture and Agricultural Community" were prepared.

4.2.2. Target Users of the Guidelines

These Guidelines are expected to be used by concerned national government agencies, provincial level administrative authorities, as well as the Tambon level local governments in order to formulate the Tambon Disaster-Resilient Agriculture and Agricultural Community Plan. Firstly, the Tambon Administration Organization (TAO) staff members, who compile Tambon level plans, and community leaders in Tambons, who facilitate community and farmers participation in planning, are target users of the Guidelines.

Secondly, provincial level government officials are target users of the Guidelines. Although plans are prepared at Tambon level, financial and technical support from provincial authorities is essential. The selection of priority Tambons to prepare Tambon Disaster-Resilient Plans is done by the provincial government. Therefore, provincial level government authorities are key players in planning and implementation.

Moreover, central level departments under MOAC need to understand the Guidelines and take initiatives for them to be reflected in policy and directives of the departments, as well as in budgetary allocations to extension programs. Along with the existing annual "Agricultural Preparedness Plan for Disaster" (see Appendix I-A-3-10 to 16 and D-15 and 16), the Guidelines be used by MOAC to strengthen community resilience, as well as formulate proposals to the cabinet for the Flood Prevention Master Plan.

4.2.3. Basic Concepts of the Guidelines

(1) Resiliency: What makes agriculture and rural community resilient?

"Resilience," a term commonly used in the field of disaster prevention and mitigation in recent years, means the ability to recover, or bounce back quickly, and implies the ability to adapt to maintain a minimum level of functionality in situations where the disaster cannot be avoided. In formulating the National Economic and Social Development Plan (NESDP) of Thailand, this concept of "resilience" is captured in the term "self-immune system," one of the three main pillars of the "sufficiency economy" philosophy initiated by His Majesty the present King of Thailand (for more details on the "sufficiency economy," see Appendix I-D-14).

By building disaster-resilient agriculture and agricultural communities, it is possible to minimize the flood impact and strengthen the community's ability to cope with the disaster by enabling them to maintain their livelihoods and to manage flood-related risks.

(2) Learning from Past Experience

"Adaptive capacity" is an important component of "resilience". It is the capacity of the society to cope with new situations by using experience of past disasters. For example, houses in flood-prone areas elevate their floor levels based on past flood levels. Houses that experienced inundation in 2011 have already started to raise their floor level by another 30 to 50cm from the highest inundation

level of the 2011 flood. Another example of adaptive capacity is a community which had built flood prevention walls after the 2006 flood, and by so doing was able to avoid damage by the 2011 flood.

When people develop flood countermeasures to mitigate disasters based on their own past experience, as opposed to adopting countermeasures that have been theoretically worked out and provided to them in a top-down manner, communities' capacity to adapt is strengthened.

(3) Learning from Local Wisdom and Good Practice

When technical interventions in rural communities fail, it is often because the intervention does not take into consideration the local people's life style and culture. In flood-prone areas, there is normally indigenous knowledge on agriculture and livelihood improvement, reflecting the relationships between people and nature, environment and production patterns. However, it is not just traditional, but also new knowledge on agriculture that can be adapted by local people based on trial and error.

Furthermore, it is important to learn from local wisdom and lessons learned regarding actions taken to solve problems in the past. An effective way for people to learn is to hear from other people with similar experience and perspectives, and find out how they solved problems.

(4) Preparation of Activities by Stage of Disaster Cycle

The disaster management cycle (figure to the right) shows the continuum of the four stages, i.e. Prevention, Preparedness, Response and Recovery. Structural measures can be planned rationally in the recovery stage, while rescue and disaster mitigation activities can be effectively implemented based on disaster risk management plans and drills prepared during the preparedness stage (JICA 2008).

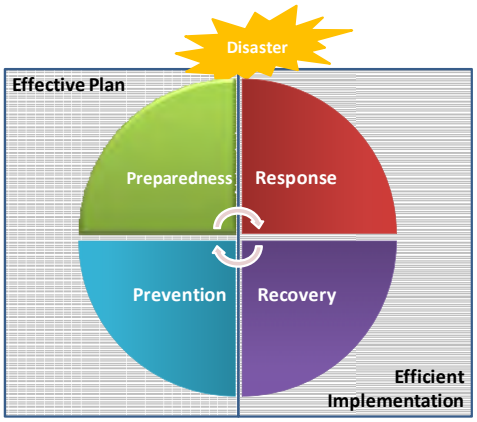


Figure 4.2.1 Disaster management Cycle
Source: Project Team based on JICA 2008

In the five Thematic Guidelines, the model activities/projects are presented separately for each issue, and are linked to each of 2P2R stages as follows:

Pre-disaster phase: "Prevention" and "Preparedness" to minimize damage and loss

During disaster phase: "Response" to the flood disaster and maintaining livelihoods during the flooding period, which may last for a long time

Post disaster phase: "Recovery" from the disaster and return to normal conditions

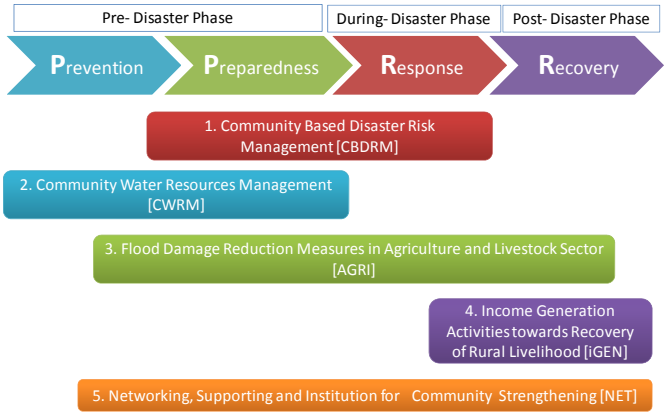


Figure 4.2.2 Implementation Phase for Disaster-Resilient Agriculture and Agricultural Community Plan
Source: JICA Project Team

(5) Selection of Co-Benefit Activities as Model Activities/Projects

It is difficult for people to change their activities and life style to cope with a large-scale flood disaster which might occur once in 100 years. And it is doubtful that the planning for such eventualities may be useful in reality. As such, the model activities and projects

should be useful not only in the case of a large disaster, but also when there are no disasters or when there is regular flooding. In other words, the "co-benefit" concept was applied as a criterion when selecting activities/project components to include in these Guidelines.

Box 4.1 Example for Co-Benefit in Pilot Projects

1. Construction of Water Purification Systems for Securing Safe Water during Floods and Selling during Normal Period
   Instead of stocking costly water purifiers for emergency use only, water purification systems were constructed and also used during normal times to sell safe drinking water. This I can allow TAOs to stock drinking water in bottles and tanks so that they will be ready to use in case of emergencies.
   By selling water on a regular basis, , or by stocking and selling during community events such as funerals, the system becomes more sustainable, both physically and economically, since this approach requires regular maintenance, and since it will secure securing regular income to be used for operation and maintenance costs.
2. Introduction of the Transplanting Method
   While it is recommended to introduce transplanting of paddy to shorten the planting period, it is also effective for reducing problems of weedy rice, insects and pests. Since transplanting results in lower production costs for agro-chemicals and labor, cost reduction will be the main incentive for farmers to change the planting method from direct seeding to transplanting.

(6) Development of Tambon Disaster Resilient Plan and Support from Provincial Administrations

In rural areas, community means village or society, often built around the school as the core institution, and woven together by human networks of relatives, friends, and various groups sharing common values, such as religion and other customs. In the field of community disaster management, the first priority is to strengthen the "self-help" capacity of individuals and households, as well as that of the larger community. On top of this, "public support" will be provided by local administrative authorities (JICA 2008).

The Tambon Administration Organization is the key local agency and is expected to play an important role as the interface between the people and the higher administrative authorities, such as provincial and national government offices.

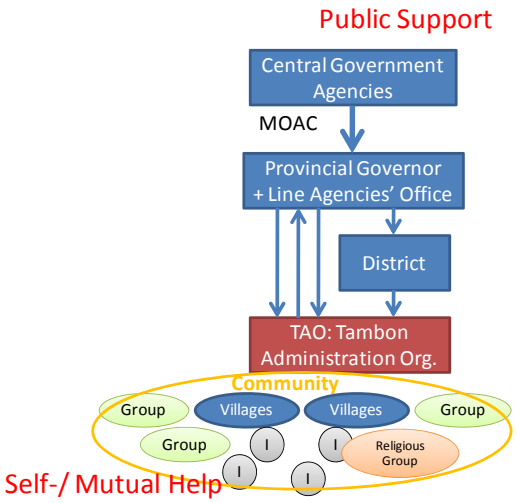


Figure 4.2.3 Community and Self-Help, Mutual Help and Public Help

4.2.4. Participatory Planning Process

To improve community resilience through self-help and mutual support, it is necessary to formulate plans with people's participation, not by giving a ready-made, top-down plan.

Figure 4.2.4 shows the process of planning, in which the common steps of Community Flood Disaster Risk Management explained in section 4.3.1 are shown in a different color.

As there are standardized procedures and tools for participatory planning processes, the following is a brief description.

(1) Assessment of flood damages and PRA

First of all, participatory surveys should be conducted with provincial implementing agencies in order to understand the overall situation of the Tambon. PRA tools such as Mapping, Time Line, and Cropping Pattern are useful to capture information on flood occurrence and damages in the past.

A Walkthrough Survey on important information can confirm accurate locations of events and record these on a map. These are important sources of information for constructing a flood hazard map.

Key Informant Interviews (KI) and Focus Group Discussions (FGD) are conducted to collect information on local resources (natural, human and social), as well as household information, including vulnerabilities, such as the elderly and people with disabilities.

After the participatory surveys are conducted, a workshop is organized to compile and review the information collected. Participants who have information about local residents are invited from each village (muban), TAO administrators, farmer group leaders, and OTOS and health volunteers. Trained provincial and district officials such as extension officers and community development officers can be facilitators. Alternatively, outsourcing to NGOs, foundations and/or consultants is recommended.

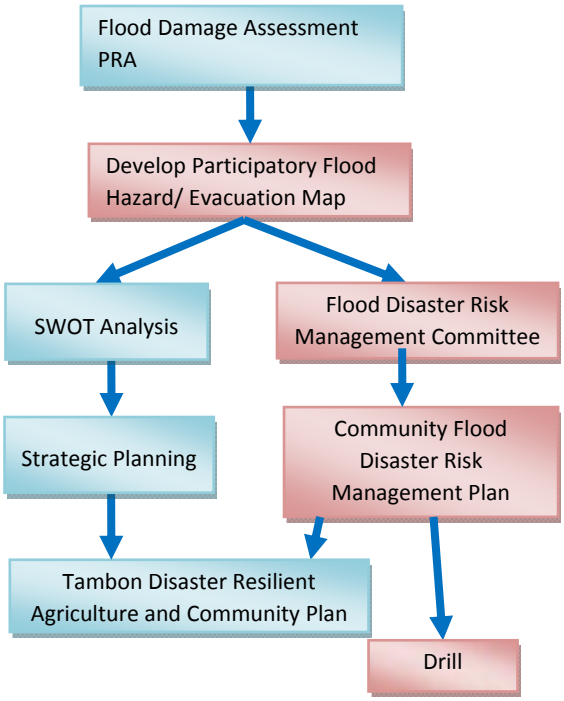


Figure 4.2.4 Participatory Planning Process for Disaster-Resilient Agriculture and Rural Community

The recommendation is for this to be a three day workshop. However, when conducting workshops during the post-flood recovery period, it is important that the schedule, duration and venue be fixed based on the convenience of local people, not outsiders, so as not to increase the burden on leaders and residents at a time when local leaders, are overburdened and tired.

(2) Planning

As a step to formulate the Tambon Flood Disaster Resilient Plan, a SWOT analysis and Strategic Planning session shall be conducted in another workshop. In this workshop, results and information from PRA, secondary data, government policy documents and national and provincial development plans shall be used for SWOT analysis.

- Strength: Local Resources
- Weakness: Vulnerability
- Opportunity: Government Policy and Market
- Threat: Flood Risk

Strategic options will be discussed and concrete projects and activities to achieve these strategies will be formulated. Finally, priority projects and activities are identified to make an action plan. These are standard steps of the strategic planning.

Nowadays, many government agencies have adopted the strategic planning method, so it is also possible to follow the method used by the government. It is important, however, to understand the basic concepts described above and to take into account the five sectors discussed below. The plan can be revised and modified over time while activities are being implemented, since all activities cannot be implemented at the same time. The plan should be flexible and dynamic rather than a static blue print. In order to enhance resilience of community towards an unforeseen and uncertain

future, the plan shall be revised based on new knowledge and information obtained.

The plan, which may include activities with Tambon budget, will need to be approved by the Tambon council and a budget should be allocated through the official process. At the same time, the plan should be utilized to get support from external sources in recovery and reconstruction in the post-flood phase without waiting for the official adjustment with Tambon development plans and/or three-year operation plans.

(3) Action plans, budget and support from agencies concerned

Once a plan is prepared, it must be implemented. Priority activities should be put into action plans and TAO will negotiate and discuss with provincial government agencies on technical support and budget allocation. It is recommended that study tours to learn from good practices and training are included in the plans. Relevance of model activities and projects presented in the Thematic Guidelines needs to be considered in view of the specific Tambon's situation.

4.2.5. Risk by Areas and Priority of Formulation of Disaster-Resilient Plan

The priority given to planning and support will depend on the risk of future floods. The highest priority area is the water retention area proposed by the Government, followed by the water retention area in the Delta as shown in Figures 4.2.5 and 4.2.6. Farmlands with large-scale irrigation systems in these areas have been designated to retain flood water to protect urban and industrial zones. However, the exact locations and boundaries are not known since the Government's Flood Prevention and Water Management Project document has not yet been finalized.

Medium-risk flood areas are the flood-prone areas in the Delta and the flood beds or flood plains in the upper Chao Phraya River basin, where floods occur every year. Protected areas as shown in Figure 4.2.5 are the lowest priority.

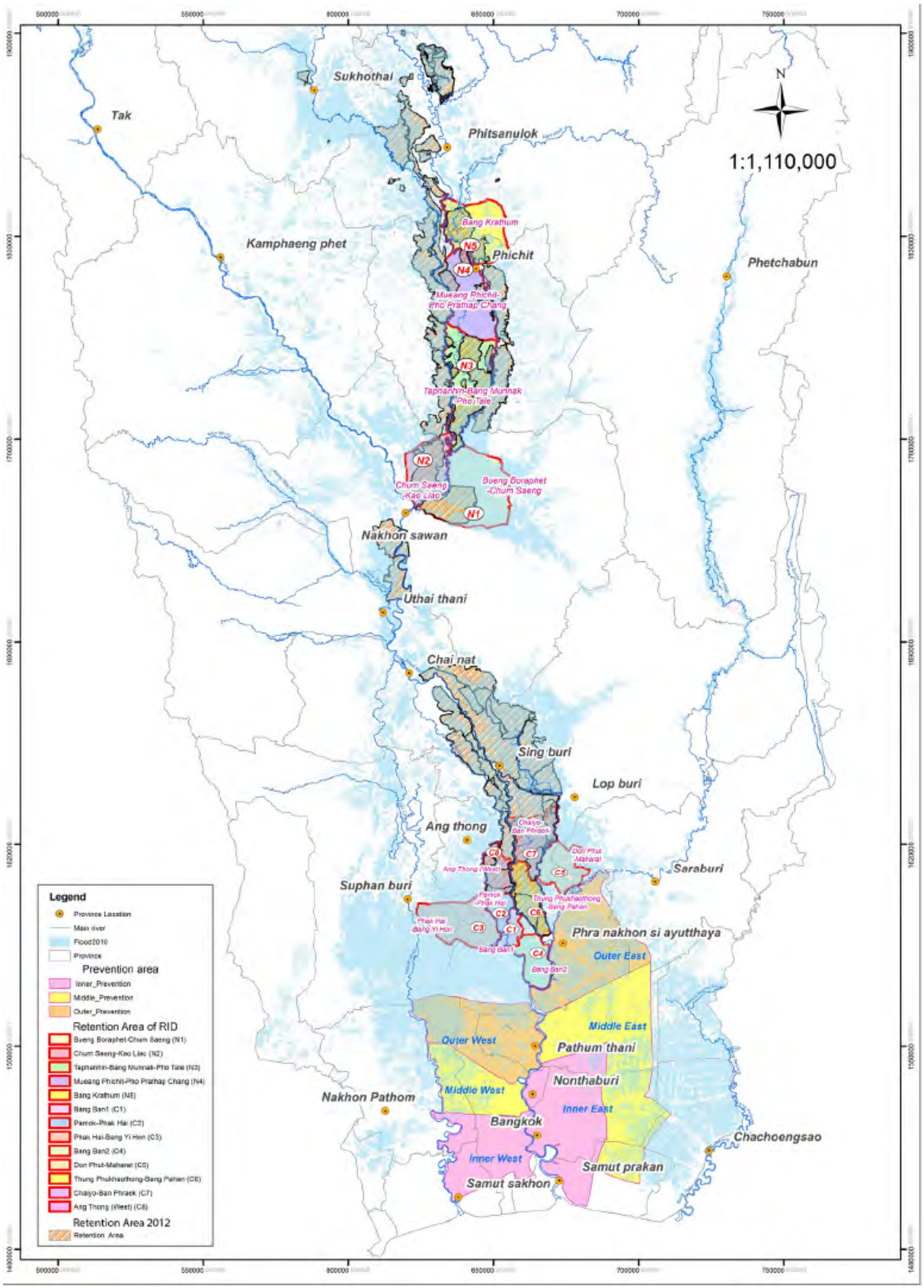


Figure 4.2.5 Retention Areas proposed by RID

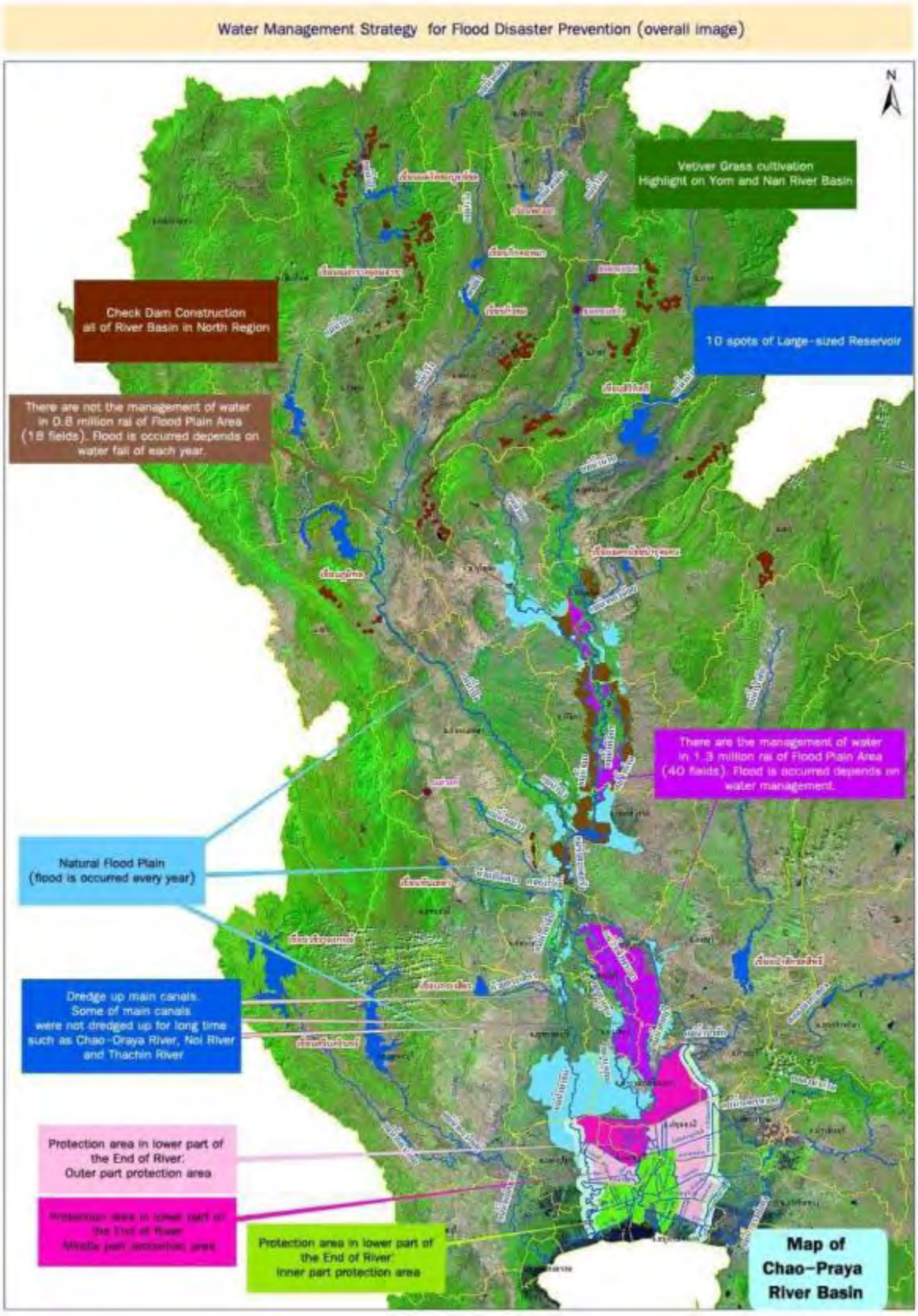


Figure 4.2.6 Flood Countermeasure Plan by Thai Government
Source: Office of the National Water and Flood Management Policy
http://www.waterforthai.go.th/

4.3. Thematic Guidelines

4.3.1. Community Flood Disaster Risk Management

(1) Community-level Institutions for Disaster Management in Thailand

In Thailand, the National Disaster Prevention and Mitigation Committee (NDPMC), established under the National Disaster Prevention and Mitigation Act issued in 2007, has prominent tasks and responsibilities for policy-making on disaster management. The 2007 Act also stipulates the Department of Disaster Prevention and Mitigation (DDPM), which was established in 2002 under the umbrella of Ministry of Interior, as a core government department in handling national disaster management work. Regarding flooded-related disasters, the Thai Metrological Department, the Land Development Department, the Department of Water Resources, the Royal Irrigation Department (RID), and other organizations have important responsibilities along with the DDPM. Overall, the disaster management plan of the country is presented in the National Disaster Prevention and Mitigation Plan (2010-2014) issued by the NDPMC. (see Appendix I- A-4 to 13)

At the community (tambon, or sub-district) level, Tambon Administrative Organization (TAO), the official local government body with two elected representatives from each village, plays a key role for disaster management. TAOs in each community are responsible for coordination among concerned government and non-government organizations in and outside the community, as well as implementation of necessary activities for disaster management with budget allocation at every stage of the disaster; pre-disaster, emergency response during the disaster, and post-disaster. Each TAO also has a staff member in charge of disaster prevention and mitigation.

There are also various community volunteer organizations involved in disaster risk management. Volunteer organizations commonly found in Thai communities are described below. These volunteer organizations were widely involved in the prevention and relief work in communities during the massive flood that occurred in 2011. Participation and involvement of these volunteer organizations as well as other community resources, such as schools, health centers, and temples, are essential for effective disaster management at the community level.

- Civil Defense Volunteer (*Or-Por-Por-Ror*)
  Civil Defense Volunteers are official community volunteers assigned to assist in general public defense work under the supervision of the DDPM. Volunteers are selected from the community and receive training for civil defense. Materials and equipment necessary for the volunteers' work, including uniforms, communication devices and vehicles, are procured by each TAO. Civil Defense Volunteers are the main voluntary force in the community to ensure public peace and support in any emergency situation, such as relief work in case of fire, flood, and accident. The volunteers also take on other tasks such as traffic direction in public events, patrol of public areas, and maintenance of criminal records.

- OTOS (One Tambon One Search and Rescue Team)
  The DDPM launched the OTOS program in 2007 to set up efficient, skillful search and rescue teams at the community level. Selected Civil Defense Volunteers are trained as OTOS team members for search and rescue operations, such as for disasters. According to the section on "Preparedness and Response Capacity Enhancement" in the Strategic National Action Plan (SNAP) on Disaster Risk Reduction 2010-2019 (Thailand), the aim is to form OTOS in all communities by 2019 with the support of the DDPM and the Department of Local Administration (DOLA). (see Appendix I-A-4 to 14)

- Mr. Warning
  The DDPM also trains volunteers for disaster warning networks, mainly in the flash flood and mudslide-prone communities. The trained villagers, called "Mr. Warning", give disaster risk warnings to the community and are equipped with necessary items, such as a simple warning siren.

- Village Health Volunteers (Or-Sor-Mor)
  The Village Health Volunteer scheme was initiated in the 1970s in Thailand by the Ministry of Public Health to strengthen the health care system in the communities, particularly in rural areas. Village Health Volunteers are also expected to support medical staff to provide medical and health care services during disasters, particularly to the vulnerable population, such as the elderly and pregnant women. Their services include first aid for disaster victims, mobile unit visits to evacuation centers and homes, as well as dissemination of public notices to prevent infectious diseases.

- Women's groups
  There are various types of women's groups in the Thai community such as saving groups and occupation groups. These groups often play a vital role in various community initiatives in times of disaster.

Because the impact of any disaster crosses administrative boundaries, inter-tambon coordination among neighboring tambons is also an important issue for disaster risk management. In the case of floods, information sharing and cooperation among tambons having a common water system is meaningful to reduce flood disaster risks of the community. Examples and the possible mechanisms for inter-tambon coordination is presented in the Section 4.3.5 Networking and Institutional Support for Communities of this report.

(2) Overview of Community-Based Disaster Risk Management

In the past, disaster management at the community level began only after the disaster struck, without any systematic effort by the community to prevent or mitigate the impact of the disaster. With increasing international recognition on the importance of community participation for disaster management, Thailand has also been encouraging community participation for making risk reduction plans. In the community-based approach, the community is central to the efforts of preventing, mitigating, and restoring damage from disasters. The concept of community-based disaster risk management in comparison with past practices is illustrated below.

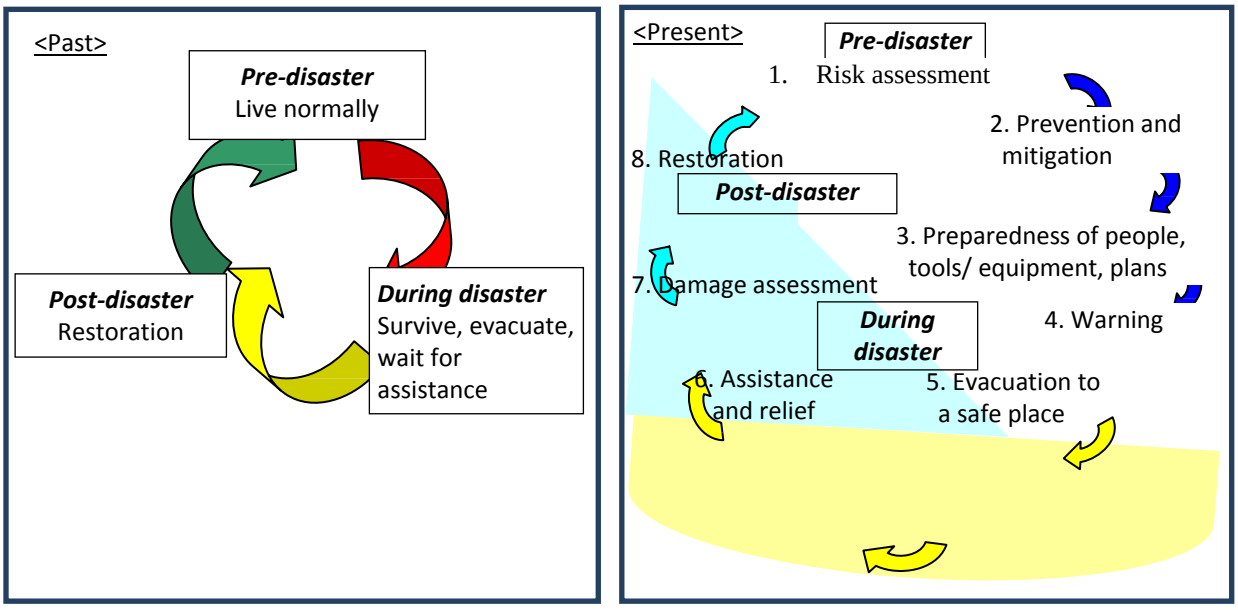


Figure 4.3.1 Comparison of Past and Present Approaches to Community-Based Disaster Risk Management

Source: Guidelines for the Community-Based Disaster Risk Management (CBDRM) (published DDPM)

As the main government department handling national disaster management, the DDPM launched the Community-Based Disaster Risk Management (CBDRM) program to strengthen the resilience of the community to protect their lives and livelihoods from disaster impacts through generating awareness among community people, encouraging their participation at every stage of disaster management, and strengthening institutional capacity of the community. The target is to develop the CBDRM plans for all tambons with a priority on high disaster risk areas. The guideline for the CBDRM was developed by the DDPM with the support of JICA's technical cooperation project, The Project on Capacity Development in Disaster Management in Thailand. Key features and principles of the CBDRM approach are presented below.

Table 4.3.1 Features of the CBDRM approach

Feature	Approach
People's participation	Community is the main actor and directly shares the benefits of risk reduction and development
Priority for the most vulnerable	Children, women, elderly, challenged people, subsistence farmers, fisher folk, urban poor, etc.
Resources	Recognition on existing capacities and survival/coping strategies
Risk reduction measures	Community specific, based on the analysis of community's disaster risks
Aim	Reduction of vulnerabilities and increase in capacities of individuals, household, communities, and society through various structural and non-structural short-term, medium-term, and longer-term risk reduction measures
Goal	Building of safe, disaster resilient and developed communities
Link with development	Links disaster reduction with development
Role of outsiders	Supporting and facilitating role

Table 4.3.2 Principles of the CBDRM approach

Principle	Approach
Participatory	Participatory process and content
Responsive	Based on community's felt and urgent needs
Integrated	Disaster management activities before, during, and after disaster, linked with other communities and the various levels of the disaster management system
Proactive	Stress on prevention, mitigation, and preparedness
Comprehensive	Structural and non-structural risk reduction measures, mixd of short-term, medium-term, and long-term measures to address vulnerabilities
Multi-sectoral and multi-disciplinary	Consideration for roles of all stakeholders and combination of local knowledge and resources with science and technology and other support from outsiders
Empowering	People's options and capacities are increased, more access to basic social services, more control over the natural and physical environment, more confidence to participate in other development endeavors
Developmental	Community development gains are protected, measures to address vulnerabilities are opportunities for development

(Source: Facilitator's Guide, JICA/DDPM Project on Capacity Development in Disaster Management in Thailand) (edited by the project team)

(3) Understanding Flood Disaster Risks of People in the Community

The most common disaster affecting Thailand is flooding. Floods affect Thai communities annually mainly in the rainy season between June and September. The Chao Phraya River is prone to swelling and overflowing during the rainy season, bringing along with it great destruction as experienced in 2011.

Floods can be classified as flash floods or inundation. Flash floods often occur near water sources in sloping highlands due to the accumulation of rain water on saturated ground. It causes sudden and rapid water flows down to low lying areas. High flow velocities can damage houses, buildings, roads, bridges, and other structures. Inundation is caused by river overflow, or unusually high water levels exceeding the waterways' capacity, leading to horizontal overflow of the water that floods buildings, houses, and agricultural lands. Inundation can also occur in city areas when there is intense rainfall over an extended period of time and poor drainage systems.

1) Characteristics and Risk of Flood Disasters

Characteristics and risks specific to flood disasters for people in rural communities, compared with other natural disasters, are summarized below. Possible countermeasures for each characteristic are also presented.

- Seasonal

  As mentioned above, floods in Thailand are, in principle, seasonal. Therefore, people can prepare for possible floods before the flood season, and thus mitigate the impact on their lives and livelihoods. Damage to agriculture can be also prevented or mitigated, for instance, by adjusting cropping patterns and schedules, or introducing short-harvest varieties and methods.

- Predictable

  Unlike other natural disasters, such as earthquakes, it is possible to predict the occurrence and timing of floods, particularly of inundation, by gathering information and by monitoring water levels in and around the community. Accordingly, people in the community can strengthen preparedness, including for evacuation. Therefore, it is important for the community to set up effective data/information collection and warning systems to use effectively the given time for preparations. Coordination and cooperation with external agencies, particularly the regional office of RID and neighboring communities located in the same water system, is essential to

obtain information in a timely manner.

- Long-term inundation

  Floods often cause long-term inundation in the community and constrain people's lives in many ways. Accordingly, it is necessary to consider the issues listed in Table 4.3.3 when communities are preparing to mitigate the impacts of long-term inundation.

Table 4.3.3 Issues to Consider for Damage Reduction in Long-Term Inundation

Issue	Necessary consideration and preparation
Transportation	Procurement of vehicles/boats to be used during inundation and operation mechanism, such as provision of public services
Supply and Support	Supply of services and relief, including drinking water, foods, other necessary materials, and medical/ health care service, to evacuees as well as people left in their houses
Security	Security in the community, including evacuation centers, evacuation spots for assets, and resident areas
Supplemental Income	Source of supplemental income to be obtained during inundation, such as fish catching/processing, and handicraft

- Large-scale inundation

  Inundation often affects large areas in the community, damaging farm land and disrupting people's lives. Accordingly, people who are engaged in agriculture and livestock production often have extensive damage from inundation. Early warning and other preventive measures, such as adjustment of cropping patterns and storage of livestock feed, are possible countermeasures.

2) Flood Disaster Risks by Locality

Flood disaster risks and impacts differ according to the locality of a community. Communities can broadly be classified as in Table 4.3.4 below, which summarizes the issues related to community disaster risk management by community characteristics.

It is important for the community to consider appropriate approaches for flood disaster risk management based on these characteristics as well as facilities and other resources in the community. People in communities located in flood-prone areas are accustomed to living with water and often have practical knowledge on flood disaster risk management. On the other hand, people in communities with low flood risk may give lower priority to flood risk management. Flood-prone communities may focus on flood disaster risk management, whereas other communities may manage flood risk as a part of overall disaster risk management. Priorities and approaches on flood disaster risk management will inevitably differ between these two areas.

Table 4.3.4 Issues for community disaster risk management

Characteristics of the community		General situation	Issues for community disaster risk management
Food risk	High (flood-prone area)	• People are familiar with living with water • People's awareness on flood disaster risk management is high	• Planning/implementation of community flood disaster risk management, including water measurement, early warning, and evacuation • Development and utilization of a flood hazard map • Utilization of local knowledge and experience • Coordination with external organizations for possible support and cooperation
	Low (non-flood-prone area)	• People are not familiar with floods • People's awareness on flood disaster risk management is low	• Planning/implementation of overall community disaster risk management, including floods • Awareness raising activities on disaster management, including floods, such as

			disaster education in schools
Type of flood risk	Flash Flood	• Caused by heavy rain mainly in sloping highlands • Rapid flow of water to the lowlands	• Establishment of early warning and evacuation systems based on rainfall and weather forecasts • Planning/implementation of community flood disaster risk management, focusing on the characteristics of flash floods
	Inundation	• Gradual overflow of water • Predicable to some extent	• Establishment of information/data collection/analysis on water level and warning system • Planning/implementation of community flood disaster risk management, including supply and assistance during inundation
Type of community	Rural	• People have relatively common interests and values • Collective activities are relatively easy to organize	• Planning/implementation of overall community disaster risk management • Utilization of community groups and networks
	Urban/ Sub-urban	• Interests of the people are different • Difficulty to organize collective activities due to inbound and outbound migrant residents	• Planning/implementation of overall community disaster risk management with stronger initiative of TAO and other authorities • Coordination with business entities in and around the community for possible support and cooperation

Source: JICA Project Team

(4) Participatory Planning for Community Flood Disaster Risk Management

Participatory planning and implementation for flood disaster risk management is effective for preventing and mitigating disaster impact, particularly for communities in flood-prone areas. This section briefly describes the steps to develop a community flood disaster risk management

plan based on experience and lessons learned from the pilot activities of the project. Refer also to the Technical Paper No. 1 "Community Flood Disaster Risk Management Plan" (Appendix II) for details.

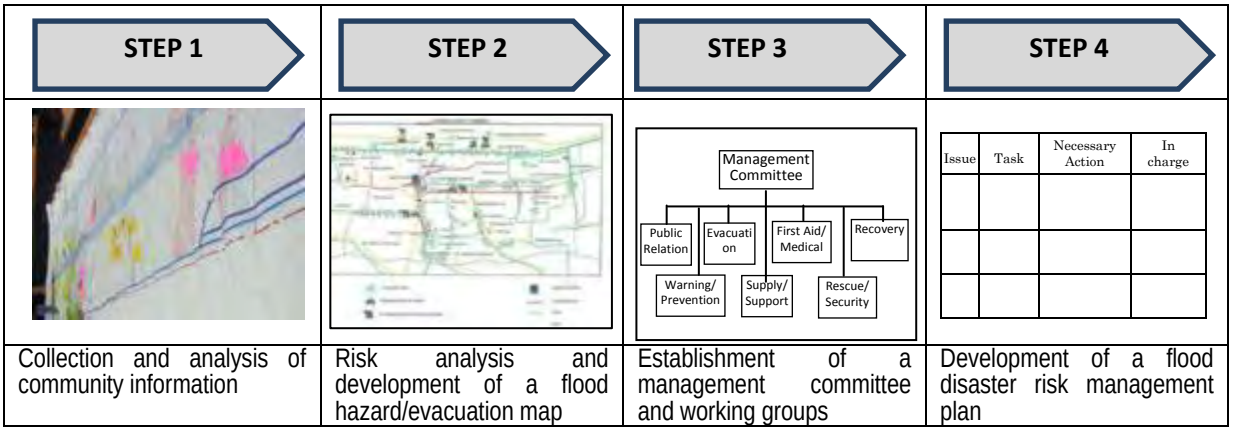


Figure 4.3.2 Process for Participatory Planning for Community Flood Disaster Risk Management

1) Process of Participatory Planning on Community Flood Disaster Risk Management

STEP 1) Collection and Analysis of Community Information

Basic information about the community is collected and analyzed using participatory methods, such as Participatory Rural Appraisal (PRA). Information to be collected include geographic, land use, demographic, infrastructure, facilities and other resources, socio-economic, and other community information.

STEP 2) Risk Analysis and Development of a Community Flood Hazard and Evacuation Map

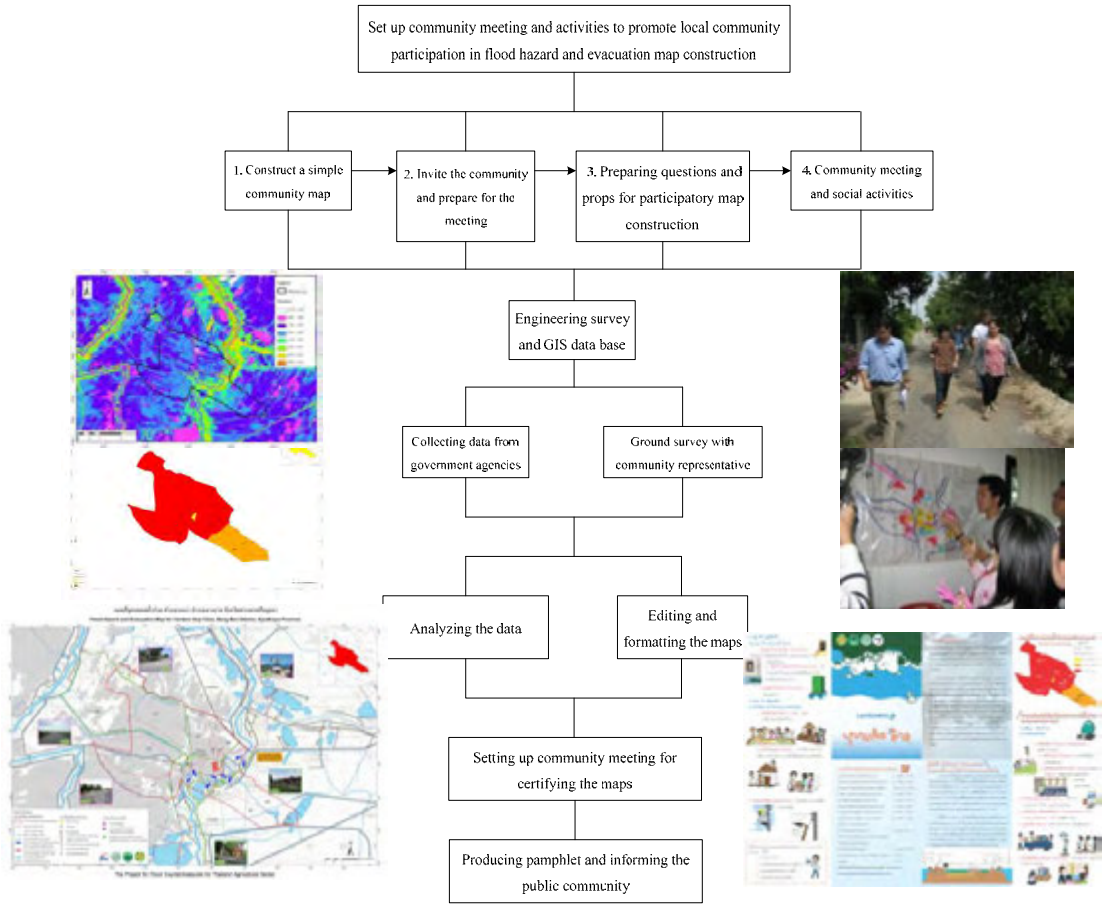
A community flood hazard and evacuation map is developed with basic community information and risk analysis by the community people. The map includes geographic information, water resources and related facilities, water flow of past inundation, infrastructure, community facilities, and evacuation places and evacuation routes for people, livestock, and assets. The map is useful for providing prompt flood warnings and evacuation announcements and, as a result, for preventing and mitigating flood disaster impact on the community. It is particularly important for communities in flood-prone areas to prepare accurate maps with detailed topographical information. Refer to the Technical Paper No.3 "Constructing Flood Hazard Map and Evacuation Map with Community Participation" (Appendix II) for more details.

STEP 3) Establishment of a Flood Disaster Risk Management Committee and Working Groups

As the third step, a flood disaster risk management committee and working groups are established. Community members participate in flood disaster risk management through different working groups under the management committee. The working groups should cover the topics such as public relations, warning and prevention, evacuation, supply and support, first aid and health, rescue and security, recovery. Additional groups to address other issues relevant to the community could also be set up.

Box 4.3.1 Preparation of Participatory Flood Hazard / Evacuation Map

By constructing a Flood hazard/ evacuation map with community participation, they can prepare for future big- flood. Process to construct hazard map is as below;



Final product of hazard/ evacuation map Evacuation/ disaster management info on back

STEP 4) Development of a Flood Disaster Risk Management Plan

In this step, problems and constraints for flood disaster risk management as well as their causes are comprehensively identified by the community based on past experience and on community characteristics. Accordingly, necessary tasks and actions are identified to prevent and mitigate flood disaster impacts on the community for each phase of the disaster: 1) preparation, 2) pre-flood, 3) during flood, and 4) post-flood. The preparation phase refers to the normal period where there are no risks of flooding, while the pre-flood phase is the period when the community faces the risk of damage from possible inundation. Tasks to be accomplished during the preparation and pre-inundation phases include risk assessment, strengthening of preparedness, and early warning. Evacuation, supply and support, security and assessment of the damages are main tasks for emergency response during inundation. Establishment of effective warning systems, evacuation to safe places, supply and support during inundation are key components of flood disaster risk management.

The preparation process for flood disaster risk management plans can be introduced in any community. It does not cost much, but needs strong commitment of the stakeholders, particularly of community leaders who need to take the initiative for both planning and implementation. The plan should be developed based on the characteristics of the flood disaster and each community, such as flood risk and type, facilities and other resources available, or the degree of urbanization of the community.

Development and implementation of a community flood disaster management plan is basically the responsibility of community leaders and members, with support from TAO. However, external support from government and non-government agencies is also required to address the institutional and financial constraints faced by the community. Technical support from the provincial department of DDPM is needed for the effective planning for flood disaster risk management, and cooperation with the regional office of the RID is essential for the community to understand fully the flood risks. Regarding awareness raising of the community, particularly of students, educational administrators can conduct school education programs on disaster risk management.

2) Collection of Water-Related Information and Establishment of Warning Systems

It is important to collect and analyze water-related information in a timely manner to assess flood disaster risks, particularly in flood–prone communities. Water information can be collected from RID offices, neighboring communities, and by taking water level measurements in the community. Therefore, networking and communication with concerned external organizations, as well as establishment of water level monitoring and recording systems in the community are important tasks. In addition to the collection and analysis of the local water levels, it is important to integrate information of water levels in the wider River Basis, which is available at RID and other internet web sites. And, based on the above information, effective communication systems can be established to deliver clear and prompt warnings. Warning mechanisms, including the appointment of responsible persons as well as warning methods such as sirens and announcements through community broadcasting towers, should be a part of disaster risk management planning. Refer also to the Technical Paper No.4 “Community Participatory Water Measurement and Database System” (Appendix II) for details.

3) Evacuation to Safe Places and Evacuation Drill

Evacuation to safe places is crucial for people to protect themselves when faced with disasters. Evacuation should be done appropriately, swiftly, and in an orderly manner. Therefore, it is necessary for the community to identify possible evacuation centers and evacuation routes in advance not only for people but also for livestock and other assets, such as vehicles and machinery. Evacuation maps should be displayed in public places and distributed to all households along with notices about preparation needed for an evacuation. Maintaining security at evacuation sites is also an important issue to be considered as a part of disaster management planning. Conducting disaster evacuation drills will; 1) raise people's awareness on disaster risk management, 2) strengthen networks among concerned organizations in the community, such as schools and health centers, and 3) provide an opportunity for the management committee and working groups to practice their duties.

4) Provision of Supplies and Services

Provision of necessary supplies and services for evacuees and people left in their houses should be considered both in terms of emergency support as well as relatively long-term support. Securing drinking water supply is one of the most urgent and important tasks for the management committee. Because the supply channels of drinking water may be disrupted during the disaster, it is good for the community to have its own sources of drinking water located in the community or in nearby areas. Refer also to the Technical Paper No. 2 "Securing Drinking Water in Emergency Case" (Appendix II) for more detail.

Box 4.3.2 Securing Drinking Water during Floods

In the 2011flood, local water supply systems were damaged by inundation and people were dependent on deliveries of emergency relief goods for their drinking water.

A water purification system at Tambon level was constructed as a pilot project at the low cost of approximately 450,000 baht in order to supply safe drinking water to people in evacuation sites or at home. Water is sold by vending machine at normal time, while emergency stocks are kept in bottles and/or tanks. By selling water in normal times, operation and maintenance cost is collected for a sustainable system.

5) Transferring Lessons to the Next Generation

Natural disasters have a tendency to strike just as people's memory of the previous one begins to fade. So, the experience and lessons of the 2011 flood should be transferred to the younger generation while the memory of the disaster is still fresh in people's minds. Issues to be shared with the younger generation include; the scale of damage, people's feelings of fear and stress, problems faced by the community, countermeasures taken by the community. Various activities can be organized for the younger people, particularly students, in collaboration with schools and community members, including guardians. Examples include exhibits of history and damages caused by past disasters, training on life skills, practice of evacuation drills, water measurement as a part of disaster education. Schools in the community can function as disaster learning centers for the next generation.

Lessons to be transferred to the next generation may not be limited to direct impacts of the disaster. For instance, the people of Tambon Khlong Ha (Pathum Thani Province), one of the pilot project sites, realized the importance of improving garbage and water quality management as a result of the long-term inundation experienced in 2011. Without garbage collection services, huge amounts of garbage were left in the community and people suffered from smelly, stagnant water. Accordingly, people and high school teachers in the community planned activities to improve their garbage and water quality management. These initiatives are also recognized as a positive response to transfer the lessons from the disaster to the next generation to mitigate future disaster impacts.

Box 4.3.3 Model Project/ Activity for Preparation of Community Flood Disaster

CBDRM-1: Participatory Flood Hazard / Evacuation Map
[Responsible Organization: TAO, Technical Support: DDPM/RID]
Prepare for future flood by preparing hazard/ evacuation map using accurate elevation data and participation.
CBDRM-2: Secure Safe Drinking Water in Flood Period
[Responsible Org.: TAO, Water management committee, Technical Support: Private company]
Construct water purification system using water well. Collect O&M cost by water vending machine.
CBDRM-3: Planning of Community Flood Disaster Risk Management and Drill with School
[Responsible Org,: TAO, Disaster risk management committee, school, Technical Support: DDPM]
Develop flood disaster risk management plan in participatory manner and conduct evacuation drill in collaboration with local school to be a disaster learning center for the next generation.

4.3.2. Community Water Resources Development and Management

(1) Importance of community level water resources development and management for floods and droughts

1) Classification of the Study Area regarding Community Water Resources Development and Management

For the formulation of community water resources development and management plans, the Study

Area is classified into two areas based on topography, meteorology, hydrology and irrigation factors: (1) the upstream area of the Chao Phraya River, from Chainat to Phitsanulok, and (2) the Delta area from Chainat downstream. The former is a rain-fed agricultural area with small-scale irrigation systems, except for the area along the Nan River which has large-scale irrigation projects. On the other hand, the latter has large-scale irrigation projects and water control facilities are well-developed. When making a development and management plan, it should be noted that the 2011 flood damaged the industrial complexes and urban areas heavily in the Delta region but flood-prone areas in Thailand are affected by flooding every year and heavy flood damage of a similar scale to the 2011 flood is generated once in several years. For instance, heavy flooding similar to the one in 2011 occurred in 1995, 2006 and 2011 in the model areas of this project.

The Figure 4.3.3 below shows the discharge hydrographs at Y.16 and C.13 river flow gauging stations. The discharge curve of C13 in the Delta area varies sharply but Y16 in upper Chao Phraya basin varies gently in the wet season. Differences can be explained by the fact that in C13 the discharge is controlled by the Chao Phraya barrage, resulting in sharp spikes with abrupt changes in water volume when water is released. On the other hand, there are no flood control facilities in the Yom River basin and water flows naturally.

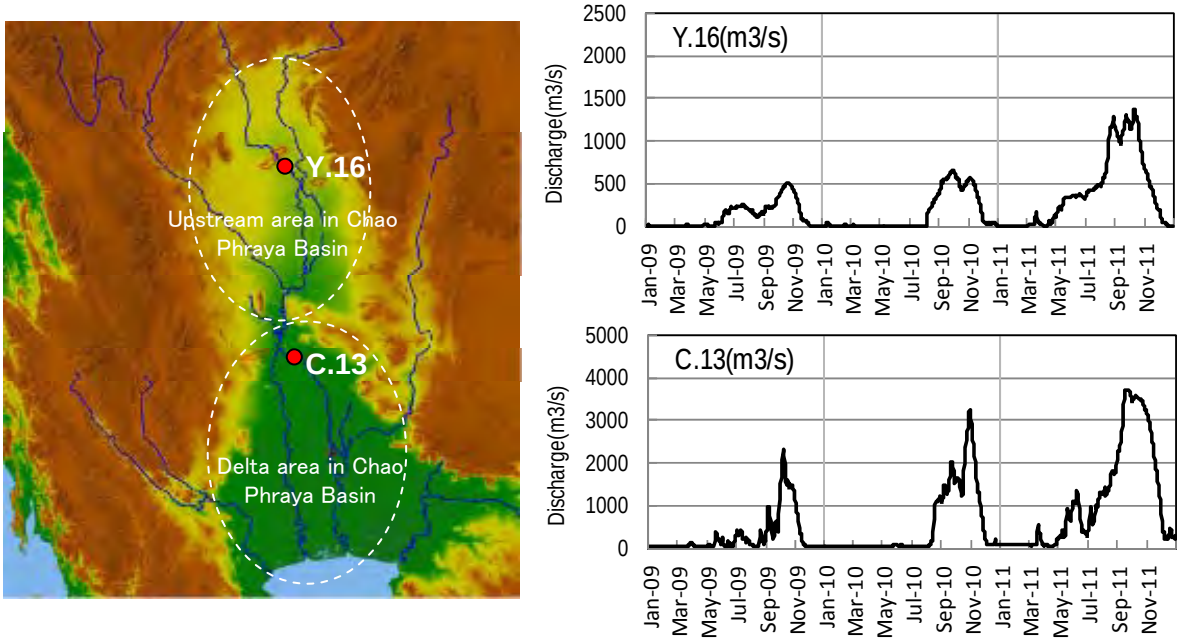


Figure 4.3.3 Comparison of Topography and Hydrology between Upstream and Delta areas in the Chao Phraya River Basin

2) Cause of Flood

Flooding in the Study Area is caused by the following:

i) Global climate change

Climate change leads to more flooding. Floods can be caused either by an excess of rainfall leading to greater surface runoff or by storm surges raising the sea level. The Study Area is mainly affected by the monsoon. Tropical storms are generated under the influence of low pressure and bring strong rainfalls.

ii) Reduction of water retention areas and monkey cheek(See Box 4.3.4 for an explanation of monkey cheek) areas

Retention areas along the river including agricultural areas have been reduced due to rapid encroachment from urbanization and industrialization in the Study Area. As a result, less water is

being retained.

iii) Sedimentation in swamps, rivers, ponds, and small-scale irrigation facilities

Due to deforestation, urbanization and industrialization, sedimentation of soil runoff into swamps, rivers, and ponds has increased significantly. Consequently, water is not retained well in these areas, and flooding becomes worse. As for small-scale irrigation facilities such as dams, weirs and regulators, these were constructed by RID in more than 6,000 projects since 1977 as a response to the water shortage problems. These facilities have been transferred to the TAOs, and many are no longer functional, in a dilapidated condition or clogged with sand because of poor maintenance.

Box 4.3.4 Function of Water Retention Areas /Monkey Cheek Areas

The difference between water retention areas and monkey cheek areas are not always clear. The definitions of these two terms are as follows.

Retention Areas: These are usually lowlands or flood-prone areas. The area is inundated every year. For large floods that occur once in several years, flood water is intentionally directed into this area. The main purpose is to protect downstream urban areas and industrial complexes from flood damage. There is no water control facility. The retention area stores the water only temporarily.

Monkey Cheek Areas: These can be lowlands, flood-prone areas, tributaries, swamps, or ponds that are inundated every year. The purpose is both flood control and water utilization. Flood water is stored in the wet seasons and is released for irrigation from the beginning of the dry seasons. Normally, there are polder dikes and intake/outlet facilities such as regulators, pumps, etc. There are two types, namely large-scale monkey cheeks in large-scale irrigation project and community monkey cheeks which are small-scale at Tambon level.

3) Importance of community level water resources development and management for flood and drought damages

As mentioned above, flood varies from location to location depending on local climate conditions that are difficult to predict with confidence. In addition, the retention capacity of water retention areas has been reduced. As a result, rural communities face difficulties when there are floods or droughts. One way to mitigate against these frequently occurring disasters is to establish monkey cheeks by expanding and rehabilitating natural bodies of water, such as swamps and rivers, as well as existing canals, ponds and irrigation facilities. Monkey cheeks are able to store flood water in the rainy season so that the water can be used for various purposes in the dry season, such as for irrigation or drinking water. There are more than 520 Tambons in the upstream Study Area. If each Tambon stores 2 MCM of flood water, about 1,000 MCM of water could be stored in the entire Study Area. This is the equivalent to the capacity of a large dam, and the monkey cheeks can protect downstream areas from flood damage and store water for irrigation in the dry season. However the decision to proceed with community level monkey cheek development should be taken based on a systematic review of the water resources network and a feasibility study.

(2) Comparison between large-scale irrigation areas and small-scale irrigation or rain-fed agricultural areas

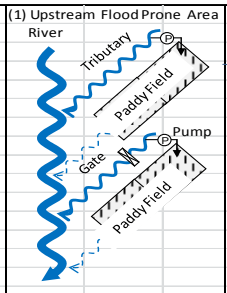
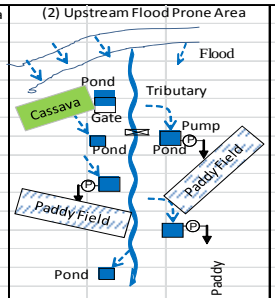
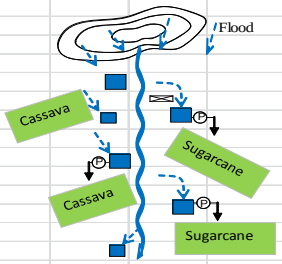
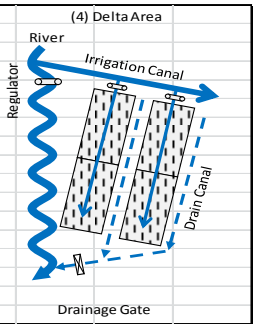
When comparing areas with large-scale irrigation schemes and areas with small-scale irrigation schemes and rain-fed agriculture, it is possible to see that impact of the flood depends on geographical features of the areas, as well as on the development levels of irrigation and drainage facilities. As noted above, areas with small-scale irrigation schemes and rain-fed agriculture are predominantly in the upper Chao Phraya River Basin. The causes of the flood in these areas are overflow of banks in the major rivers and surface runoff from mountainous or hilly areas. In areas

characterized by small-scale irrigation systems and rain-fed agriculture, the extent of flooding is essentially determined by the river's water level rising or the amount of water flow from hilly areas because there are few drainage facilities such as canals, gates and weirs. Furthermore, since the drainage canals and gates for storing flood water are not adequate, flood damage during the rainy season and water shortage during the dry season are the main issues in these areas.

On the other hand, floods in the downstream delta areas are caused by overflow of banks in the major rivers. However, since drainage canals and gates are well developed, flooding can be controlled by using these drainage facilities. For example, the rainfall in these areas can be drained out to major rivers by using drainage canals during the beginning of the rainy season, and when the water levels of major rivers rise up by the middle of the rainy season, the drainage gates can be closed to prevent the flood water flowing in from major rivers.

Table 4.3.5 shows the different types of floods and their causes in the upstream and delta areas, as well as irrigation facilities, drainage canals and drainage gates. According to the table, in the upstream area, inundations in the flood season and drought in the dry season are two big issues. In these areas, small-scale irrigation and drainage facilities such as the Small Scale Irrigation Project (SSIP) have been constructed by RID but large-scale drainage canals and drainage gates have not been constructed. In the delta area, the cause of flood is mainly the major rivers. But it is possible to control and manage the flood water levels by using drainage canals, gates and pumps because RID has already set up large-scale irrigation projects. In this Project, for flood-prone areas and the mountainous, hilly areas in the upstream areas of the Chao Phraya basin, a structural measure of Community Monkey Cheek Development is proposed. On the other hand, in the delta area, a non-structural measure of Flood Water Management Plan is proposed. Figure 4.3.4 shows the conceptual design of the water resources development and management.

Table 4.3.5 Water Resources Development and Management Plan at Community Level

	(1) Upstream Flood Prone Area	(2) Upstream Flood Prone Area	(3) Upstream Hilly Area	(4) Delta Area
Basic Concept				
RID project type	Small Scale (SSIP,SSIFP)		Small Scale (SSIP,SSIFP)	Large Scale
Cause of Flood	Main River	Rainfall from /hilly area	Rainfall from mountainous area & Flash Flood	Main River
Issues	Flood & Drought		Flash Flood & Drought	Flood
Irrigation & drainage network	-			✓
Intake facilities	Small scale Mobile pump, Weir, Gate			Regulator, permanent pump station
Irrigation & Drainage canal	-			✓
Drainage gate	-			✓
Development Type	Type A	Type B	Type C	✓
	Structural Measures			Non Structural Measures

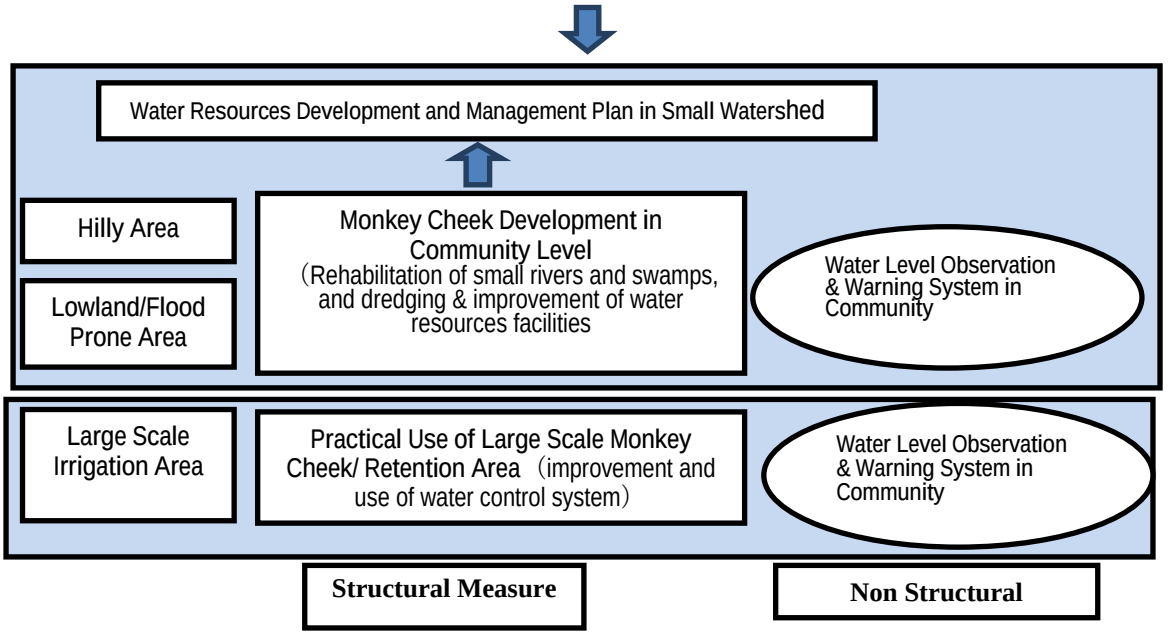


Figure 4.3.4 Conceptual Design of the Water Resources Development and Management Plan
Source: JICA Project Team

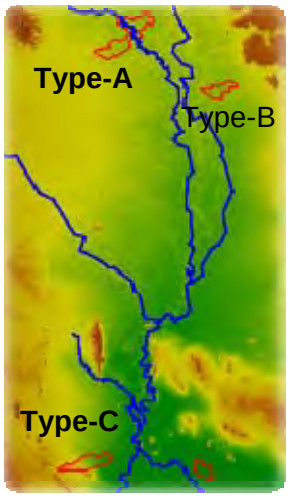
(3) Community Monkey Cheek Development from Concept to Practice

Based on the characteristics of the topography, flow channel of tributaries, flood outbreak situation and existing irrigation and drainage development levels in the Study Area, community monkey cheek development is classified into three types.

[Type-A] Community Monkey Cheek Development in lowland areas affected by flooding caused by overflow of major rivers

[Type-B] Community Monkey Cheek Development in lowland areas affected by flooding caused by runoff from hilly areas

[Type-C] Community Monkey Cheek Development in lowland and hilly rain-fed agricultural areas affected by flooding from mountainous areas



1) Community Monkey Cheek Development

The concept of the monkey cheek development at community level is shown in Figure 4.3.5. Work components are the same for Types A, B, and C and consists of heightening of the dike crest, expansion of the canal section by dredging, dredging of existing ponds, and rehabilitation and construction of regulators and weirs. With these improvements, it will be possible to store flood water in the canal and to reduce flood damage along the canal, as well as to store water for irrigation in the dry season. Expected water storage by community monkey cheeks is roughly estimated as 1 MCM to 2 MCM in each Tambon. Refer to Technical Paper No.5 "Community Monkey Cheek Development Plan" (Appendix II) for more details.

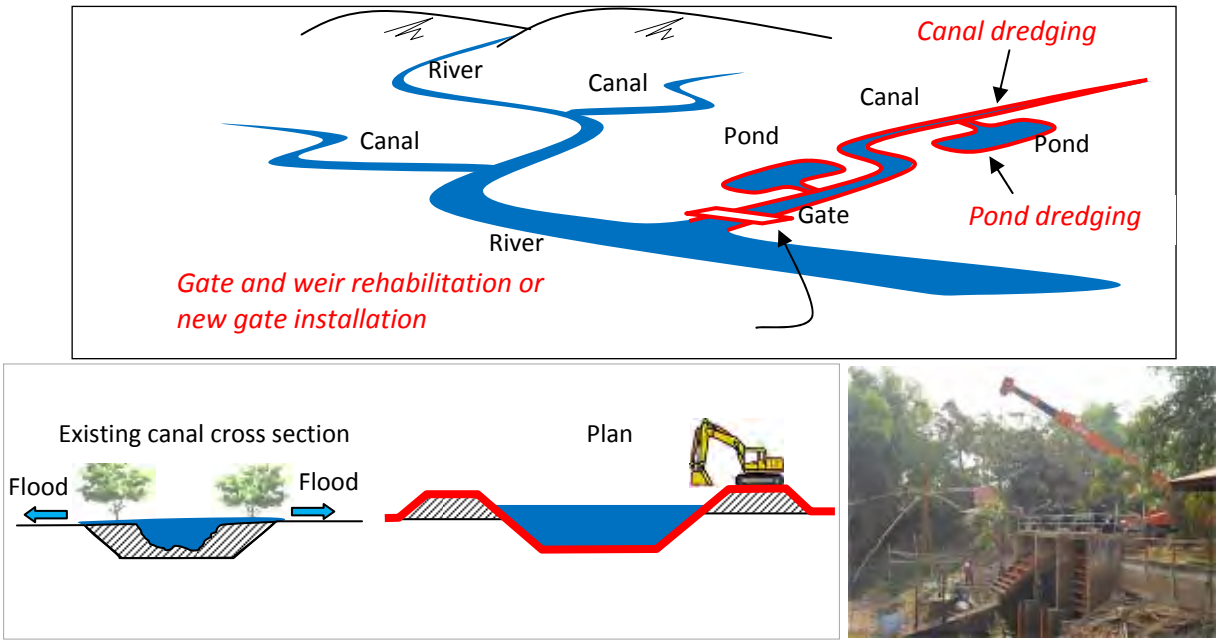


Figure 4.3.5 Concept of community monkey cheek development
Source: JICA Project Team

2) Necessity of Monkey Cheek Development in Small Watershed Water

There are many Tambons dependent on rain-fed agriculture or on small-scale water resources. These Tambons suffer damages from floods and droughts frequently. This small watershed water resources development and management plan is a important concept and useful for these Tambons in the upper Chao Phraya River basin as a model of monkey cheek development, not only to reduce the flood and drought damage in their own area but also to reduce the flood damage to the downstream areas.

When formulating water resources development plans, to secure and manage water resources in the Tambon effectively, people found that this plan is essential for collaboration with other TAOs in the watershed. The concept is to reduce damage caused in the smal watershed by flood and drought occurring once or twice in several years by developing and managing water resources properly and through Inter-Tambon collaboration. The rehabilitation of deteriorated small water resources to increase their storage capacity is the output of this project. Refer to Technical Paper No.8 “Inter-Tambon Micro Watershed Water Resources Development Plan” (Appendix II) for details.

(4) Participatory Flood Management in Large-Scale Irrigation Areas

1) Flood Water Management in Large-Scale Irrigation Projects

The irrigation and drainage canals, the permanent pumps and the gates have been constructed for operating proper water management in the large-scale irrigation scheme areas. These canals are used for irrigation and drainage in ordinary times. However, based on the experience of the large floods in 2006 and 2011, the Thai government has been reviewing a proposal to use these large-scale irrigation systems as monkey cheeks. By opening and closing the drainage gate at appropriate times, flood damage from periodic, smaller floods can be reduced, and for larger floods, swamps in low lying areas can be used as monkey cheeks to retain water.

RID manages the irrigation and drainage facilities in large-scale irrigation project areas, but water management data distributed by RID often do not reach Tambons and farmers. In 2011, it was reported that flood information was not adequately transmitted to farmers, and as a result, the rice suffered damage before it could be harvested. To avoid similar situations in the future, while flood

management operation is appropriately operated by RID, it is important to establish an information-management system by which people can verify or compare RID's reported water level data with those from the community's staff gauges. By establishing such a system, it will be possible for people to make timely decisions during big floods.

2) Flood water control by RID

The role of the drainage gate in a large-scale irrigation project is to intercept the flooded water which flows from the lower stream of the river, and reducing the flood damage to farmland. Moreover, after the rainy season, the flooded water in the farmland is drained out to the river as soon as possible. After that, the drainage gate is closed to store the water in the drainage canal and to utilize this water for irrigation at the beginning of the dry season. By draining the flooded water soon after rainy season, rice planting of the dry season can be started earlier. As a result, the rice planting in the rainy season can also be started early, resulting in an earlier harvest in the rainy season, thus completing the harvest before the flood season in October.

Box 4.3.5 Example of the drainage gate operation of Bang Chom Si Drainage Gate

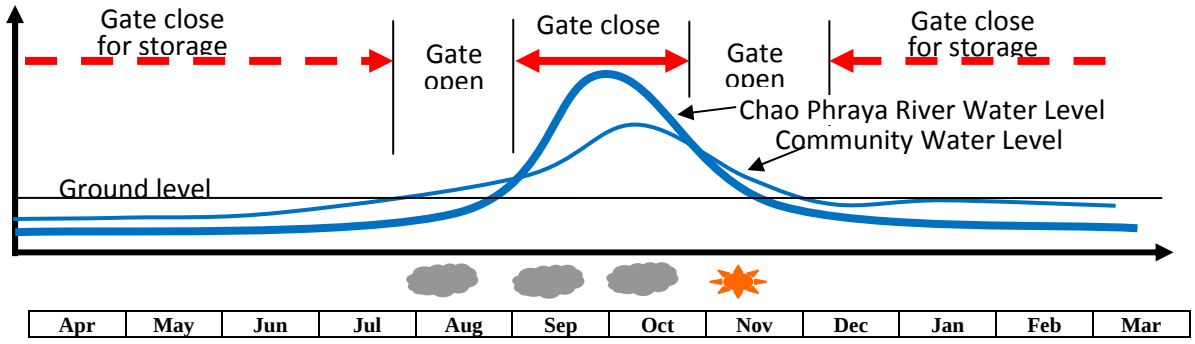
The following figure shows an example of the drainage gate operation of Bang Chom Si Drainage Gate by RID10 (Manorom & Maharaj Large Scale Irrigation Project). Drainage gate operation is aimed at mitigation of the flood damage in an irrigated area, and the effective use as monkey cheek in the lowlands area, and early commencement of rice planting in the dry season, etc.

August : Open drainage gate and drain the water in farmland to Chao Phraya River.

September to October : The water level of Chao Phraya River goes up. Drainage gate is closed in order to prevent the flood inflow from Chao Phraya River to farmland. The water level in farmland rises up by rain.

November : After the water level of Chao Phraya River becomes low, drainage gate is opened and the water in farmland is drained.

December to July : For the paddy cultivation in beginning period of dry season, drainage gate is closed for the purpose of storage water in drainage canal.



3) Current Flood Water Monitoring System by RID

RID has classified the three zones of water volume discharge as a flood monitoring and warning system at main gauging stations and RID O&M Project offices. Figure 4.3.6 shows the river discharge volumes during the past three years at Chainat gauging station (C13) in the Study Area with RID's three water volume zones in green (low), yellow (warning) and red (danger). By monitoring the levels, warnings can be issued when the yellow zone is reached, allowing for timely storage of drinking water and food, and for preparation of evacuation sites and measures, such as boat and helicopter, well in advance of the arrival of a big flood. Warning systems for big floods in other large-scale irrigation areas should be formulated in accordance with RID's flood water discharge monitoring system.

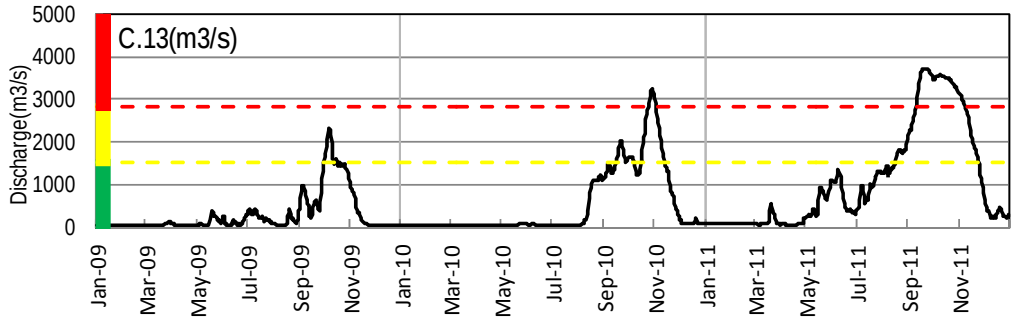


Figure 4.3.6 Discharge Record (2009-2011) and Flood Warning Zone at C.13 gauging station in Chao Phraya River

Source: RID

4) Development of a Community Flood Information System

In a model pilot project, a flood water management website was introduced into the Tambon office. This website allows for comparison and analysis of the staff gauge water level data installed in the community and RID's water level data. This simple system is web-based so that the local community, the general public and government agencies can all access the data in real time. The website contains information for community water management and warnings for floods and droughts such as:

- ✓ Water level and discharge data from RID telemetering stations that affect the water levels in the community areas. Data from RID telemetering stations can be found at the hydrology and water management center for each region. The data can be entered into the community database and shown in the community website in the form of graphs and tables.
- ✓ Community water level data from staff gauge station monitoring. Historical water level data is shown in graph and table formats.
- ✓ Regional and national water management data, such as flow charts showing discharge and water level of the river basin, and real time CCTV showing dam operation in upstream areas.
- ✓ Weather conditions and weather forecast of the community
- ✓ Web links to important agencies for community water management such as the Royal Irrigation Department (RID), the Thai Meteorological Department (TMD), the Provincial Office, and the Department of Disaster Prevention and Mitigation (DDPM).
- ✓ Community news and useful water-related information.

The community water level data and RID water records must be entered by a committee or a district officer who is assigned as the website administrator. The data should be updated daily in the community website. Refer to Technical Paper No.4 "Community Participatory Water Measurement and Database System" (Appendix II) for more details. The current information flow and the proposed changes in information sharing are shown in the following Figures 4.3.7 and 4.3.8.

Box. 4.3.6 Pilot Activity/Project for Development of Water Resources and Management

CWRM-1: Community Monkey Cheek Development Plan,[Implementation：TAO, Support：RID]
Community monkey cheek development utilizing existing water resources facilities in Small Scale Irrigation Areas/ Rain-fed Agricultural Areas

CWRM-2: Inter-Tambon Micro Watershed Water Resources Development Plan
[Implementation：TAO、Support：RID, PAO, DOLA]
Micro Watershed Monkey Cheek Development in collaboration with Tambons, Local Government Cooperation Scheme

CWRM-3: Community Participatory Water Measurement and Database System
[Implementation：TAO, Support：RID, University]
Necessary Flood Information System for Participatory Flood Water Management in Large Scale Irrigation Areas

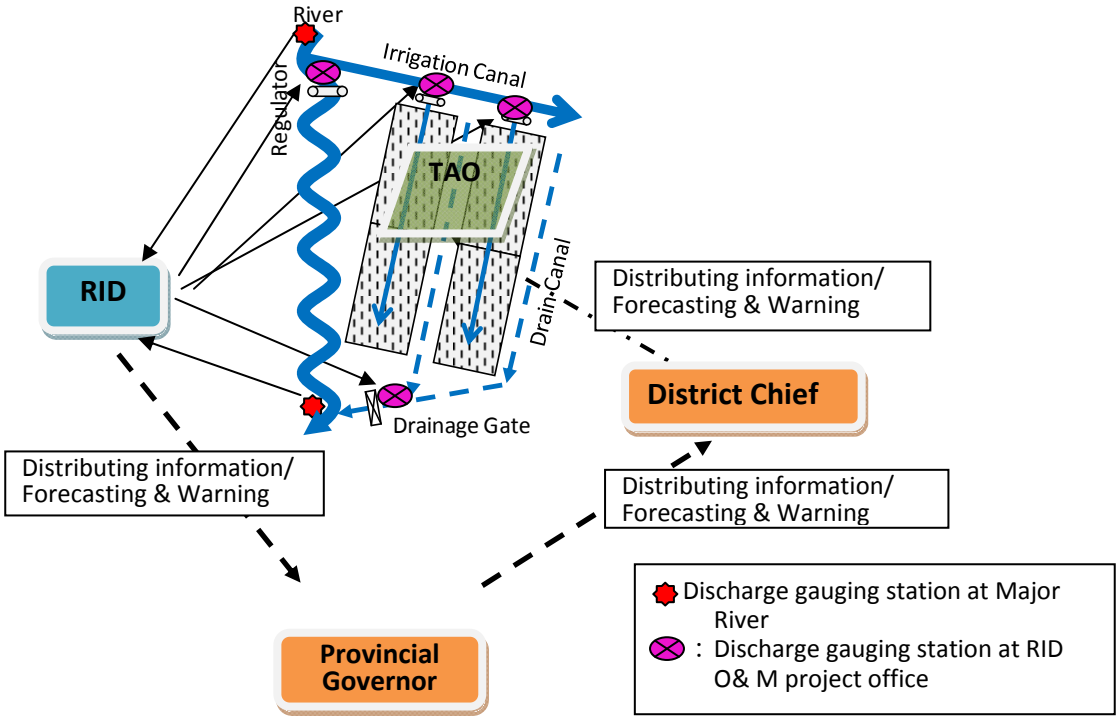


Figure 4.3.7 Current Information Flow; RID→Province→District→Tambon

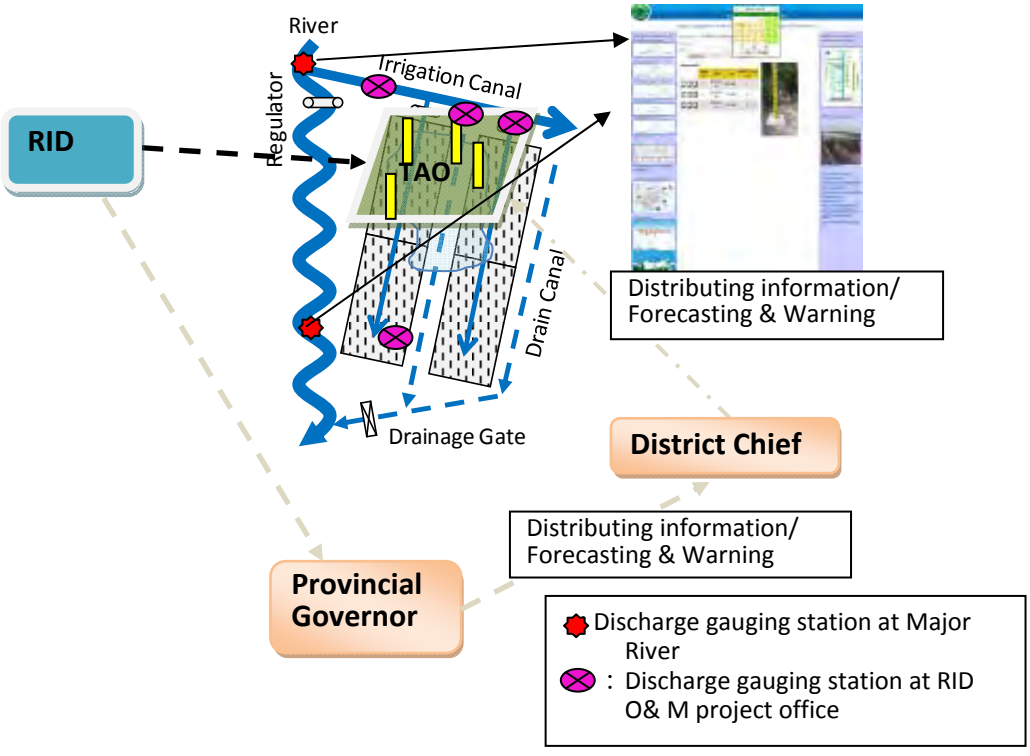


Figure 4.3.8 Proposed Distributing Information/ Forecasting & Warning System RID→Tambon←Water Level Gauging Station

4.3.3. Flood Damage Reduction Measures in the Agriculture and Livestock Sector

(1) Background

The 2011 flood has reminded a lot of people about the hazards of flooding in Thailand. But at the same time, the agricultural sector is constantly dealing with floods and droughts; a flood is not necessarily a special event in Thailand. What is important is to reflect the risk of floods, as well as droughts, into the ordinary production systems of agriculture, fish culture, and livestock rearing.

There are several types of agricultural areas in terms of flood risks in the Chao Phraya River basin. There are some areas where floods occur almost every year, especially in the lowland areas of the upper Chao Phraya River basin. In such areas, preventive actions need to be taken to ease the risk of flood even at a certain level of cost. A typical example is to cultivate paddy only twice a year, avoiding the risk of floods damaging the third harvest.

On the other hand, there are other areas with less risk of flooding especially in large-scale irrigated areas of the lower Chao Phraya River basin. In some of these areas, the 2011 flood was almost the first flood in the past decades. In these areas, farmers may not need to change their current farming system for a once-in-a-lifetime event.

Since flood risk varies among provinces, Tambons and river basins, countermeasures need to be customized according to each local area. In this chapter, many flood countermeasures are proposed as a conceptual guidance, so that government officers and farmers can choose the most appropriate measures.

(2) Categories of Countermeasures in the Agriculture and Livestock Sector

Proposed countermeasures towards the vision of "enhancing resilience of agricultural and rural communities against flood" are summarized in a framework in Figure 4.3.10. In the framework, there are three major stages of 1) prevention and preparedness, 2) response, and 3) recovery correspond to the three phases of "before," "during" and "after" the flood. For each stage, strategies, approaches and specific project activities are proposed.

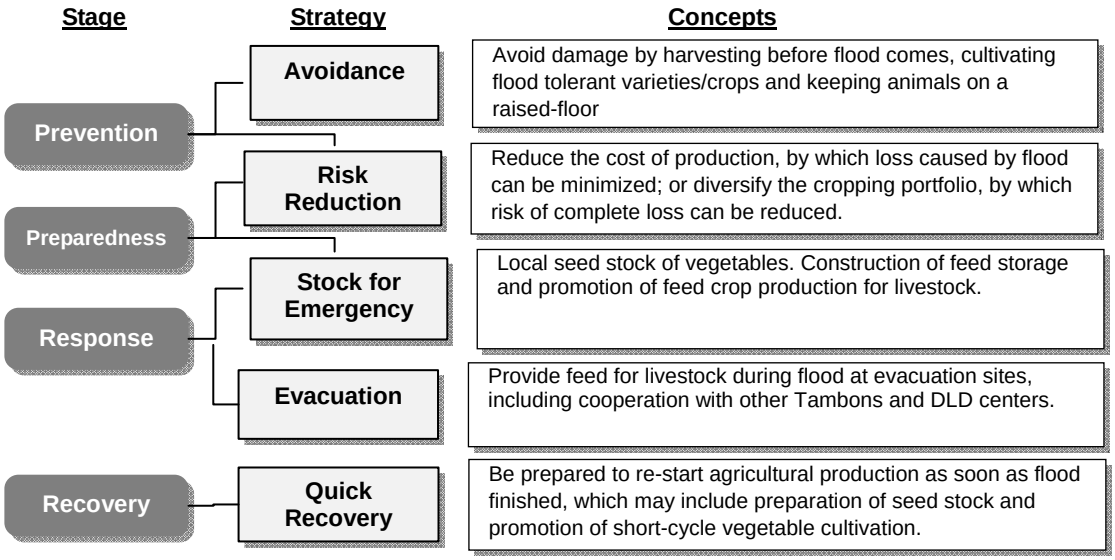


Figure 4.3.9 Main Concept of Proposed Strategy by Stage of Flood

For example, for the prevention/preparedness stage, there are two major strategies "avoidance," and

"risk reduction." And for the response stage, strategies are "evacuation." Then, after communities experience flood damage in the agriculture and livestock sector, "quick recovery" is the main strategy for the recovery stage.

As shown in Figure 4.3.9, an "avoidance" strategy seeks to avoid damage to the agricultural and livestock production system. A typical example is to harvest paddy before the flood comes, or to shorten the cultivation period by transplanting and/or cultivating early maturing varieties. In the "risk reduction" strategy, on the other hand, the focus is on reducing the cost of agricultural and livestock production. Even if the flood cannot be avoided, losses caused by the flood can be minimized by reducing the cost of production. Alternatively, risk of complete loss can be reduced with more diversified farming systems.

The aim of an "evacuation" strategy is to prepare a support structure for evacuating people or livestock. Feed storage at community or Tambon level, for example, can be a useful resource for livestock evacuated from flooded areas. While there are many difficulties caused by flooding, there are also some benefits, including increased availability of fish or improved soil fertility. Thus, making the best use of these availed resources can be an alternative strategy of "utilization."

Finally, if flood damage could not be avoided, "quick recovery" is important. To recover quickly from flood damage, preparedness is essential for every aspect of the production systems. For example, seed stock of paddy can be a useful resource for a quick re-start of cultivation after a flood. Or, having prior experience in vegetable cultivation is preferable if cultivation of short-cycle crops is to be the main strategy after flood.

While there are activities that can be managed mostly by individual households, there are others that need to be implemented by the government in cooperation with the private sector, universities, and local institutes. Examples include financial compensation for loss and damages, provision of crop insurance, and institutional support for coordination among stakeholders across multiple sectors, including government-private partnership.

The framework in Figure 4.3.10 summarizes all strategies, approaches and project activities by stage, with information on "expected level of disaster," "expected range of target area," and "main agencies concerned.". For example, "1.1 Shortening of paddy cultivation period" is a program under the "avoidance" strategy, which should be done in the "before flood" stage. For this program, one essential activity is the "introduction of transplanting," either by machine or by parachuting method. This activity will be effective for both "mega-floods" and "periodical floods" because if the paddy can be harvested before the floods arrive, harvest can be secured.

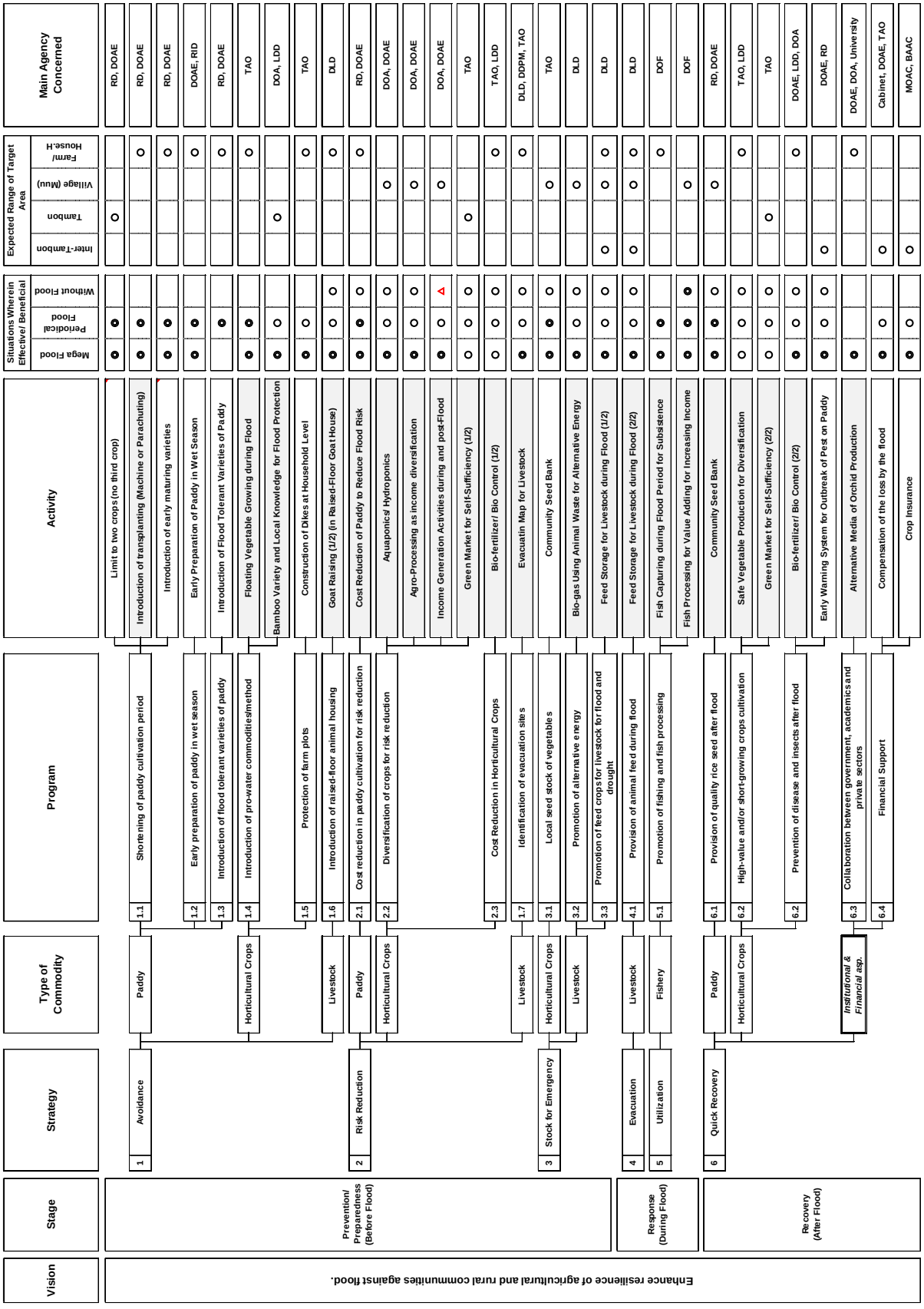
In terms of the "expected range of target area," the introduction of transplanting is primarily an activity done at farm or household level, as opposed to an activity that requires coordination with other households at village or Tambon level. Finally, regarding main agencies concerned in the activity, in this example, they are the Rice Department (RD) and the Department of Agricultural Extension (DOAE). The RD is a research and development institute developing new technologies, such as new varieties, while DOAE is responsible for extension services of these technologies including the promotion of transplanting.

Factors affecting Appropriateness of Activities

When selecting activities to implement, it is helpful to consider the factors of effectiveness, adaptability, and sustainability. Even if the effectiveness of a proposed method is extremely high, it may not be appropriate if it cannot be adapted by farmers to their

context. Farmers often will not adopt a new approach unless they are fully convinced, even if it is known to be effective. Also, activities need to be sustainable, both technically and financially. If the dependency on external support is significantly high, activities may not be continued once outside support is terminated. Moreover, necessary action may differ depending on the level of development or readiness of the communities. In summary, the countermeasures proposed in Table 4.3.10 should not be automatically promoted as a standard package. Instead, the activities should be seen as potential activities to be reviewed in order to select relevant ones based on local conditions. Activities should also be adjusted, as necessary, to fit local conditions in a sustainable way.

Figure 4.3.10 Flood Countermeasure Framework in Agriculture and Livestock Sector



(3) Paddy

The agro-ecology of the Chao Phraya River basin is broadly characterized by paddy cultivation; paddy makes up 69.86% of the total agricultural land use in the lower Chao Phraya River basin (RID, 20101). In addition, it was estimated that paddy accounted for 59% (10,560 million baht) of the total damage (17,848 million baht) caused by the 2011 flood in terms of compensation value. Since Thailand is abundant in water, paddy is cultivated twice or sometimes three times per year. At the same time, however, there is always a certain risk of flood every year. Thus, strategic planning of paddy cultivation is a central issue in the agriculture sector.

In theory, it is quite easy to avoid flood damage. No matter how big the flood is, paddy will have no damage if it can be harvested before the flood. The challenge is how to ensure this. The government policy recommends farmers to limit the number of cultivations to twice a year, so that paddy cultivations can be done completely outside the flooding season.

In reality, however, many farmers take the risk of a third crop to sometimes suffer from flood damage, including in 2011. This is because their concern is to maximize income, even if there is a risk of flooding. Given this fact, some measures focusing on cultivation approach are also proposed in the section below.

1) Proposed Measures

As shown in Figure 4.3.11, there are two main ways to reduce the risk of flood regarding paddy cultivation: avoidance of flooding season and cost reduction. For avoidance, three specific approaches are proposed: limit the number of crops to two per year, introduce transplanting and use early maturing varieties of rice. For cost reduction, on the other hand, appropriate use of chemical inputs is the primary recommendation. And the use of microorganism, such as “por dor,” and use of home-grown rice seeds are proposed to replace costly inputs.

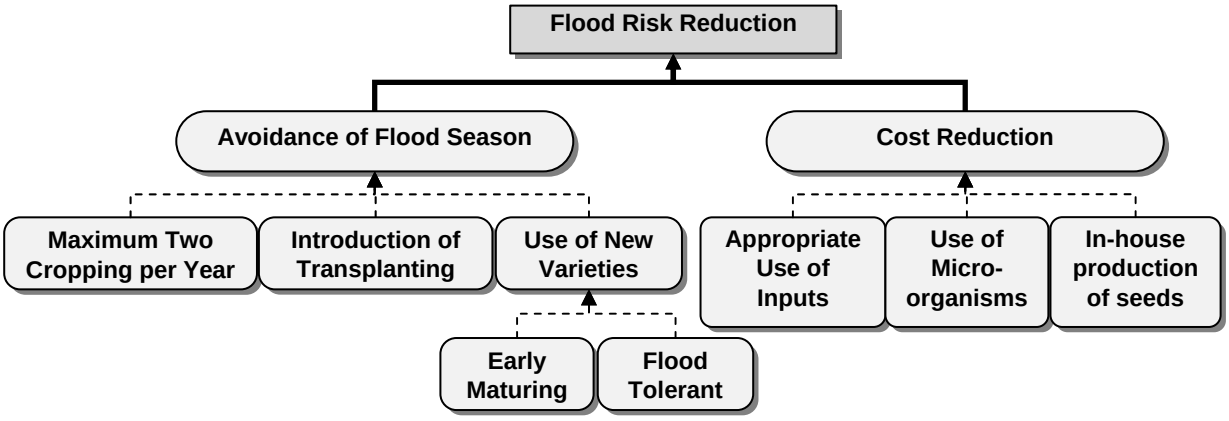


Figure 4.3.11 Countermeasures to Reduce the Risk of Flood to Paddy Cultivation

Avoidance of Flood Season

i) Limiting the Number of Croppings to Two

The first recommendation, in line with the government policy, is that the number of paddy cultivation should be limited to two times per year throughout the region. With only two crops, the chance of being hit by floods can be significantly reduced. It also helps synchronize the cropping calendar in the area. Where paddy is cultivated three times a year, or five times in two years, cultivation is often delayed and, as a result, one of them will fall into the flood risk period.

[1] http://kromchol.rid.go.th/lproject/2010/index.php/-25-/101-10

Therefore, the practice of two crops, or less, should be the main approach.

Table 4.3.6 Typical and Proposed Cropping Calendar

Cropping Pattern	Dry Season				Rain Season						Dry Season	
	Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
2 crops per year	2nd Cropping				1st Cropping				Risk of flood			
2 crop per year transplanting	2nd Cropping			Nursery	1st Cropping						Nursery	
								Flooding Period				

Source: Interview with DOAE (case of Phitsanulok area)

Note: 1) This table intends to show the concept of the countermeasure; the actual cropping calendar may vary depending on the location and varieties of paddy. 2) The second crop can be managed by direct seeding but by shortening the second cropping period, it would be possible to start the first crop earlier in the following year. 3) There are some cases in which irrigation water is available only from May. Even in such a case, a nursery can be organized in a small plot and then transplanted onto the main field after water is available.

ii) Introduction of Transplanting

To shorten the cultivation period in the field, the transplanting method is useful. By preparing seedlings outside the main field, the duration when the crop is in the main field can be minimized. In other words, preparation of seedlings can be started two or three weeks before the main field is ready.

Transplanting by parachuting (left) and by transplanting machine (right): which one is more suitable in central Thailand?

Although transplanting is not commonly practiced in Thailand, there are two transplanting methods seen in the country: transplanting by machine, and by parachuting by hand. By machine, seedlings of about 20 days are planted in about 30 minutes per rai. On the other hand, in the parachuting method, skilled laborers throw the seedlings, at the age of around 15 days, upward so that they land with the roots down.

A field trial carried out under this project, identified some advantages and disadvantages of the various planting methods as compared to the conventional direct seeding method prevailing in the area. See the discussion below for details.

iii) Use of Early Maturing Varieties

There are a number of short maturing varieties available in Thailand. Superior to the conventional varieties that take 105 days (RD-41), 104-112 days (RD47) and 110-120 days (RD31), short maturing varieties, such as RD 43 and RD 51, can be harvested in 90-95 days after sowing using the direct seeding method. Therefore, the use of such varieties can also shorten the growing period of paddy in the main field.

A leaflet introducing a newly developed variety of a rice cultivar

On the other hand, as the maturing speeds of these varieties are faster than those for conventional varieties, the potential number of tillering is relatively low. Therefore, these varieties may not always be suitable to transplanting by machines that keep wider spacing for enhanced tillering. In addition, the quality of early maturing varieties is often challenged. Thus, for shortening the growing period, the transplanting method may have more advantages.

Cost Reduction

i) Appropriate Use of Input

For cost reduction, the government has been promoting the concept of "appropriate farming systems" including the reduction of seeds, chemical fertilizers and agrichemicals. The government does not necessarily discourage their use but promotes the appropriate use of these inputs. When fertilizer is applied with the right timing, composition and amount, the total amount of fertilizer used can be reduced. Also, if farmers can produce quality seeds by themselves, they do not have to purchase costly ones from the shops.

A leaflet promoting the appropriate use of agrichemicals for cost reduction

In other words, the way fertilizer is applied by farmers can be somewhat incoherent; adding urea when the leaf color is still deep green, for example. As a result, the amount of fertilizer and other chemicals used in practice is often much greater than what is recommended by the Rice Research Center or Department of Agricultural Extension. Therefore, appropriate use of chemicals should be the first step for cost reduction.

To determine the appropriate level of inputs, it is desirable to conduct a soil analysis. Each field has its own chemical and physical characteristics and the composition of chemical fertilizer should be adjusted based on the actual soil condition. Today, easy-to-use soil analysis kits, developed by Kasetsart University, are available in Thailand and LDD also provides soil analysis services. Thus, the provision of extension services on appropriate use of inputs should be increased.

ii) Use of Microorganisms and Organic Materials

As a part of cost reduction measures, use of micro-organisms and organic materials, as alternatives to expensive chemical inputs, is also recommended. For example, instead of applying insecticide repeatedly after each appearance of insects, such as brown planthopper (BPH), it would be more cost-effective to apply the fungus beauveria as a preventive measure to suppress the population density of the insect below the economic threshold. This approach does not necessarily rule out the use of chemicals but will help to reduce production costs. For more details, refer to the next sub-section of this report.


A strain of Beauveria (left) and being propagated on the culture medium (corn) (right).


A body of a small insect (4-5mm) infected by Beauveria through direct contact infection.

2) Pros and cons of different planting methods

As noted, the transplanting method, either by machine or by parachuting, is recommended to shorten the cropping period of paddy in the main plot. Yet, there are some advantages and disadvantages of these methods as compared to the conventional broadcasting method.

Broadcasting (DS) by broad caster

Transplanting (TP) by machine

Transplanting by parachuting (PC)

Table 4.3.7 Specification of Three Planting Methods: DS, TP, and PC

Item	Broadcasting (DS)	Transplanting by Machine (TP)	Transplanting by Parachuting (PC)
Outline	Broadcast rice seeds directly on the surface of paddy field	Transplant seedlings about 20 days after sown on tray (w/o holes)	Throw seedlings on the surface of paddy field at about 15 days after sowing on tray (w/ holes)
Total Days*1	105.7 days	114.0 days	115.9 days
Planting Period*2	103.7 days	96.9 days	95.9 days
Amount of Seeds	20 kg/rai	15 kg/rai	15 kg/rai
On Farm Management (Labor Work)	Difficult	Easiest due to wide spacing in line	Easier due to wide spacing
Weed Management	Susceptible against weedy rice	Weedy rice is well managed	Weedy rice is well managed
Insect Management	Difficult to apply pesticides	Easier to apply pesticides	Easier to apply pesticides
Cost of Planting	50-60 Bt/rai	1,100-1,300 Bt/rai	1,200-1600 Bt/rai
Cost of Agricultural Chemicals	560.3 Bt/rai	439.7 Bt/rai	436.5 Bt/rai
Yield	630.1 kg/rai	714.5 kg/rai	678.4 kg/rai
Total Cost	4,385 Bt/rai	5,282 Bt/rai	5,815 Bt/rai
Income	8,097 Bt/rai	9,495 Bt/rai	8,932 Bt/rai
Profitability	Low	High	Middle
Access to service provider	Well Accessible	Not enough	Not enough

Source: Field trial under this Project in the 2012/13 dry season.
Note: *1) Days from seed soaking to harvesting. *2) Days after sowing or days after transplanting onto the main field (excluding nursery period).
Qualitative descriptions are comparative.

Table 4.3.7 summarizes the findings of a field trial conducted by this project to compare the three planting methods of broadcasting (BC), transplanting by machine (TP) and transplanting by parachuting (PC). As shown in the table, in terms of total days, BC was the shortest among the three methods, however, for the planting period, PC was the shortest, followed by TP and BC. However, TP and PC methods both have a nursery period outside of the paddy field in order to grow seedlings. Based on this result, if the farmer can control the cropping pattern, which includes seedling growing, land preparation and water management, TP and PC can shorten the planting period and avoid flood damage.

For weedy rice management, it was easier to see and remove the weedy rice from the TP and PC fields because there is more space between the hills. It was also easier to apply agricultural chemicals such as herbicide, pesticide and fungicide in the TP and PC method fields. Thus, the cost of agricultural chemicals of TP and PC were lower than BC. Planting cost and amount of seeds were different among the three methods: the planting cost of BC was lowest but the amount of seeds was highest.

The TP method recorded the highest production, the second was PC and the third was BC. For BC, the total cost was the lowest but the income was also the lowest. In some cases, rice produced by TP or PC methods can be sold at a higher price, because of the high quality of seeds. Therefore, from the results of the field trial, we can conclude that TP was the most profitable method of the three. However, in some places, it is difficult to find service providers required for the TP and PC methods.

3) Recommendation

Based on the above, the recommendations are as follows. First of all, although its impact is limited (10 to 15 days), transplanting is an effective flood countermeasure as it shortens the cultivation period in the main field. It can be an effective strategy when farmers need to modify their schedule, for instance when the previous cultivation has been delayed. Moreover, the transplanting methods have an advantage in weed management at the early stage of the cultivation. In fact, weedy rice, a group of weeds that shows similar characteristics to rice cultivars, has become problematic particularly in the paddy fields where the broadcasting method has been repeatedly used.

Therefore, the transplanting methods can be promoted both as a means to deal with weed problem and a means to shorten the cultivation period. If the issue of adaptability of the technology is considered, the reduction of 10 to 15 days may not be attractive enough for many farmers. However, its benefit in weed control may persuade them to change their farming systems. Thus, when promoting transplanting methods, the advantages and disadvantages of various aspects should be addressed.

The advantages of transplanting by machine are that bigger areas of paddy fields can be covered, and that less labor is needed. The latter is an important factor given the decrease in the younger population engaged in agriculture. However, the mechanization in the paddy sector, particularly the use of transplanting machines, is still at an early stage. Also, there are some areas where transplanting machines cannot be used because of soft foundations or inappropriate land preparation. Thus, in the short term, or as a transition phase, parachuting would the first priority because it is less costly to implement.

On the other hand, it was found that service providers for machine transplantation and parachuting are still limited. Thus, the development of service providers in this field should also be a priority. One of the recommendations for the government sector is to support this process, especially for training in parachuting. It is better to train existing service providers who are specialized in broadcasting, rather than training those without some prior related experience in this field.

4) Other Issues to Consider

Coordination with responsible agencies in irrigation management is also important. For transplanting either by machine or parachuting, seedlings need to be prepared before planting in the paddy field. If there are delays in the irrigation schedule, or if the schedule is not specified, seedlings cannot be planted at the right time. So, the irrigation schedule should be clarified and farmers before the

preparation period of paddy cultivation. Lastly, for smooth recovery of the paddy cultivation after a big flood, good quality seeds should be produced and kept in a seed bank.

(4) Vegetables

As a means to cope with floods, vegetable cultivation can be useful for individual farmers. As listed in Figure 4.3.12, there are four major approaches to strengthen resilience in agriculture: avoidance of flood, risk reduction, stock for emergency and quick recovery. Avoidance of flood may include the use of commodities or cultivation methods suited to flooded environments. It also includes protection of farm plots by constructing dikes around the plots, particularly for high-value crops like fruits.

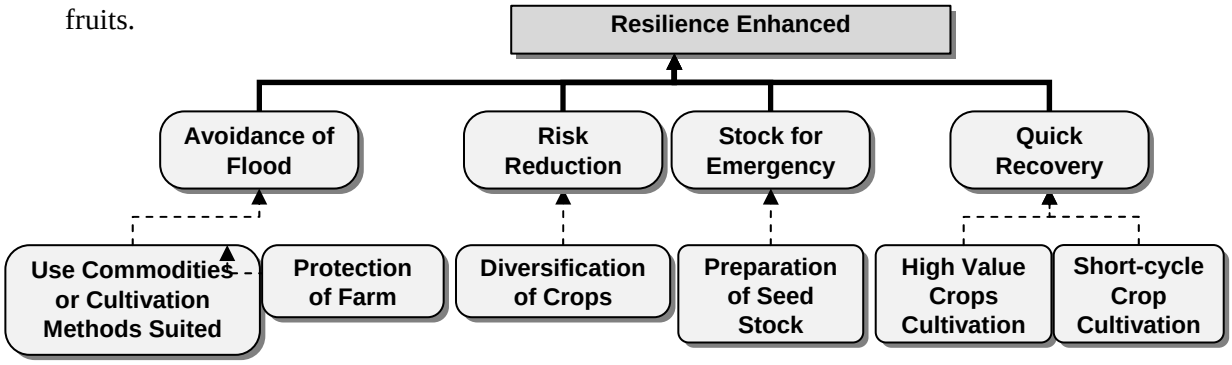


Figure 4.3.12 Countermeasures Related to Vegetable Cultivation

Risk reduction can be achieved by diversification of crops. Since paddy cultivation is the prevailing farming system in the Chao Phraya River basin, the biggest economic loss was generated in the paddy sub-sector in the 2011 flood. In this context, vegetable cultivation can provide farmers with more alternatives, so that farmer households can be more resilient to flood damages.

Vegetable cultivation can be, first of all, organized in a small upland area, facing less risk of flood.

Moreover, preparation of seed stocks for possible emergencies is recommended. If farmer households have their own seeds, restarting vegetable cultivation can be easy. Lastly, quick recovery will be the main strategy when farmers were not able to avoid flood damage. For quick recovery, farmers should be familiar with vegetable cultivation by cultivating it under normal circumstances without floods, especially high-value crops and short-cycle crops.

Among these approaches, appropriate ones can be selected based on the conditions of the household/community or the types of crops. Practically, these approaches listed above are suited to individual households consistent with the "sufficiency economy" philosophy. For large-scale commercial-based horticulture, more preventive measures with higher investment are required.

Floating raft is a special but still applicable means for emergency. Bamboos can also be used.

a) Avoidance

First of all, it will be easier avoid flood damage, if vegetable cultivation is adopted. Cultivation can be done in a small plot especially for home consumption, and thus a small upland area can be allocated for vegetable cultivation. In the event of a flood, even if paddy on lowlands is flooded, vegetables on the upland are more likely to survive, and can provide food or income for the household.

Another avoidance strategy is to use special methods of vegetable cultivation that are suitable even during floods. Typical examples include the use of rafts for vegetable cultivation and the selection of pro-water vegetables like morning glory. Of course, if special materials like polystyrene foam are required, it may be less practical, but it can be a good alternative for emergency situations.

Diversifying crops and income sources is a good way to reduce risk unless they have the same risk pattern (an example of aquaponics).

Other project activities in this category include: "Floating Vegetable Growing during Flood," (Technical Paper No.11 in Appendix II) "Bamboo Variety and Local Knowledge for Flood Protection," (Technical Paper No.18 in Appendix II).

b) Risk Reduction

As noted above, vegetable cultivation on uplands is more likely to survive than paddy. Thus, incorporating vegetable cultivation into the farming portfolio of individual farmer households can reduce the risk of total loss. Diversification of crops with different risk patterns is an orthodox but effective way to mitigate risk. So, any type of crop or farming activity, such as aquaponics, hydroponics, agro-processing, and other income generation activity can be included into the portfolio, unless they have the same risk pattern in terms of tolerance to flood.

However, vegetables can also be washed away in the event of a huge flood or when upland areas are limited. Even in such cases, low-input vegetable cultivation can minimize the risk of economic loss with the same level of return. Thus, to reduce the potential that could be lost, cultivation of safe vegetables using less chemical inputs is recommended. In addition, such vegetables are also popular with consumers.

Risk reduction can also be achieved through reducing production costs. One method appropriate to the Thai rural context is to use bio-extracts, a natural repellant made from various types of herbs and plants boiled in hot water, then distilled. Materials for bio-extract, such as neem, ginger leaf, and lemon grass, can be found locally. Another example is the use of compost instead of chemical fertilizer. Because of the poor sedimentary soil of the river basin, the physical structure of the soil needs to be improved for sustainable vegetable cultivation.

Distilling the boiled water of various herbs, making a natural repellant: it can be a good alternative to chemical insecticides

Other programs in this category include:

"diversification of crops for risk reduction," and "cost reduction in horticultural crops."

c) Quick Recovery

If everything is washed away by a flood, farmers will need to start a recovery process as soon as the flood recedes. In the case of paddy, it is difficult to restart cultivation due to its larger scale, requiring more funding for farmers who lost their investment by the flood. By contrast, vegetable cultivation can be started relatively easily once the land becomes dry.

Although the income from a small plot is quite limited, with vegetable cultivation, farmers can earn cash in about three to four weeks. This kind of small but quick cash income can help farmers in the recovery process since the cash can be used for agricultural inputs, food or house repairs.

Thus, vegetable cultivation, especially safe vegetable cultivation with low-cost inputs, can be a good strategy for recovery. In addition, if farmers already have access to an established market, this will also help speed up the recovery process.

Farmers selling their safe vegetables at a green market. Once a marketing route is established,the activity can be more sustainable and easier to restart even after flood.

(5) Cash Crops

In addition to paddy, field crops such as sugarcane and cassava are also cash crops. However, these field crops are usually cultivated in upland areas where the risk of drought is greater than the risk of flood. Therefore, flood countermeasures for these crops are not an urgent concern for farmers. On the other hand, severe damage has been reported on horticulture crops, especially fruit trees and orchids. These crops require substantial time to mature, i.e. they have a relatively long vegetative growth stage. As a result, economic loss tends to become significant, even for a small area.

It was reported that some farmers gave up restarting mango tree cultivation as they could not wait for 4 to 5 years without cash income from selling mango fruits. In such cases, farmers need to consider 1) planting more short-cycle commodities such as banana instead of mango; 2) protecting the farm plot against flooding with dikes; and/or 3) limiting the location of fruit cultivation to only upland areas. For fruit production, more conservative approaches that involve less risk may be more appropriate because of the high level of investment required.

A mango orchard damaged by the 2011 flood, where bananas are newly planted instead of re-cultivating mango trees because of the high cost of investment.

(6) Private-Public-Academic Collaboration for the Recovery of Sub-Sectors

In the horticulture, fruit and orchid sub-sectors, which suffered enormous economic loss from flood damage, reconstruction of the industry as a whole is necessary. Issues faced by these sub-sectors cannot be addressed at the individual farm level. To solve these issues, industry, government and academia need to collaborate to come up with innovative solutions. The issue of collaboration

between the private sector, public or government sector and academic institutions, such as universities will be discussed in 4.3.5 Networking, Supporting and Institutions for Flood Disaster in this report.

(7) Flood Countermeasures in the Livestock Sector

The most serious issue in the livestock sub-sector during and after the 2011 flood was the shortage of animal feed. Therefore, the preparation of feed crop is proposed as a major countermeasure for the livestock sub-sector. As shown in Figure 4.3.13, this consists of two programs; the preparation of stock for emergency before the flood, and the provision of animal feed under the evacuation strategy. Identification of evacuation sites is a program under the risk reduction strategy aimed at ensuring the safety of animals during floods. The identified evacuation sites will be included in maps indicating flood hazards and evacuation routes, which are prepared as part of the community-based flood disaster risk reduction plan. In Thailand, goats are mostly raised by Muslim communities, and for these communities, the raised-floor animal house program is proposed as an avoidance strategy.

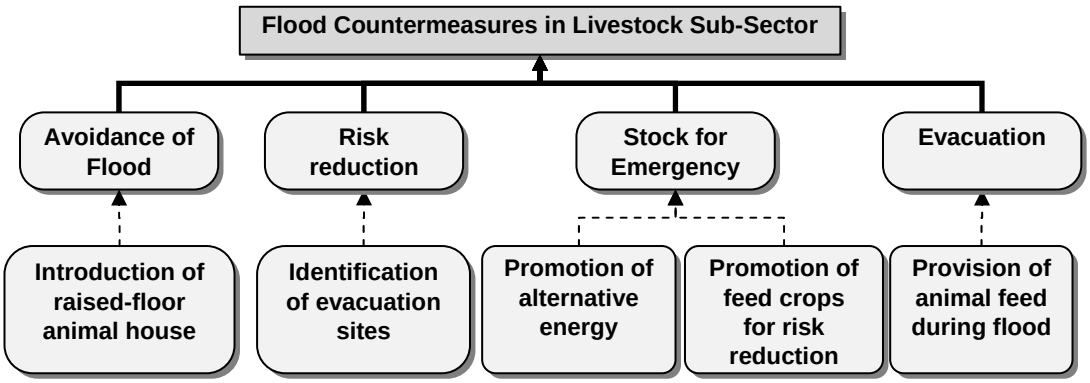


Figure 4.3.13 Countermeasures Related to Livestock

1) Evacuation Plan

In areas identified as high flood risk areas by the flood risk analysis, it is recommended to prepare an evacuation plan for animals as part of the Participatory Flood Disaster Risk Management Plan. Evacuation sites and routes of animals should be planned and indicated in the flood hazard/evacuation map. Also, the number of ruminants, mainly cattle, goat and sheep, to be fed during and after the flood should be estimated. Specifically, the following should be addressed:

- Preparation of the community map showing road networks, elevation and location of livestock farmers, livestock population, and pasture areas for forage production;
- Relocation of livestock should be discussed in the community, in consultation with TAO, provincial and district DLD offices, if the rainfall is expected to considerably exceed the annual average;
- Through community discussions, evacuation site(s) should be identified and agreed upon prior to the flood; and
- The number of ruminants that will stay in the community throughout the flooding period should be noted. This will be the target number of ruminates for supplying feed.

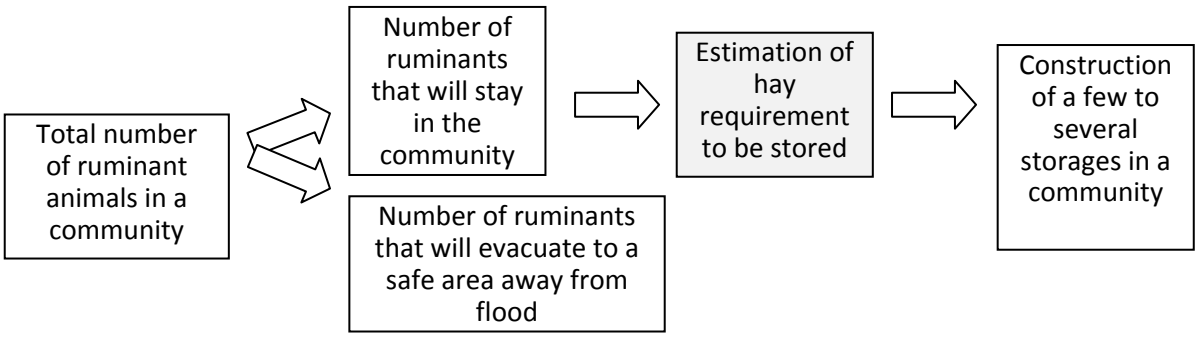


Figure 4.3.14 Flowchart of Feed Storage Planning

2) Forage Production and Hay/Silage Production

The most serious issue in the livestock sub-sector during and after the 2011 flood was the shortage in animal feed. For forage production, cultivation of Pangola grass and Pakchong-1 (Giant Napier grass) is proposed. This is consistent with the DLD's policy of cultivating Pangola grass in the lowlands and Pakchong-1 in the uplands. Main features of Pangola Grass and Pakchong-1 are summarized in Table 4.3.8. As shown in the table, profitability of Pangola Grass is 1.24 times higher than paddy in irrigated areas and 2.02 times than that in non-irrigated areas.

Table 4.3.8 Main Features of Pangola Grass and Pakchong-1

Item	**Pangola Grass**		**Pakchong-1**
Suitable land for cultivation	Low land		Upland
Planting method	Seedlings		Seedlings
Appropriate time to plant	All year round		Early in the rainy season
First Cutting	60 to 70 days after planting		75 days after planting
2nd and subsequent cuttings	Every 45 to 50 days after cutting		Every 45 to 60 days after cutting
Cuttings per year	Normally 5 to 6 times a year		Normally 5 to 6 times a year
Utilization	Fresh & as hay		Fresh & as silage
Expected Yield in fresh matter	18 to 24 ton/rai/year		More than 77 ton /rai/year
Expected Yield in hay	4,000 to 6,000 kg/rai/year		-
Longevity	5 to 6 years		6 to 8 years
When flood going down	Immediately apply urea 25 to 50 kg/rai		-
Condition	Irrigated	Non-irrigated	
Cost of production	5,268Bt/rai	1,603Bt/rai	
Yield	3,845 kg/rai	1,200 kg/rai	
Selling Price	2.24 Bt/kg	2.25 Bt/kg	
Gross Income	8,612 Bt/rai	2,699 Bt/rai	
Net Income	3,344 Bt/rai	1,096 Bt/rai	
Profitability compared to paddy	1.24	2.02	

Note: Cost and benefit calculations are based on DLD survey data (2004/05)

Making Pangola Grass Hay:

- Hay must be protected from rain.
- For quality hay, moisture content should be reduced to around 15% by drying in the sun for two to three days.
- By using a hay baler attached to a tractor, 800-1,000 bales (15-20 kg/bale) can be prepared per day.

Making Pangola Grass Silage:

- Silage is recommended for preserving Pangla grass during the wet season.
- Silage is a kind of preserved feed that can be used during floods.
- Silage can be used 20 days after packing.

Making Pakchong-1 Silage:

- For packing, plastic bags similar to fertilizer bags with a capacity of 30 kg-50 kg, or plastic cases (drum containers) can be used.

- With a suction pump, vacuum the air from the plastic bag, and then seal the bag.
- After packing, it needs to be kept for about 21 days before being used as cattle feed.

3) Strengthening Forage Storage

i) Concept of Feed Stock

A national perspective is needed to review the feed supply system for emergency situations so that livestock farmers in flooded areas are supported by supplies of stored feed from non-flooded areas (see Figure 4.3.15). Considering the number of livestock, size of flooded areas and the duration of the flood, a huge amount of forage is required. Since stocks of feed from the Animal Nutrition Research and Development Center (ANRDC) will not be adequate, communities and individual livestock farmers will also need to store feed for cattle and goats/sheep. In the past, feed stock was not usually prepared at community level because livestock farmers had not experienced serious flooding before 2011. Therefore, it is proposed to strengthen feed production and storing at DLD centers and in communities.

ii) Feed storage

Function of Feed Storage

Feed storage at community level contributes to strengthening feed supply in a time of disaster, keeping ruminant animals healthy and productive, which in turn ensures a stable income for livestock farmers. When there are floods, communities in non-flooded areas can support livestock farmers in flooded areas by supplying hay and silage from their storage. Similarly, feed storage with bigger capacity at DLD's ANRDCs can support livestock farmers when disasters occur.

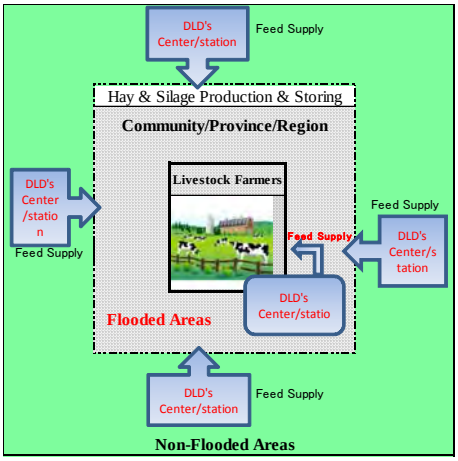


Figure 4.3.15 Concept of Feed Stock

Estimation of Hay Storage Area

The floor area of storage as a model for 100 LU (livestock unit) can be calculated as shown below:

Table 4.3.9 Estimation of the Floor Area

Conditions	Assumption
Body weight of a cattle (1 LU)	500 kg
Intake of hay per day	13.5 kg/day/LU
Flood period	60 days (to be varied depending on areas
Number of cattle (LU)	100 LU (100 cattle)
Requirement of hay	81.0 ton
Cubic volume of hay per ton	3.9 m^3 m^3/ton
Estimated cubic volume of hay	315.9m^3
Height of hay bale's heap	4.0 m
Required floor area	79.1 m^2 (8.9x8.9 for example)

Location

The recommendation is to identify a few to several storage sites at elevated locations in the community, taking into consideration the locations of farmers raising ruminant animals, and the locations of pastures and how hay and silage bales will be transported during the flood. To do this, it is best to decide on the location and capacity of the storage using maps and through discussions involving TAO, provincial and district DLD officials, livestock and pasture farmers.

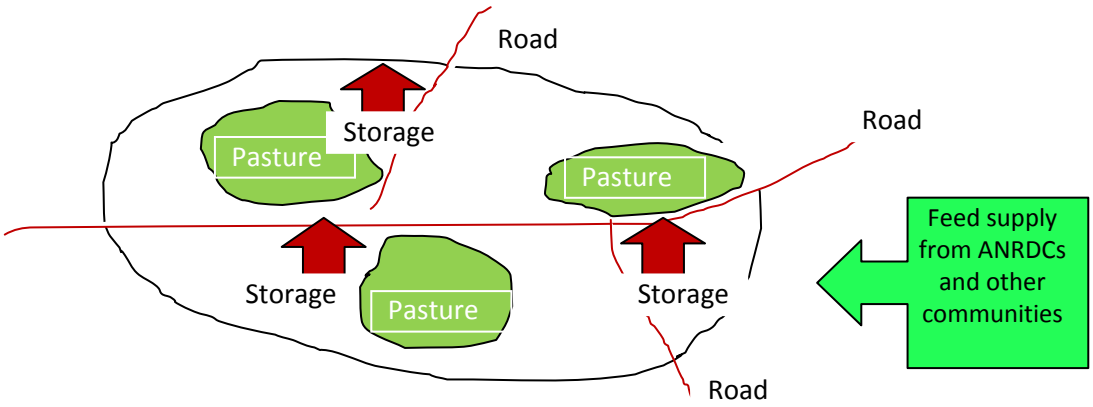


Figure 4.3.16 Location of Forage Storage in Community Level

iii) Hay Storage Monitoring by the DLD HQ

The DLD HQ is required to monitor the status of feed stored at 29 ANRDCs in the country every month. There are a total of 116 feed storage sites of varying sizes. Out of 29 ANRDCs, 28 centers have 1 to 7 storage facilities in the size of 10 x 20m each. To cope with future floods, ANRDCs have a very important role to play because they produce and store large quantities of forage. In addition, the DLD HQ is expected to develop a national plan for transporting hay to disaster areas.

4) Goat Housing against Flooding

i) Function of a goat house with raised floor

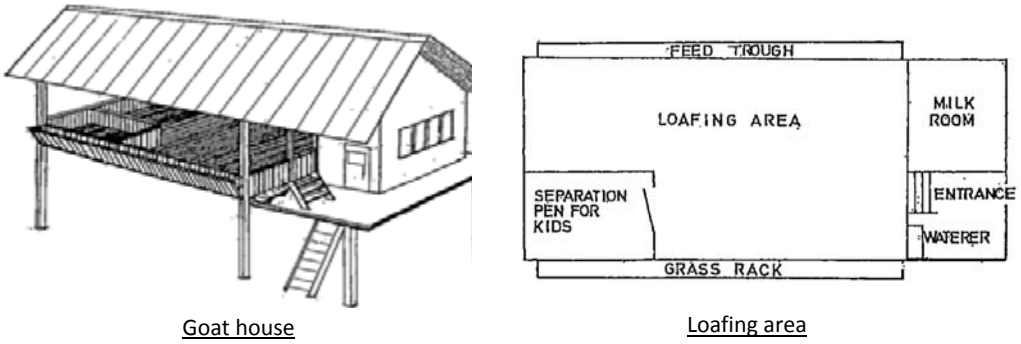
There are two reasons for proposing a goat house with a raised floor. First, goat houses with the flooring raised 1.5 to 2.0 m above the ground will withstand flooding. Second, a house provides a comfortable environment for goats. Good housing makes goats healthier and more productive, and it also makes it easier to manage the animals. An ideal goat house is one that can provide the maximum comfort for goats, protecting them from floods, strong winds, heavy rains, and predatory animals. The proposed design allows for good ventilation, is easy to clean and has adequate floor space.

ii) Site selection for construction

A goat house should be constructed at as elevated place which will not be affected by high floods. Wet sites should be avoided because goats do not do well in wet areas.

iii) Designing a goat house

- Space for one adult goat: 1.86sq.m
- Height of the loafing floor: 1.0 to 1.5 m in non-flooded area and 1.5 to 2.0 m in flooding area
- Material of goat house:
  - Column support: precast concrete pile with 10 cm to 15 cm square or timber of 15 cm to 20cm square.
  - Roofing: corrugated galvanized iron sheets or wooden slats.



Goat house　　Loafing area

Figure 4.3.17 Raised Floor Goat Housing

Housing for a dairy herd should be partitioned so that kids, pregnant does, milking does and bucks can be kept separate. Make sure that the pen for kids is adjacent to that of their mothers. Keeping the bucks far away from the milking does helps prevent the milk from absorbing the strong smell of bucks.

iv) Cost

The cost of construction of a goat house with a raised floor is estimated at 5,500 baht per sq.m including construction materials and labor costs. The cost can be reduced if cheaper materials are used.

Box 4.3.7 Pilot Activity/Project for Flood Countermeasures in the Agriculture and Livestock Sector

AGRI-1: Shortening of paddy cultivation period by transplanting, and development of service providers for transplanting [Implementation ：Rice Grower, Support：RRC, DOAE]
Shortening & harvesting before flood of paddy cultivation period by parachuting transplanting method <Avoidance of Flood damage>

AGRI-2: Safe Vegetable Production and Opening of Green Marketing [Implementation：Vegetable Grower Group, Support：DOAE, LDD]
Crops diversification by vegetable production<Risk Reduction>and early earning of cash receipt after flood< Quick recovery>

AGRI-3: Establishment of Forage Providing System in Emergency Case< Construction of Feed Storage> [Implementation：TAO, Livestock Group, Support：DLD]
Strengthening of Forage Supplying Ability when a disaster strikes by construction of Feed Storage in Community Level <Store for emergency> <Evacuation>

4.3.4. Income Generation Activities Towards Recovery of Rural Livelihoods

(1) Resiliency based on diversity in rural livelihoods and vulnerability to floods in intensification agriculture

In rural areas, people are engaged in various livelihood activities utilizing available local resources to make their living. Although the major income source is sale of paddy from one or two harvests a year, farmers also have supplemental income sources and also obtain items through barter or exchange. It is recognized that smallholder farmers use diversification as a strategy to manage their livelihood. Especially in rain-fed agricultural areas, people dependent on rainfall and other forces of nature tend to focus on reducing risk, rather than maximizing benefit due to the uncertainties of nature.

On the other hand, in paddy monoculture areas with well-developed irrigation facilities, farmers

concentrate on paddy cultivation to achieve maximum profit, selling the entire harvested to the rice mill without keeping any for their own consumption. It can be said, therefore, that livelihoods of farmers are vulnerable to disasters. Furthermore, diversity is decreasing in peri-urban areas, where non-farm activities are increasingly replacing agriculture as the main source of income.

It is possible to increase income during and after floods by introducing new income generation activities, or by improving on current activities. Such efforts will contribute to the recovery of livelihoods and strengthen the resilience of rural communities, but at the same time will also have the added benefit of diversifying livelihood during normal times.

The table below summarizes the key issues related to flood impact and income generation activities, as observed by JICA team members in the project areas.

Table 4.3.10 Natural and Social Environment, Issues on Flood and Income Generation Activities

Area	Natural and Social Environment	Issues on Flood Situation /Flood Prevention Projects	Remarks for Income Generation Activities
Flood-Prone Area/ Upper Chao Phraya River Basin	***Resilience to flood*** - Living with flood - Diversity of livelihoods and natural resources	Changes in amount of fish captured caused by flood prevention projects (shorter/longer inundation by drainage/ water retention)	Expansion/improvement of existing simple fish processing will be assisted on a small scale
Rice bowl/ Paddy monoculture area in the Delta	***Vulnerable to big flood*** - Less diversity of livelihood and natural resources - Existence of large landlords and many tenant farmers, agricultural workers who may be more vulnerable	- Proposed to use farmland in large-scale irrigation areas for water retention - Limited cultivation in flood risk period, less than 2 paddy crops a year may have negative impact on livelihoods of tenant farmers and agricultural workers	Consider impact on loss of livelihood / income of landless farmers and agricultural workers. They may not participate in any community groups and be excluded from support Fish processing during flood, salty eggs etc. in normal period
Flood-Prone Areas in the Delta	***Aging society*** - Young generation work outside community, aging of farmers	- Long inundation period due to proposal to use farmland as monkey cheek areas	Select simple and easy activities, e.g. fish processing and handicraft at home, since aged people enjoy group activities
Peri-urban areas	***Urbanization/ non-farmer*** - Farm land being converted into housing estates - New residents/town workers increasing, original residents/farm families decreasing	1. Protected area Least risk of flood	Near urban markets Potential to invest in higher value products (Use group activities as way of connecting with new residents)

Source: JICA Project Team

(2) Income Generation Activities, Food/ Agro-processing and OTOP as Flood Countermeasures

The experience of pilot activities in model areas suggests that income generation activities have both direct and indirect benefits as flood countermeasures for community people. The direct benefit is to increase cash income for households. This has two functions; first, to reduce the negative impact to the household economy during the flood and second, to reduce the risk of future disasters by diversifying the source of income. In order to reduce the risk, these activities must be combined with other activities such as vegetable growing promotion. Indirect benefits are to relieve feelings of depression during floods and to strengthen relationships within the community. The positive impact

of income generation activities as flood countermeasures are summarized in the following figure.

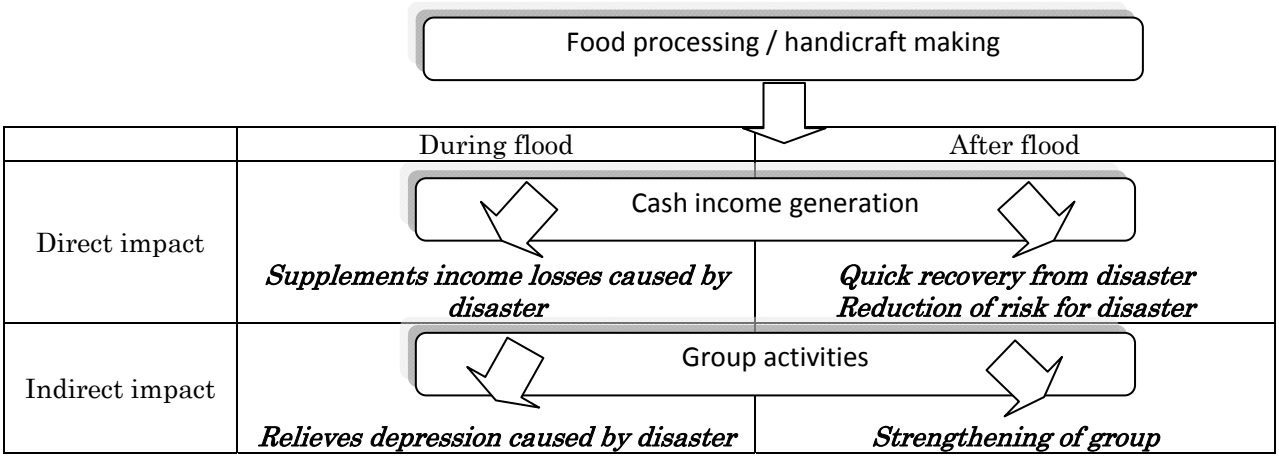


Figure 4.3.18 Direct and Indirect Impact of Flood Countermeasures

There are also limitations of income generation activities. When income generation activities are being proposed as flood countermeasures for a community, it is necessary to keep in mind the following points.

- ✓ Income generation activities do not always grow into independent businesses even with support from Tambons or other governmental organizations, since there are many factors affecting whether the business succeeds or not. When communities introduce income generation activities, it is important to consider both direct and indirect impact of the activities.
- ✓ In the case of food processing activities, in order to sell food products outside the community, certification by the Food and Drug Administration (FDA) is needed. For certification, investment to facilities and equipment might be necessary. To introduce a food processing activity, it is better to aim for a pre-GMP standard and to only sell in local markets.
- ✓ Judging from experiences gained in the Project areas, food processing facilities damaged and contaminated by flood waters need to obtain FDA certification again. These damaged facilities may need external support for reinvesting in facilities and for developing capacity regarding hygiene controls at pre-GMP level.

(3) Sustaining Livelihoods during Long Inundation Periods

One reason why even people in flood-prone areas, who are accustomed to floods, faced difficulties in 2011 is because the disruption to transportation and distribution channels for goods lasted longer than usual. Surveys conducted in this Project with processing and OTOP groups found that in addition to losses from innundation of their stock, incomes were also affected because finished products or raw materials could not be transported.

Considering such difficulties, fish capturing is the most important income source during a flood. In flood-prone areas, it is said that a flood is not disaster but an opportunity to gain income by catching fish. Although the proportion of people relying on fish for their livelihood may normally be about 10 to 20 percent in a given community, during floods, the majority will gain cash income by catching fish, snakes, etc. The fish are sold to middlemen, or at the local markets or are traded within the community. Other traditional adaptations of income generation during floods is simple fish processing through sun drying, smoking, grilling and fermentation of fish products, both for household consumption and for sales of surplus.

The three issues below are important to take into account for enhancing disasater-resilience and sustainable livelihood through fish capturing and processing;

1) It is necessary to consider the impact of construction of flood prevention structures on fish and fisherfolk in flood-prone areas.

2) The production capacity of existing simple processing methods can be enhanced so as to increase sales volume and expand the market to increase benefits to the community, and

3) In the newly assigned water retention areas, which have increased flood risk, it is recommended to introduce fish capturing and processing to compensate for the lost opportunity costs from farming. Marketing and sales of the produce can be supported by the provincial government.

Groups formed for food processing can also have a social function. Especially women and aged people often prefer to gather and work together even during flood periods. Bonds between group members are important for helping each other during long inundation periods, for example by asking after each others' health and problems. Specifically in an aging society, it is important to nurture such ties or social capital in the community, which will result in enhanced resilience.

Processing activities based on local resources available during floods are recommended, not only fish processing but also water hyacinth, for example. Approaches to be encouraged for processing activities during long-inundation periods are the use of local resources, simple processing, and processing that can be done at home.

(4) Role of External Support for Livelihood Recovery

Communities starting income generation activities may benefit from linking up with the following governmental and non-governmental agencies/stakeholders.

Table 4.3.11 Related Agencies/Stakeholders for Income Generation Activities

	Name of agencies/stakeholders	Possible support/cooperation
1	Department of Agricultural Extension (DOAE), Cooperative Promotion Department (CPD), Ministry of Agriculture and Cooperatives	・ Registering a group as "Community Enterprise" ・ Supporting establishment of cooperatives ・ Providing loan to Community Enterprise
2	Community Development Department (CDD), Ministry of Interior	・ Institutional support (formation of group) ・ Preparation of business plan ・ Linkage with other OTOP projects
3	Food and Drug Administration (FDA)	・ Certification of food processing product
4	Department of Industrial Promotion (DIP), Ministry of Industry	・ Support for Community Product promotion and certification
5	Universities (Faculty of Agriculture etc.)	・ Technical support for quality improvement of product (production development, analysis, packaging and marketing)
6	Non Governmental Organization	・ Coordination between other agencies mentioned above and communities ・ Facilitate community needs assessment

Source: JICA Project Team

Shown below are steps for establishing income generation activities in the community and key points to be considered by agencies and stakeholders.

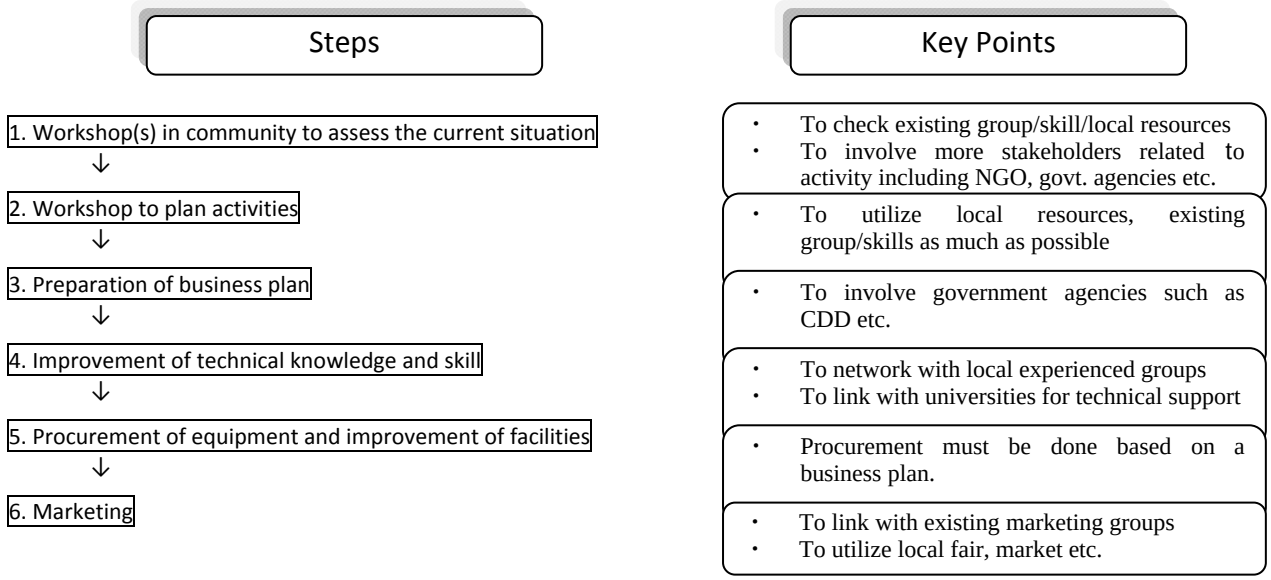


Figure 4.3.19 Flow Income Generation Activities

Source: JICA Project Team

After floods, recovery strategies that include income generation activities involving processing will result in a faster recovery of livelihoods compared to a strategy that relies solely on farming. The following are points to keep in mind for external agencies supporting the promotion of income generation activities

1) Marketing is important for selling products outside the community. This is an area where external support is relevant and critical, since villagers lack relevant knowledge and experience. While government agencies organize OTOP events and tourism promotion fairs inviting OTOP and community groups free of charge, the private sector and individuals can provide effective support by internet and word-of-mouth marketing.

2) The recent trend has been for supporters of OTOP and community products to focus on improved packaging as a marketing strategy, thereby increasing costs. Considering the competitive market, such cost increases would further reduce the profit margin, which is already very small.

3) Government support tends to focus on group activities. However, it is also possible for individual and private entrepreneurs in communities to produce and sell the same product by hiring other group members. If the objective is the recovery of livelihoods, supporting such individual entrepreneurs to enhance production and sales will result in enhancing the livelihoods of a wider group of people, e.g. through employment and purchase of raw materials from community members.

4) There have been some cases in which different OTOP-related government agencies were not well coordinated in their support to groups. For instance they supported the same group with different approaches, confusing and dividing the group. This kind of external support can undermine the group's initiative and will subsequently have a negative impact on the resilience of a community.

BOX 4.3.8 Model Program: Income Generation Activities Towards Recovery of Rural Livelihood

iGEN-1: Income Generation utilizing Local Resources [Imple.Org.: Processing Group ： Technical support: CDD, DOAE]

Supplemental cash income from simple processing of local resources available in rainy season such as fish and water hyacinth <Utilization>

4.3.5. Networking and Institutional Support for Communities

(1) Institutions and Organizational Arrangements at National Level

As natural disasters seriously affect economic activities and people's livelihoods, there are a number of agencies at national level responsible for the protection, mitigation, rescue, recovery and support for the general public. These include the National Security Council at the highest level under the cabinet and relevant sectoral ministries and departments. Since this project concerns floods in agricultural or rural areas, the discussion below will focus on institutions related with flood damage on crops and people's livelihood in rural areas.

DDPM and provincial and local governments under MOI and MOAC are the major agencies directly in charge of flood countermeasures. The Single Command Authority, including ONWFMP under OPM, is involved in large-scale water-related disaster management. It was established in May 2012 to remedy the weaknesses seen during the long-lasting 2011 flood.

DDPM

Under the current policies, local governments at various levels have large responsibilities. DDPM assigns provincial DPM officers for all 77 provinces to coordinate between the DDPM and provincial governments.

MOAC

MOAC is responsible for agricultural production development, resource management as well as the development and promotion of farmers, farmer groups and co-operatives. Under the MOAC, OAE is the key office for policy formulation and development planning, and was assigned as the counterpart agency for this project. As far as countermeasures for the flood damages are concerned, the Ministry took actions based on the MOAC's Preparedness Plan for Agricultural Disaster in the Budgetary Year 2012 for the 2011 flood damages and the MOAC prepared a Manual for Aid to Disaster Victims in the Agricultural Sector.

However, the ministry's plan, based on the 2P2R concept of prevention, preparedness, response and recovery, deals mainly on preparation and actions to be taken by the government. It is not intended to be a guideline or plan for the rural community and people, to support them to take necessary actions against the flood disaster. Furthermore, the Manual mainly is mainly concerned with the urgent actions to be taken by MOAC and related agencies before, during and after the disaster, including the issue of compensation. However, the actions for strengthening the resilience of rural community and local people cover a wider scope, and thus it is necessary to have a highly collaborative organizational arrangement enabling effective cooperation among the agencies concerned.

Single Command Authority

The Single Command Authority includes NWFPC, WFMC and ONWFMP. The NWFPC is for policy making, WFMC is to take action following the policies given and the ONWFP is the secretariat for both national level committees. ONWFMP, as planned and approved by the cabinet, initiated an international bid to select a contractor for sustainable water resources management and flood mitigation project.

The Authority as a whole is given exclusive powers for policy formulation, operational planning, implementation and trouble-shooting for flood and water management. Another important task of the Authority is to direct relevant government agencies to implement policies. However, this is at national level and actual actions in the field are to be taken by the relevant government agencies,

except in the case of large-scale water-related disasters. As such, the flood countermeasures and water resource management planning at the community level as discussed in this report are not within the scope of the Single Command Authority.

(2) Role of Provincial Line Agencies and Integration

Tambon Disaster Resilient Plans are to be formulated and implemented mainly by Tambons, by using a participatory approach. In most cases, however, technical and budgetary support by provincial government is required for each step of the process. The provincial government will direct the high priority Tambons to formulate their plans. But what is important is that the actions in the plan are integrated, to maximize effectiveness as flood countermeasures. Therefore, one of the most important factors for promoting Tambons' resilience to flood disasters is coordination among line agencies at provincial level and integration of planned actions.

One practical approach is to set up a task force, headed by the provincial governor to support this process. The task force will assume the responsibility, 1) to prioritize Tambons in need of plan formulation depending on the flood risks as determined by data and information collected, and 2) to support Tambons' actions in an integrated manner. The task force and the line agencies would also work together in supporting model activities requested by non-prioritized Tambons and farmers.

There is no standard organizational structure specified by the relevant ministries for task forces of this nature. Figure 4.3.20 below shows the structure of the task force established for the current project in Ayutthaya Province. The task force was appointed during the implementation of the Project, but it plans to continue its work for post-JICA project monitoring, as well as to support and monitor replication of pilot activities.

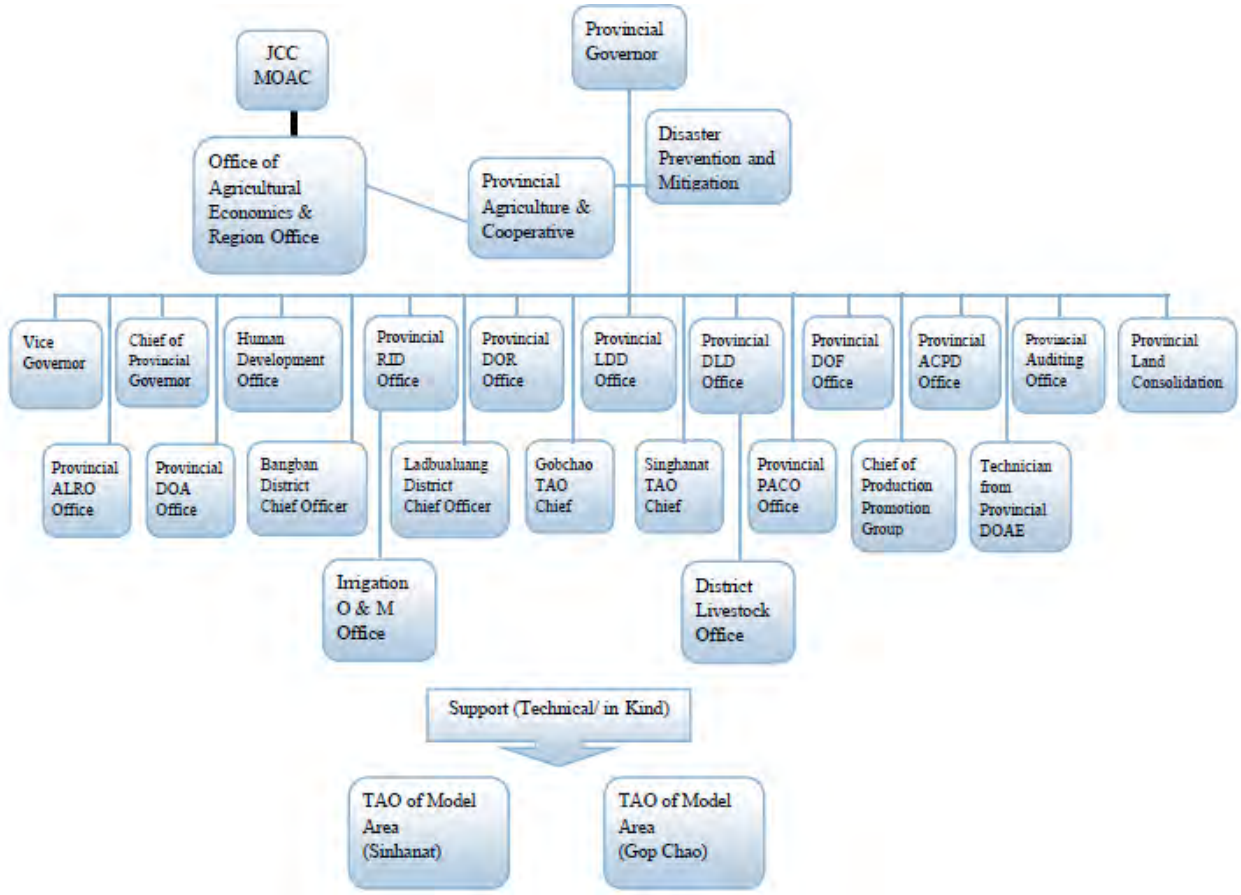


Figure 4.3.20 Structure of Provincial Task Force (Example of Ayutthatya)

Source: JICA Project Team

In fact, coordination among the line agencies at provincial level was assumed by the office of PACO, Ayutthaya. Line agencies include most of the MOAC departments with additions of DDPM and CDD under MOI. The JICA Team's assessment is that coordination by PACO has been effective in ensuring participation of provincial officers assigned by line agencies, Tambon level officials and people concerned with the pilot project implementation.

Box.4.3.9 Lessons learned from provincial task forces organized for pilot project implementation

The Task Force, during project implementation, carried out the following tasks;

1. Plan, monitor and make suggestions to the JICA Project Team on the implementation of pilot activities
2. Coordinate the implementation of community surveys and support meetings organized in pilot areas
3. Support the preparation of the Guidelines and consolidate lessons learned

It is proposed that these Task Forces be maintained, in the future, to oversee flood countermeasure activities in the pilot area and in expansion activities to other flood risk areas of the province.

Lessons learned include:

*Policies and initiatives of the provincial governors are key for the effectiveness of the task force.
*Inter-Tambon coordination needs to be further enhanced.

(3) Organizations at Tambon level

The organizations at Tambon level are; TAOs responsible for the Tambon Disaster Resilient Plan, representatives from each village, and groups and farmers has involved in various activities under the plan. Groups can include Community Enterprises and OTOP groups which are registered with government agencies although usually not incorporated, and more information social groups or voluntary associations..

The multitude of such Tambon groups and the strong bonds between members can enhance "bonding social capital," whereas "bridging social capital" can help the community to strengthen its network with outside institutions. Both these types of social capital are considered important to enhance the resilience of the community or Tambon.

Table 4.3.12 Main Actors for Model Projects/Activities

Issues	Model projects/activities	Actors	Supporting organizations at provincial level
Community disaster prevention and management plan	1)Preparation of hazard map	TAO	DDPM, RID,
	2) Secure safe water	TAO, Water Management Committee	Private companies
	3) Flood disaster management plan	TAO, Committee, School	DDPM,
Community water resources management	4)Development of monkey-cheek projects	TAO	RID
	5) Inter-Tambon Micro Watershed Development	TAOs	RID, PAO/DOLA
	6)Participatory flood water management	TAO, PDA	RID, Universities
Countermeasures for mitigating/reducing flood damages in agriculture and livestock sectors	7)Transplanting of rice	Individual farmers	RRC
	8)Safe vegetable production + Green market	Marketing committee, Vegetable production group	DOAE, LDD, Health promotion foundation, Universities
	9)Production and stockpiling feed for livestock	Pasture/livestock group/TAO	DLD
Securing income for restoring livelihood	10)Processing by using local resources	Processing group Rural enterprises, OTOP group	CDD, DOAE, Universities

The roles and responsibilities of TAOs in the agriculture sector are often not clear. As per the data and information disclosed by the DOLA, MOI, the national average revenue for a TAO is estimated at 7.47 million baht a year (in 2003) and the number of staff is 15 (6.5 permanent and 8.5 temporary status) (in 2006).

The lessons learned at Tambon level through pilot project implementation are as follows.

Planning

- In most cases, a well-balanced combination of top-down and bottom-up planning process works efficiently. In this process, TAO is the interface, coordinating between policies of the provincial government office and the people's needs. In plan formulation, TAO plays the facilitator role.
- In order to secure positive cooperation from the local people, the selection of target sectors and allocation of budget needs to be made and presented with sufficient justifications. Especially when convincing people to prepare for future floods which may or may not occur, it is necessary to identify high priority areas based on past experiences and formulate strategic action plans in a participatory manner. For this process, external support is required.

Implementation

- For local people, implementation of activities is important. Some sub-contracted survey work by research institutes caused confusion because local people are not interested in research and survey. Without follow-up action, good cooperation cannot be expected.
- To improve water management operations in one Tambon, it is necessary to seek collaboration and coordination among neighboring Tambons. RID and the provincial government offices can help facilitate such collaboration.
- Most model activities are also useful for non-flood disasters. Study tours and training programs are useful for learning and adapting ideas depending on the issues prevailing in each locality. TAO budgets can be used for study tours and training programs for leaders of farmer groups in the Tambon, not only to learn individual techniques but to learn about flood countermeasures in a holistic way.

Sustainability / Potential for future expansion

- Post-project maintenance is the key to long-term sustainability and adoption of pilot projects in other Tambons. If income can be generated through the project, this creates a positive incentive for beneficiary farmers, and, at the same time, generates funds that can be used for operation and maintenance, contributing to project sustainability.
- Farmers and group of farmers who were supported in this project by the provincial government agencies to implement model activities can be designated as "centers of learning". Those interested from other Tambons can visit these learning centers to share experience. These centers may also function as the center for extension of good practices, for which continuous support from the provincial and local government offices should be made available.
- For long-term sustainability, collaboration with schools in the locality is effective. Knowledge and good practices learned can be transferred not only to the next generation of school children but also to their parents.

(4) Inter-Tambon Organization Network and Cooperation with the Provincial Administrative Oragnization

1) Water and flood management by inter-tambon organization

Since the area covered by water resource development as well as flooding is quite extensive, what can be achieved by one Tambon is quite limited. In addition, administrative boundaries and such boundaries as irrigation command areas and river catchment areas often differ from one another. Collaboration among neighboring Tambons is, therefore, required to address problems. The facilitation process for inter-Tambon networks includes:

- Organize meetings among representatives of neighboring Tambons to identify common issues such as flood and drought.
- Organize meetings with Provincial DOLA and PAO to explain the situation and request their supervision and coordination.
- Organize a study visit to areas considered to have good practices (Ubonratchathani Province as example for water resources development) to learn about their successful experience of inter-Tambon cooperation
- Prepare a plan for inter Tambon cooperation

Moreover, in terms of the budget for project development, the available budget of one Tambon is usually too small for any substantial project. This requires collaboration among Tambons with similar projects, for which some supporting funding has recently become available from the PAO budget.

Box. 4.3.10 **Project on Enhancing the Capacity of Local Public Service Provision through Local Management Cooperation supported by Provincial Administrative Organization**

From February 2010 to February 2013 the Project on Enhancing the Capacity on Local Public Service Provision through Local Management Cooperation supported by the Provincial Administration Organization was implemented by DOLA, MOI with cooperation by JICA. Under the project, 3 pilot projects in 3 provinces listed below were implemented based on the MOUs signed aiming at enhancement of public services through local management cooperation by neighboring Tambons and Thesabans (municipalities).

*Ang Thong Province	Improvement of water environment (4 Thesabans and 5 Tambons along a canal)
*Chachoengsao Province	Tourism promotion (Map and sign board) (3 Thesabans and 2 Tambons with similar target)
*Ubon Rachathani Province	Small-scale water resource and farm ponds (9 Tambons in 1 Amphoe (district))

Of the above, the case of Ubon Rachathani indicates how the budget could be secured and TAOs could implement more water management projects with the limited budget. Major accomplishments by the pilot model are:

*Subsidies for new construction of 1,374 (1,200 m3 capacity) farm ponds
*Dredging for the existing ponds in 13 places for 463,004 m3
*Construction of 20 small-scale weirs
*Installation of pipe irrigation covering 20,636 rai (1,592 farmer beneficiaries)
*Securing of retention areas as countermeasures for flood and drought
*Reduction of TAO's load for time-consuming tender-related works
*Working Manual was prepared by the provincial task force

According to data and information provided by DOLA, the average annual revenue per PAO is 282.9 million baht as of the year 2003. This is considered as one budget source for inter-Tambon collaboration projects including the replication of water management pilot projects covering several Tambons. The project experience in Ubon Ratchathani by DOLA and the PAO provide good lessons learned.

(5) Networking with Universities, Foundations, NGOs and Private Sector

Experience from the good practice case studies (refer to Appendix I-D), shows that if a community already has linkages with outside institutions, not only government agencies but also universities, foundations, NGOs and the private sector, it is easier to get assistance when the community face flood –related disasters. Therefore, Tambons are recommended to implement activities that foster relationships involving technical or financial support with such institutions under Tambon Disaster Resilient Plan, so that the resilience of communities will be enhanced.

The table below is summarized based on experience of pilot projects implementation, including sub-contract, good practice case studies, and interview survey, but it does not give a comprehensive list of institutions.

Table 4.3.13 Institutes and their potential areas of collaboration

Institute	Scope/ Area	Major Areas of Expertise/Collaboration	Remarks
University	Engineering	Expertise, theories, knowledge on irrigation, hydraulic structures, water management, buildings and communication/IT technologies. Being neutral to Govt. policies, can deal with new challenges too.	Recommended to collaborate on social science aspect like relationship with communities etc.
	Agriculture Agro-processing	Knowledge and information on cutting-edge research are available. Specialized in many fields and need of team work by assembling specialists. Highly specialized testing and analysis are possible. Farmer training also covered.	For each type of farming technology, it is necessary to verify whether it is appropriate for farmers.
	Social Science	Study and advice to respond to the community needs in the fields of social science and business administration are available. After the project, the relationship with the community can be continued as education programs. Can be a reliable partner.	For the timing, the university schedule tends to be given priority. Also applies to the other faculties.
Government institute	Social science field Community development field	Program can be operated with external funding in addition to the government budget. Possible to get technical and financial assistance. Capable in coordination and negotiation with the government agencies. Accumulation of good practices on program base and nationwide network.	Need to review whether the program meets the community's needs
Foundation	Health promotion	Fund provision and support for program participation for the activities in line with their missions. There are programs to meet the model projects as discussed in the Guidelines like promotion of safe vegetable and green market. If provincial offices exist, collaboration at provincial level is easier.	Possibility to have different views from MOAC on the certificate for farm produce (GAP and organic)
NGO	Environment conservation	Mission-based activities. NGOs with missions on environmental conservation, climatic changes and rural development have participatory facilitation techniques and experience in identifying good practices and local wisdom. Collaboration with these NGOs are recommended. Such NGOs have networks with other rural communities, well-informed and knowledgeable persons so can be effective in expanding community networks.	If the cost is borne by Thai government budget, NGOs have to be registered officially as consultants. Technical content of NGO activities may need to be verified by technical experts.
Private sector	Manufacturer of input materials and machineries	Collaborative support can be expected with their interest in developing new technologies and materials including field trial use which may create cause new opportunities for the business expansion.	Specialists may need to be involved to determine feasibility.
	Industrial estate	Example of supporting neighboring areas. As a part of welfare for factory workers, corporate social responsibility (CSR) to build up good relationship with neighboring communities. Possibility to sale market for farm produces and processed foods.	Need for coordination between the private companies/industrial estate and rural communities.
Religious organization		Groups based on religions like Muslim. Supported disaster damaged community by the own network covering nation-wide.	Careful attention on the possible conflict with the other religious group in same Tambon.

Source : JICA Project Team

(6) Towards Collaboration among Stakeholders to Improve Resilience in the Agricultural Sector

There is a need for collaboration among stakeholders of different sectors such as farmer's groups, producers, universities, government offices and private companies. Collaboration across industrial sectors such as agriculture, manufacturing and commerce is increasingly common, globally and in Thailand. This kind of collaboration aims to increase effectiveness through combining knowledge and resources of each stakeholder. Exchange of opinions among stakeholders of different expertise and sectors may help to resolve difficult, long-standing issues. The figure below illustrates an example of such collaboration.

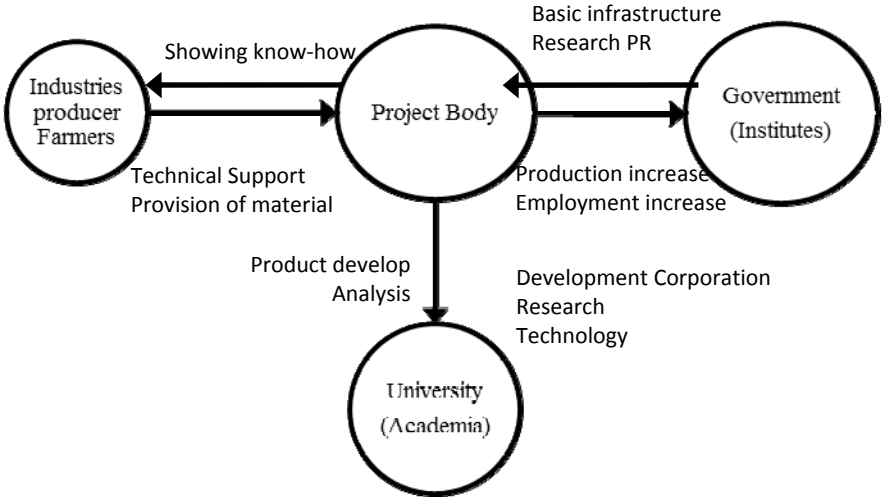


Figure 4.3.21 Structure and Roles in Stakeholder Collaboration

Based on Figure 4.3.23, government agencies should play two important roles; one of facilitating the overall collaboration for project management and the other of making available the research functions of various government institutes and laboratories. Under this project, an example of such collaboration was carried out for the recovery of the orchid sub-sector to find an alternative plant growing media for orchid nurseries which had been totally destroyed in 2011. Information on this project component and lessons learned are provided below as an example.

Box 4.3.10 Recovery of Orchid Production Sub-sector by Collaboration of Industry, Government and Academia

Under the pilot project, collaboration was pursued to find alternative orchid growing media materials and to lower production costs in order to replace the media materials which were totally damaged by the 2011 flood. The project component and the lessons learned from the implementation of pilot project are as follows.

-Project outline (Field experiment)
*Comparison of orchid growing media materials
*Experiment on micro-organisms
*Application of mycorrhiza fungi

-Stakeholders:
(1) Kasetsart University
(2) LDD, DOA, DOAE
(3) Air Orchid & Lab (private sector), Farmer producers

-Lessons learned

- Through combining new technologies already developed by different stakeholders, technology appropriate for farmers was identified
- The collaboration helped to maintain motivation to sustain the project for both farmers and the private sector company.
- It is difficult for farmers themselves to solve problems caused by global changes, but this kind of collaboration may help to find solutions.
- For government research institutes, collaboration with other sectors is easier if external funding is available, while participation in using only the government's regular budget is difficult.
- Regular meetings to discuss and exchange opinions among stakeholders helps advance project activities, because ideas from different perspectives can often lead to innovations. Participation of members of industrial sectors and farmer producers help to keep the focus practical and to meet the actual needs.

*Stakeholders are often motivated by "green" activities that are good for the environment.
*Collaboration may help find innovative ideas which may not have been proposed by a one single sector.

4.4. Conclusion and Recommendations

4.4.1. Conclusion

The large flood in 2011 caused tremendous hardship for many people throughout the country. Based on this experience, people in the project's model areas formulated the Disaster–Resilient Agriculture and Agricultural Community Plan at Tambon level. When implementing pilot activities for flood countermeasures, participants learned important lessons, which were captured in the form of a General Guideline and five Thematic Guidelines. Activities that were found to be effective flood countermeasures during pilot implementation have been written up as Model Programs to be promoted and expanded to other areas. The following are important and concrete recommendations aimed at enhancing disaster-resilience in agriculture and rural communities.

4.4.2. Recommendations

(1) General

1) Recommendations to the Government of Thailand

✓ The main recommendation is to implement these Guidelines, particularly in areas which will be

affected by the Government's countermeasure project for flood mitigation, such as flood water retention areas. Where special budget allocation may be required, it is proposed that priority be given to high risk areas. For extension of the model activities, information and communication materials prepared by the Project such as leaflets, booklets and DVDs can be utilized.

- ✓ MOAC is well-positioned not only to implement compensation program for flood damage, but also to inform departments under MOAC about the concept of strengthening resilience of agricultural communities.
- ✓ Since "sufficiency economy" is a key concept in Thailand's National Economic and Social Development Plan, it is also necessary to give more importance to the concept of "resilience in agriculture and agricultural communities", in view of the risk of natural disasters, in addition to increased income and productivity through agricultural development.

2) Recommendations to provincial governments and TAOs

- ✓ It is recommended that Disaster Resilient Agriculture and Agricultural Community Plans are formulated for all Tambons with high flood risk, and implemented as soon as possible.
- ✓ Model projects should be reviewed to determine their suitability to the local conditions and possible expansion to other parts of the province.
- ✓ In the plan formulation at Tambon level, some high priority emergency projects and parts of the learning process, such as study tours, should be implemented by TAO's own budget in order to increase ownership of the project by the communities. As for countermeasures which require coordination in wider area than a single Tambon, requests for budget support can be submitted to PAO in collaboration with neighboring Tambons.

3) Recommendations to JICA

- ✓ It is necessary to monitor whether and how these Guidelines are being used.
- ✓ It is also necessary to follow-up on the implementation of the ongoing model projects.

(2) Recommendations by Sector

1) Community Based Disaster Risk Management

- ✓ The methodology for participatory preparation of flood hazard maps is described in the Guidelines. For areas with high flood risk, hazard maps are required, and for this, collaboration with DDPM and RID is necessary. To ensure smooth coordination among these agencies, it is recommended to establish an implementation body at provincial level similar to the Provincial Task Force that includes the provincial DDPM and is led by the provincial governor.
- ✓ The provision of small-scale water purification systems will enable communities to produce and stock drinking water to be used during floods. It is recommended that TAOs introduce such a system as a flood countermeasure.

2) Community Water Resources Management

- ✓ The installation of water level gauges in Tambons will make it possible for communities to monitor water levels themselves. By comparing the local measurements with water level data from major RID stations using a web-based system, projections of water levels in the Tambon can be made, thus allowing for flood forecasting and early warning. In Tambons located within irrigation areas with

high flood risk, it is recommended that this participatory system is introduced.

- ✓ With a monkey cheek system, flood water can be retained during the wet season and used for irrigation during the dry season. If each Tambon in the upstream basin area retained 2 MCM of flood water, a total of as much as 1,000 MCM could be retained, the equivalent of a large dam or reservoir, which would help prevent flooding downstream. Monkey cheek development in small river basins is in line with the government policy to promote development projects by inter-Tambon collaboration, so it is recommended that PAO supports this as the main promoting body.
- ✓ SSIP has been implemented nationwide since 1977, with the total number of projects reaching more than 6,000 to date. The project consists mainly of construction of small infrastructure facilities such as weirs, regulators, farm ponds and small dams. These project facilities have been transferred to TAOs due to an administrative reform, but no longer function well due to deterioration and insufficient operation and maintenance. MOI is well-positioned to formulate plans to improve these SSIP facilities to function as monkey cheeks, as well as to support the TAOs to rehabilitate and expand the SSIP facilities with cooperation from RID.

3) Flood Countermeasures in the Agriculture and Livestock Sector

- ✓ In order to promote transplanting as a countermeasure to flood damage, an urgent issue is to increase the number of service providers for the transplanting method of parachuting. Either RRCs stationed in each province or DOAE under MOAC is expected to develop service providers. For this, the government agencies concerned should provide necessary training not only on transplanting techniques but also on other technical issues such as seedling preparation, reduction of seeds input and seed selection methods. The production of safe vegetables is actively promoted under the MOAC policy, but roles and responsibilities of various government agencies are not clearly defined for the important activity of securing reliable markets for sale. To address this issue, the recommendation is for TAOs and farmer producers to establish green markets in cooperation with foundations and universities and also to expand sales to schools and hospitals with support from the provincial government. DOAE and LDD are jointly expected to provide necessary support for farmer producers on production-related matters.
- ✓ In areas with high risk of flood and with many small-scale livestock farmers, animal feed should be stocked at both household and community levels as a precaution against future floods. Furthermore, cultivation of fodder crops in these areas should be promoted. It is recommended that DLD fully brief all officers in charge at provincial and district (Amphoe) levels to provide required support for livestock groups working to set up community fodder storage facilities.
- ✓ The activities proposed above are to be promoted not only when there is flooding but also in periods without floods. These recommendations are in line with government policies, and can therefore be supported through the regular government budget in areas with high flood risk. In other words, such activities can be implemented without special budget support for flood countermeasures. Extension work for farmers is necessary, and these Guidelines can be used to ensure that the measures proposed are effective flood countermeasures.

4) Income generation for recovery of livelihood

- ✓ Fish capture is an important activity in areas often affected by flood, and it is recommended that the Government conducts a survey on fish resources as well as impact on local farmers before implementing any flood countermeasure projects.

- ✓ A new policy has been introduced to apply stricter standards in the food processing industry. It is, however, doubtful that the required investment needed to obtain certification will result in sufficient return for rural enterprises and OTOP groups to make it worthwhile. In addition to setting up standards for safety, government agencies concerned, such as DOAE and CDD, are requested to provide necessary guidelines for quality improvement, as well as training programs about hygiene issues for community members. Further, some financial support is also necessary for certification, although compensation for the processing facilities damaged by the 2011 flood disaster has not been provided. It is necessary for the Thai Government to introduce policies to bridge the gap between the capacity of OTOP groups and rural small enterprises and the stricter quality standards enforced.

5) Institutions and other issues

- ✓ It is recommended that provincial governments support TAOs so that the PAO budget may be available for TAO projects, not only for water resources development but also for flood countermeasures when they are implemented in collaboration with other Tambons.
- ✓ While communities themselves make efforts to enhance their resilience against flood disasters by applying the Guidelines, the government should ensure a system for rapid flood disaster assessment and appropriate valuation for victims in water retention areas designated by the government to save urban areas from flooding.
- ✓ Under the pilot projects implemented, a GIS land parcel database was established to accelerate and ensure compensation payments to farmers as a pilot project. It is recommended that the Office of Agricultural Economics continue the work on similar practical application of the database as listed below.
    - ✧ Remote sensing technologies to analyze satellite images on rice growing stages
    - ✧ Acceleration and standardization of data collection procedure for practical database construction at Tambon level
    - ✧ Outsourcing of work to institutes and private companies in order to expand the system nationwide