APPENDIX D : AGRICULTURAL AND RURAL INFRASTRUCTURE

APPENDIX-D AGRICULTURAL AND RURAL INFRASTRUCTURE

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APPENDIX-D AGRICULTURAL AND RURAL INFRASTRUCTURE

D.1 Introduction

D.1.1 Objectives of the Study

The main objectives of the study is to clarify the present conditions of agricultural and rural infrastructure and to suggest the optimum improvement plan in the Study Area for the Study on Integrated Agricultural Development Plan in the Dong Thap Muoi Area (hereinafter referred to as "the Study").

D.1.2 Summary of Field Work

Following data and information were collected.

COLLECTED DOCUMENTS AND DATA INFORMATION

1.	Hydraulics Planning in Dong Thap Province
2.	The Supplementary Design for Hydraulics Planning in Dong Thap Province–1995
3.	Report on Socio-economic Development Plan Implementation in1998 and Plan for1999 – Tien Giang Province.
4.	*Climacteric Preventing Projects in 1999 - Dong Thap Province* *Present Conditions of the electric pumping stations in Dong Thap.* *Present Conditions of the diezel pumping stations in Dong Thap.* *Present Conditions of the flood controlling dike systems in 1999 – Dong Thap* *To-be-constructed dike systems in 1999 – Dong Thap.*
5.	Document on Technology Training Course for 1999's Summer-Autumn Crop in Dong Thap Muoi.
6.	Average Flow and Flow Directions in the period of Oct.05-19, 1997. (table)
7.	*The Pre-Feasibility Study Of The Hydraulic Integrated Development Project In Northern Hong Ngu – Dong Thap Province* *Water Supply for the Northern Hong Ngu area in 2010 (table).* *Water Supply for the Northern Hong Ngu area in 1996 (table).*
8.	Report on Electricity Production and Supply in 1998 & The Objectives and Targets for 1999.in Dong Thap Province
9.	Investment Phasing of Waterway Construction in Dong Thap Province Investment Phasing of Bridge and Road Project in Dong Thap Province The general of roadway network and bridge network.
10.	**Maps** - *Hydraulic Planning In Dong Thap Province* - *Max Discharge And Total Flood Flow In 1961, Tidal Inundation In 1994, 10 % Of Rainfall* – Current Topography In 1996. - *Soil Map In Northern Hong Ngu – Dong Thap Province* - *Supplementary Selected Schemes (Including the main flood drainage network in Dong Thap Muoi)* – The Pre-Feasibility Study For The Southern Cao Lanh Project. - *Topographic map of hydraulic zones in the Mekong Delta.* - *Maximum Inundation Depth in 1996 – Mekong Delta.* - *Main Hydraulic System in the Mekong River lower basin.* - *Current Conditions of Hydraulics ad Agriculture in 1994* – The Pre-Feasibility Study For The Southern Cao Lanh Project. - *Isolines for the highest Flood Water Level in 1984 in the Mekong Delta.* - *Isolines for Annual Rainfall in the Mekong Delta.* - *Rainfall in 1996 and Annual average rainfall in comparison.* - *Topographic map of flood planning of the Mekong Delta.* - *Highest Inundation Depth in 1997-Mekong Delta.* - *Isolines for maximum flood level in 1997-Mekong Delta.* - *Isolines for maximum flood level in 1994-Mekong Delta.* - *Isolines for maximum flood level in 1996-Mekong Delta.*

	- *Highest Inundations Depth in 1996-Mekong Delta.*
11.	- *The layout of Hydraulics System and Inhabitant – Scheme No.2* - Feasibility Study for Agriculture, Forestry, and Inhabitant in the Binh Thanh area – Duc Hue District – Long An province. - *Soil Map* - Feasibility Study for Agriculture, Forestry, and Inhabitant in the Binh Thanh area – Duc Hue District – Long An province.
12.	**Cross-sections** - *Rach Goc Canal* - *Typical Layout Diagram for Interior field (Using the D12pump) and The cross-section of third canal* – Feasibility Study for Omon-Xano Sub-project – Hydraulics Development Project in the Mekong Delta.
13.	**Index** of the documents with attachment of the worked-out profile on **Flood Control Dike System in Sa Rai Town**
14.	Report on The Master Plan for Socio-economic Development in Tan Phu Commune – Cai Lay District in the period of 1997 – 2010.
15.	Report on Socio-economic Development Plan Implementation in1998 and Plan for1999 – Tien Giang province.
16.	Statistical Book 1997 – Tien Giang province
17.	Some Major Socio-economic Data of Tien Giang province as a part of the Dong Thap Muoi project
18.	The Master Plan for Socio-economic Development in Cai Be Town – Cai Be District (1993-2010).
19.	The Master Plan for Socio-economic Development in Tien Giang province (1995 2010)
20.	The Master Plan for Socio-economic Development in Cai Lay District – Tien Giang province (1995 – 2010)
21.	Report on Agriculture Production in 1998 & The Targets and Plans for Agriculture Production in 1999.- Hong Ngu District – Dong Thap province.
22.	Main Report on Output – Yield – Cultivating Area for Perennial Plants in 1998 – Dong Thap province
23.	Main Report on Output – Yield – Cultivating Area for Annual Plants in 1998 – Dong Thap province
24.	**Main Report** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 1)
25.	**Summary Report** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 2)
26.	**Report on Hydraulic Model Calculation** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 3)
27.	**Report on Meter-Hydrology Calculation** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 4)
28.	**Report on Irrigation and Drainage Calculation** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 5)
29.	**Report on Land Resource Surveys and Evaluation** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province1996. (Vol 6)
30.	**Report on Land Use Planning and Agricultural Production Development** The Pre-feasibility Study for Hydraulics Development and Integrated Development in Southern Cao Lanh Region - Dong Thap province 1996. (Vol 7)

Overall field survey on infrastructures concerned in the Study area was carried out and physical conditions and problems were found out. Those were confirmed through the hearing investigation from farmers and local officers.

D.1.3 Summary of Infrastructure Improvement Plan

Based on the results of fields survey and analysis of present conditions, several projects were proposed for irrigation and drainage improvement in the Study Area.

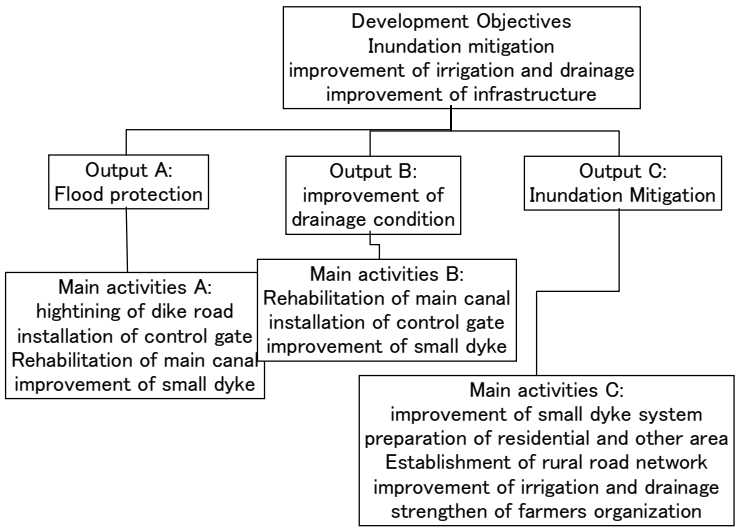
(1) Development Objectives and Approach

Based on the development concepts, the development objectives for agricultural and rural infrastructure sector are set as inundation mitigation, improvement of irrigation and drainage and improvement of rural infrastructure. For the achievement of the final goal of the Master Plan with the

development activities of other sector, following development objectives for each zone are set with a consideration of "the Flood Control Master Plan of Mekong Delta" which was approved in June, 1999.

Development Objectives for Each Zone	
Zone A: Deep Inundation Area (Single Paddy)	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.
Zone B: Middle Inundation Area (Dabble Paddy)	Inundation mitigation and other infrastructures will be considered and perfect prevention will not be considered.
Zone C: Shallow Inundation Area (Dabble, Triple Paddy)	The perfect prevention from inundation will be considered in feature. Inundation mitigation and other infrastructures will be considered in urgent.
Zone D: Shallow Inundation Area (Paddy and Fruts)	The perfect prevention from inundation will be considered in feature. Inundation mitigation and other infrastructures will be considered in urgent.
Zone E: Deep Inundation Area (Inland fish)	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.
Zone F: Middle Inundation Area (Preserver, Forest)	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.

For the achievement of development objectives, the expected outputs are set as "flood protection", "improvement of inundation conditions", "mitigation of inundation conditions" and following projects are proposed and studied.



Output A: Protection from Flood	Output B: Improvement of Drainage Condition	Output C: Mitigation of Inundation Condition
Project A: Flood Control on Boundary Area	Project B: Flood Control on Southern Nguyen Van Tiep	Project C: Small Dike System Improvement
Objective: To control the flood from June to Aug. Targeted Zone: Zone A	Objective: To prevent inundation through out the year Targeted Zone: Zone C, Zone D	Objective: To control inundation, to prepare residential area Targeted Zone: Zone B, Zone C

The Project A and Project B were proposed in the Flood Control Master Plan of Mekong River Basin and these development objectives were approved by the Government of Viet Nam in June 1999.

(2) Development plan

Project A: Flood Control on Boundary Area

With heightening of dike road from Hong Ngu to Hung Ha (around 42 km) and installation of 10 main control gates (w=7 to 25m, h=9 to 10 m), the flood from Cambodian borderline will be controlled in July and August. The protection of big flood and stabilization of S-A rice crop are expected.

Main components
Tu Thuong water control works: dredging two canals, constructing 3 spillways
Tan Thanh – Lo Gach water control project: To construct the flood control channel biside the National Road No.1
Improvement of Dike road: hightning of dike road 42 km, 10 control gate and spill ways
Improvement of Tien and Vam Co rivers: dredging canals (28 canals: So Ha, Tan Thanh – Lo Gach, Hong Ngu, Dong Tien, 2/9, Khang Chien Binh Thanh and Thong Nhat and others)

Project B: Flood Control on Southern Nguyen Van Tiep

With rehabilitation of 20 main canals (widening and dredging) at the southern part of Nguyen Van Tiep Canal and improvement of dike system, the flood condition of upper part will be improved and the area at lower part will be prevented from inundation throughout the year. Improvement of drainage conditions and stabilization of 3 rice crops are expected.

Main components
Dreading and widening of main canal: 20 main canals total length 180km, width 15 to 25 m
Related structures: small control gate (height 5 to 7 m 123 unit), bridge 72 unit
Heightening of small dike: heightening 30 to 40 cm, total length 1,300 km, culverts (height 5m, width 5m, 324 units)

Project C: Small Dike System Improvement

With improvement of small dike system, installation of bridges, strengthening of farmer's organization and applying of rotational inundation control, the residential, forest, and other areas will be prepared, rural road net work will be improved, irrigation and drainage system will be established and inundation will be controlled without any big impacts on the outside area. The improvement of rural living conditions and increase of rice production will be expected.

Main compornents
Improvement of small dike: heightening 0.2 to 1.2 m, width 0.6 to 4.2 m total length 2,900 m related structures (spill way, culverts, control gates), gravel pavement
Irrigation and drainage system (104systems):irrigation system (pump, canal, diversion work), drainage system (pump, canal)
Installation of bridge: bridge for car access 26 bridges, bridge for bike passing 329 bridges
Strengthen of farmers organization: 9 combined organization will be established based on 202 dike units

The area for Zone B and C can be divided into 9 project areas based on the present conditions of inundation, existing infrastructures, acid sulfate, cropping pattern, etc. as shown below.

Block									
Number of dike systems	19	18	20	33	31	20	23	34	29
Total area (ha)	16,221	14,517	16,271	21,153	20,220	10,450	13,680	19,794	14,448
Benefited area (ha)	12,977	11,614	13,017	18,228	17,482	8,360	10,944	17,843	11,559
Dike length （km）	267	206	387	345	343	251	321	340	347
Mean Heightening (m)	1.2	1.4	1.1	1.1	1.0	0.5	0.5	0.5	0.3

The influence of rotational inundation control is roughly estimated as follows and more or less 10 cm of water level will be increased for 30% of non-inundated control.

Based on the comparison analysis, those blocs can be classified into following 4 categories;
Blocks for implementation at first stage:④⑧
Blocks for second stage：③⑦
Blocks for third stage：⑤⑥⑨
Blocks for after discussion with Cambodia : ①②

(3) Implementation plan

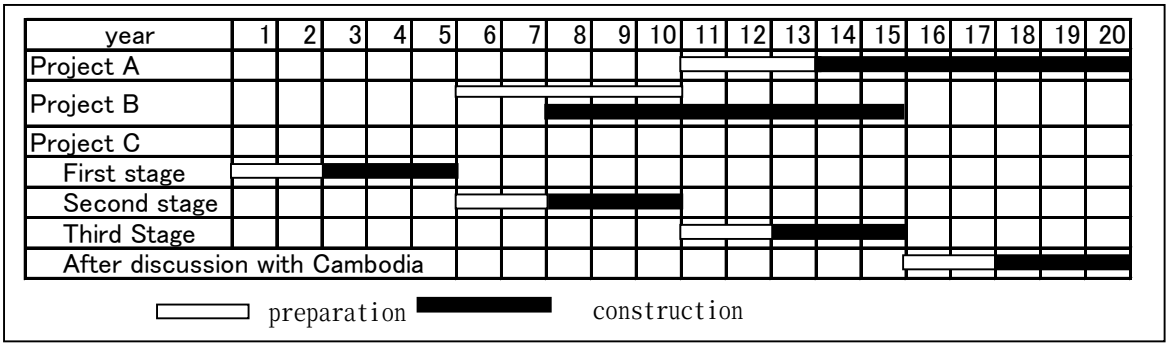
The implementation plan is studied and the results are summarized below;

Project A: After confirming the results of KOICA study team, F/S should be carried for 1 year. The discussion will be required with Cambodian government based on the study results. After that, detailed design and tendering for 2 years and construction for 7 years will be required.

Project B: After confirming the results of KOICA study team, F/S should be carried for 1 year. After that, for each main canal, detailed design and tendering for 1 year and construction for 1 years will be required. Then 2years will be required for 1 canal. Total period will be estimated as 10 years.

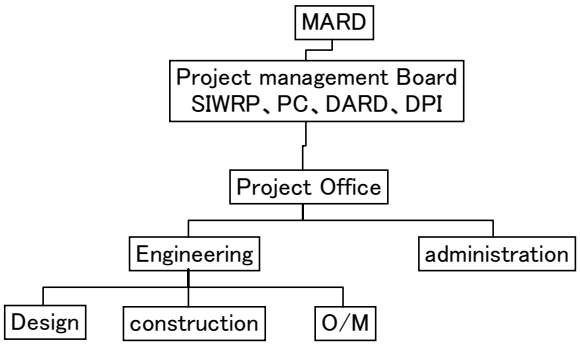
Project C: For each block, 3 months for F/S, 1 years for detailed design and farmers agreement will be required. 3 years for construction period is expected considering stabilization of embankment and transportation of materials. The total period is 5 years. 9 blocks is divided into 4 gropes as shown below;

First stage：④⑧, Second stage：③⑦, Third stage：⑤⑥⑨,
After discussion with Cambodia : ①②

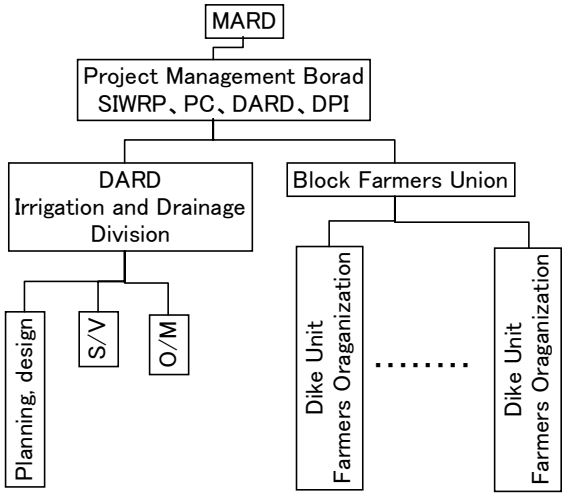


(4) Implementation and O/M Organization

Implementation and O/M organizations for projects proposed as shown below.



Organization structure for Project A and B



Organization for Project C

The new project office will be required for projects A and B under the management board which consists of SIWRP and other related agencies.

The project management board is also required for Project C. Under the project management board, the sections of planning/design, construction S/V, O/M of irrigation and drainage division of DARD will work for preparation, construction and O/M respectively. The rotation inundation control plan and distribution of payment for farmers will be decided by each block farmers union which consists of farmers organizations of each dike unit. The operation of gate control, correction of management fee, etc. will be operated by staff of related commune PC under management of DARD O/M section. The farmers organization of dike unit will consist of existing farmers collectives which are managing the O/M of irrigation and drainage system as water users association now. DARD will support for strengthen and unifying of farmers organization.

(5) Project costs

The costs of projects are estimated as shown below. Estimated EIRR for the Project A and B and estimated FIRR for the Project C are also shown for the reference

Project Costs

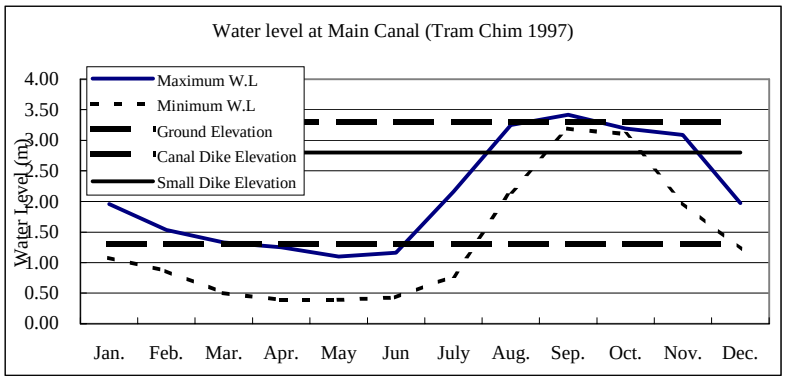
Project	Project Cost		O/M Cost		Reference
	Billion VND	(million US$)	Million VND/year	(thousand US$/year)	
Project A: Flood Control on Boundary Area	1,654.5	(118.2)	2,545.5	(181.8)	EIRR14%
Project B: Flood Control on Southern Nguyen Van Tiep	2,163.6	(154.5)	3,818.2	(272.7)	EIRR14%
Project C: Small Dike System Improvement	1,793.0	(128.1)	66,268.3	(4,733.4)	

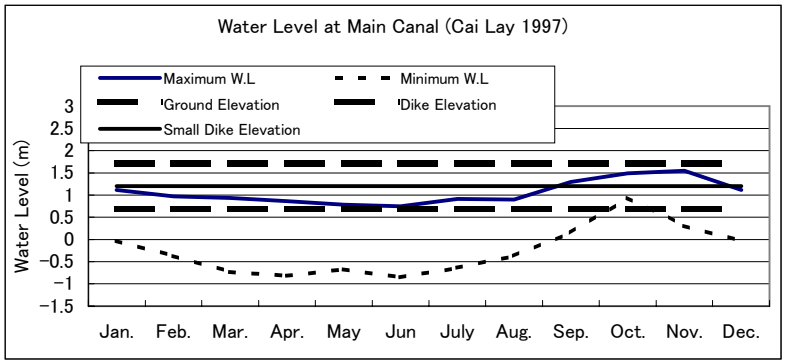
(6) Recommendations

- As large impacted area is expected for Project A and B, it is necessary to make F/S based on the results of KOICA Study Team.
- The environmental impact on water level, discharge amount, water quality should be studied for Project A and B. In addition, the discussion with Cambodian Government will be required for Project A
- The impacted are for project C will be small. However, it is necessary to study on environmental impact. And it is necessary to study for reduction of impact in the F/S.
- The rotational inundation control system should be required for Project C. Therefore, the it is necessary to study for obtaining of farmers agreement, strengthening farmers organizations and O/M system.

D.2 Present CONDITIONS

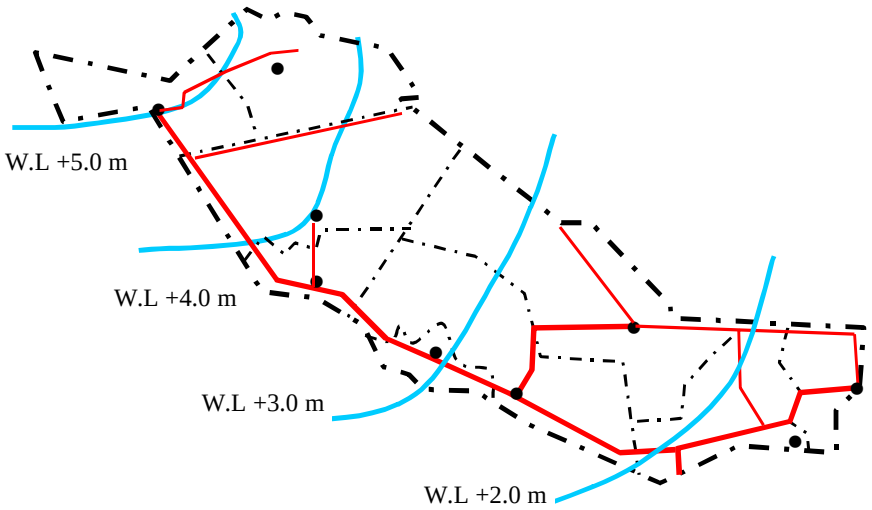
D.2.1 Inundation Conditions





In the Study Area, there are three types of inundation occurring in rainy season (August to November). The one is caused by big amount of flood water from the Mekong River.

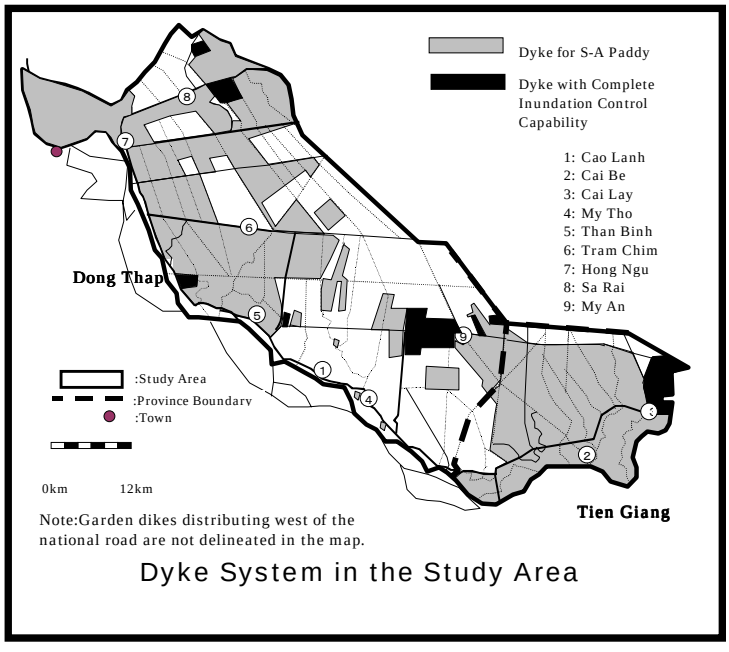
Usually in August, the inundation starts from northern part of the Study Area and, within around two weeks, this inundation covers all the Study Area for three to four months. The water depth of inundation is approximately more than 4.0 m (Northern part) to 0.5 m (Southern part) and this is one of the biggest constrains for agricultural activities. The dikes with 1.0 m to 4.0 m height are installed along the most of main and secondary canals. In addition, small dike systems with 0.5 m to 3.0m height for 50 ha to 300 ha have been improved in around 60 % of the agricultural land since early 1980. The inundation can be mitigated by this small dike system in August for securing the harvest of summer-autumn paddy crop. Only around 5 % of small dike systems can prevent inundation throughout the year (the case in 1996 is exceptional). Since these dike systems do not have structures such as spillway and water gate, farmers are now doing pumping operation and cutting dike to drain the water inside of dike system. The maximum water level in 1996 is illustrated as shown below.



Maximum Water Level in 1996

The second type of inundation is caused by influence of tidal wave and occurs also in rainy season when river water is high. This occurs only at the Tien river side area at Southern part and continues around 10 days with 12 hours interval. The third type is caused by direct runoff from rainfall with high intensity and this occurs in the rainy season for a few hours with around 10 cm of water depth.

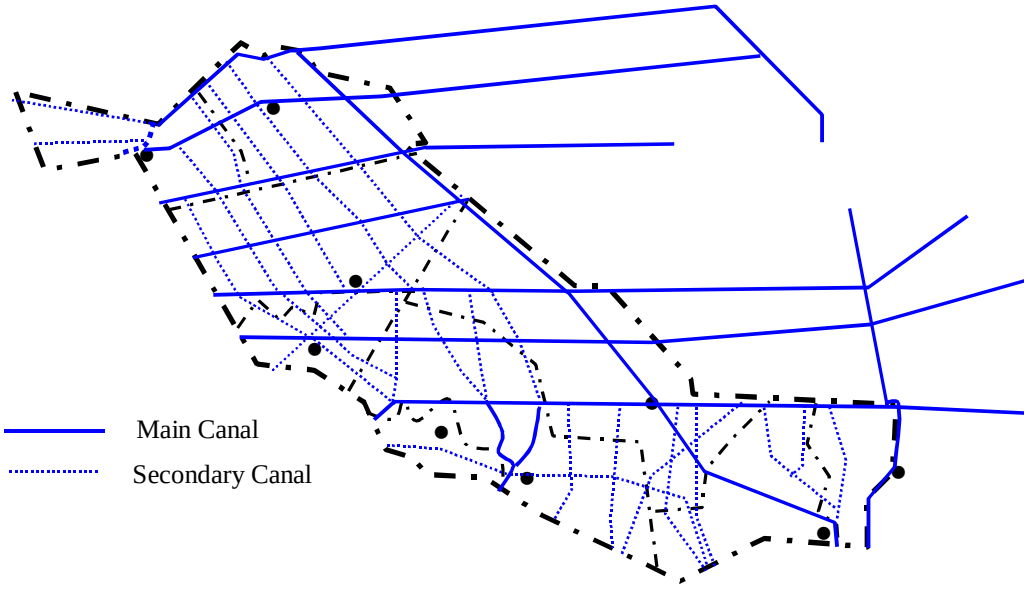
The small dike systems have been constructed since the early part of 1980s and they cover around 60 % of agricultural land in the Study Area. Most of them are designed for water level in August for harvesting of summer-autumn crop. In the upper part of the Study Area, farmers say it is impossible to make double cropping without dike system. There are no such structures as spillway, water gate, culvert, bridge, etc. and farmers have to cut dike for irrigation and drainage. Every commune has a plan to improve dike system. Even in shallow inundation area in Cai Lay and Cai Be, PCs intend to improve the dike system.



Dyke System in the Study Area

D.2.2 Irrigation and Drainage

The canal networks are established consisting of 11 main canals and 21 secondary canals in the Study Area. Most of those have been constructed from the middle of 1960s to 1980s and used as drainage canals as well as irrigation water sources. Total length of main canals is 695 km with 10 to 30 m width and that of secondary canal is 487 km with around 10 m width. These canals cover 476,800 ha of irrigation area and 667,500 ha of catchment area including those in the outside of the Study Area. Basically, the water from the Tien river is flowing from West to East or North to South through the canal network. However, depending on the river water level, direct runoff from rainfall in the area is drained to canals and flowing into the nearest river connecting point. The water level in the canals are influenced by tidal wave and varies approximately 3.0 m/day (at Southern part) to 0.6 m/day (at Northern part) in dry season.



Canal Net Work in The Study Area

Though there is enough water for irrigation even in dry season, it is necessary to pump up from main or secondary canals to tertiary canals. There is a few public pumping stations covering approximately 5 % of irrigation area and most of farmers are using the private pumps. Those pumps are operated based on the farmers' requests and farmers pay to pump owner under coordination of farmers' organization such as agricultural collectives. Those pumps are also used for drainage particularly at the end of inundation season (November) for land preparation of winter-spring crop. 550,000 to 750,000 VND per ha as pumping fee are paid by farmers for each crop. Most of the pumps have been used more then 20 years and their capacity is not enough especially when the canal water level is low. In the area with small dike system, it is necessary to cut dike for irrigation in dry season and to embank again for mitigation of inundation in rainy season.

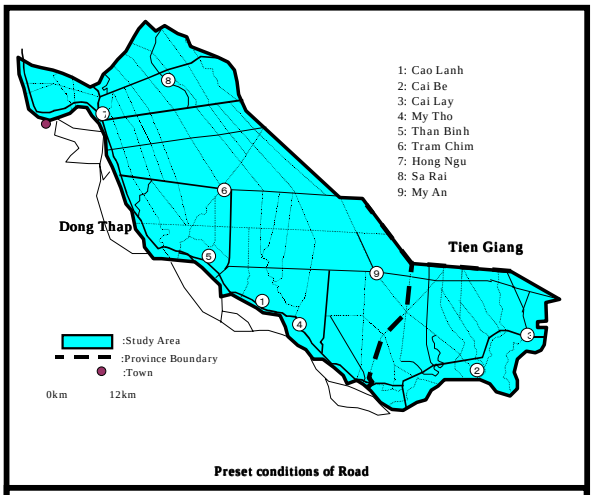
Most of the canals have been constructed during the period of 1970s and 1980s and have been used for

boat transportation as well as irrigation and drainage. The pumping operations are required for irrigation and drainage and more than 3,000 private pumps are operating. Though water resources in the canal are sufficient even in dry season, water level varies with influence of tidal wave. Most of the pumps have been used for more than 20 years and efficiency of pumps is quite low. Water use is coordinated by farmers' organizations such as agricultural production collectives and irrigation groups and farmers pay pumping charge to pump owners through collectives or directly.

D.2.3 Other Infrastructures

(1) Road Conditions

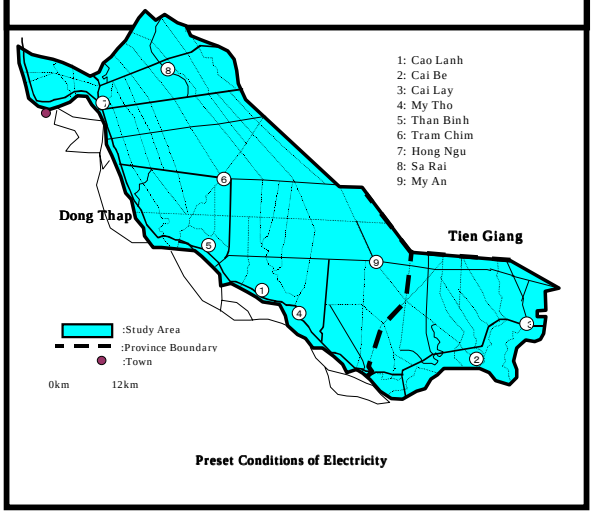
In the Study Area, only National Road No.1, No.30 and route from My Tho to My An are perfectly prevented from inundation. Most of the other roads are inundated from August to November and are not paved. It is difficult to pass by car after rainfall and this is one of the reasons for boat transportation being developed. Though bridge construction has been made by the Ministry of Transportation, the Ministry has a improvement plan only for national road by the year 2010.



Preset conditions of Road

(2) Electricity

The electricity line covers every commune in the Study Area, however, about 55% and 70 % of house holds are supplied electricity service in Don Thap and Tein Gang Provinces respectively. Power capacity is not enough for all provinces and power cut occurs so often in dry season.



Preset Conditions of Electricity

D.3 Basic Development Concepts

D.3.1 Potentials and Constraints

(1) General Description

Basic concept as attached will explain in a simplified way the process of achieving the final target from respective activities, through outputs of each activity and the achieving of the project objectives as described in the Scope of Work (S/W).

Based on this concept, long-term development plans of two provinces are taken into consideration in identifying potentials and constraints of the study area. Development orientations in these plans of the two provinces are characterized by the focus on industrialization of the economy although agricultural sector will remain the core of the regional economy. Behind this are the limited land resources for future expansion and the increasing population and labor force. The long-term development plans of the two provinces were prepared in 1994-5, the days of robust economic growth of the country and the countries in the region. The economic crisis occurred in1997 gave seriously impact on the region as well as the country. Therefore, long-term development target is seen as too ambitious to be interpreted directly under the current economic situation in the country as well as in the region.

(2) Development Potentials and Constrains

The study area, located at the upper part of the Mekong Delta and bordering Cambodia, is endowed with rich natural resources. With rather short history of development in the country and even in the Mekong Delta, the area achieved remarkable development performance in agriculture, particularly in rice production. This, as mentioned already, is attributed to the continuous development effort by government and people investing in flood control, irrigation and drainage, followed by intensive cultivation of paddy introducing high yielding varieties.

In the study area, expansion of agricultural land is not expected anymore. Almost all the available land has been developed already. Under the situation of growing population and labor force, equitable income of the people in the study area in future depends on the intensive/diversified agriculture and the creation of non-farm job opportunities. In the agriculture, though the study area has the potentials due to its comparative advantages, there exist constraints for increasing income and improving the living condition of the rural people. Infrastructure for flood protection, inundation mitigation, transportation network improvement and others need to be focused not only for agricultural production but also for the improvement of living conditions. In addition to inundation, a

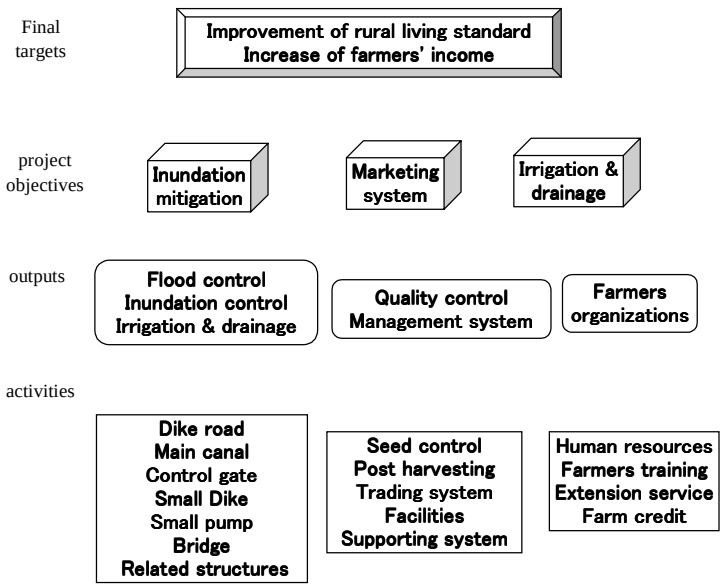
certain part of the area is covered by acid sulfate soils which limit agricultural production.

Potential and constraints are summarized below.

Potential	Constraints
・Canal network for irrigation / drainage exist. ・Transportation by boat is available in the canal system. ・Enough irrigation water is available in main canal even in dry season. ・Small dike system enables 2-3 crops a year.	・Situation of infrastructure is not at satisfactory level. ・Living conditions against inundation is poor. ・Canals obstruct road transportation. ・Irrigation / drainage system within the dike is not well established. ・Dike system lacks such structures as control gate, culverts, and spillways.

D.3.2 Basic Development Concepts

Basic Development Concepts formulated for the Master Plan is illustrated below, showing the process from respective activities to the achievement of final targets. The final targets are set as the improvement of farmers' living conditions and the increase of farmers' income based on the field survey results and mutual discussion between the Vietnamese side and the Study Team. It should be noted that, although the activities, output and project objectives are vertically connected to the final target, these activities are closely connected with each other. Without this horizontal coordination, any project objective and hence the final target will not be attained.



Basic Development Concepts

D.3.3 Target and Strategies

The target year of the Master Plan is set as the year 2010, following the existing plans at the national, regional and provincial levels. In setting target year, two points should be mentioned. One is the term seems rather short of 10 years, which could cover the limited portion of development projects to realize the final target. Another is the serious change of economic situation surrounding the country and the region after the economic crisis occurred in1997. The existing plans at regional and provincial levels were prepared mostly in 1994-5, when the country as well as the region enjoyed the high economic growth rates. The targets of these plans, therefore, are required to be modified to some extent. In this context, the

figures of the target year in the existing plans were practically referred seeing the current situation instead of direct linkage to the Master Plan exercise.

The targets, strategies, and external conditions of each sector are under study now. The preliminary results are summarized below and these will be studied further more in detail.

Targets and Strategies

Targets	Strategies	External Conditions
・Protection from flood at Zone A. ・Improvement of Drainage conditions at Zone C. ・Mitigation of inundation conditions at Zone B and C.	・To control flood from Cambodian border ・To improve flow capacity of canals. ・To improve small dike system.	・Agreement with Cambodia on the construction of major work. ・Farmers unanimous consensus on improvement plan.

D.3.4 Development Objectives and Approach

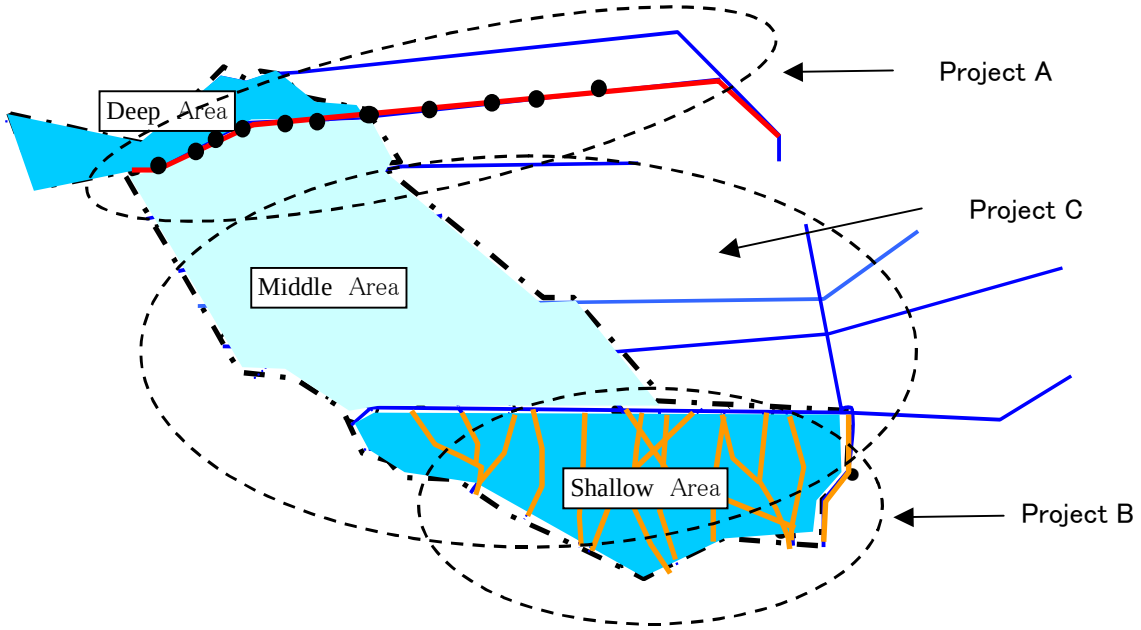
Based on the development concepts, the development objectives for agricultural and rural infrastructure sector are set as inundation mitigation, improvement of irrigation and drainage and improvement of rural infrastructure. For the achievement of the final goal of the Master Plan with the development activities of other sector, following development objectives for each zone are set with a consideration of “the Flood Control Master Plan of Mekong Delta” which was approved in June, 1999.

Development Objectives for Each Zone	
Zone A: Deep Inundation Area （Single Paddy）	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.
Zone B: Middle Inundation Area （Dabble Paddy）	Inundation mitigation and other infrastructures will be considered and perfect prevention will not be considered.
Zone C: Shallow Inundation Area （Dabble, Triple Paddy）	The perfect prevention from inundation will be considered in feature. Inundation mitigation and other infrastructures will be considered in urgent.
Zone D: Shallow Inundation Area （Paddy and Fruts）	The perfect prevention from inundation will be considered in feature. Inundation mitigation and other infrastructures will be considered in urgent.
Zone E: Deep Inundation Area （Inland fish）	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.
Zone F: Middle Inundation Area （Preserver, Forest）	Based on the development plan of other zone, the countermeasure will be considered in the feature. In urgent, improvement plan will not be considered.

For the achievement of development objectives, the expected outputs are set as “flood protection”, “improvement of inundation conditions”, “mitigation of inundation conditions” and following projects are proposed and studied.

Output A: Protection from Flood	Output B: Improvement of Drainage Condition	Output C: Mitigation of Inundation Condition
Project A: Flood Control on Boundary Area	Project B: Flood Control on Southern Nguyen Van Tiep	Project C: Small Dike System Improvement
Objective: To control the flood from June to Aug. Targeted Zone: Zone A	Objective: To prevent inundation through out the year Targeted Zone: Zone C, Zone D	Objective: To control inundation, to prepare residential area Targeted Zone: Zone B, Zone C

Proposed Project of Infrastructure Sector



The Project A and Project B were proposed in the Flood Control Master Plan of Mekong River Basin which was approved by the Government of Viet Nam in June 1999.

D.4 Development plan

D.4.1 Project A: Flood Control on Boundary Area

(1) Objectives and Functions

In the present condition, flood water from the depressed landfields in Cambodia flows freely over the boundary into the Dong Thap Muoi with a yearly immense amount of water. In 1996, the discharge of flood water ranged from 8,500 m^3/s – 9,000m^3/s and with a total amount of 45 billion m^3 occupying 75% in the amount to the DTM. The 50 km route of spilling water, in which mainly flood water concentrates in Hong Ngu – Thong Binh, is from Hong Ngu to Vinh Hung. Then, this amount of water has to be controlled effectively in order to;

1. Mitigate inundation in the interior field of DTM, guaranting for stable 2-crop production in deep inundation area (> 1m) and 3-crop production in the shallow inundation area. Reduce the damages of human loss and property, and the cost of infrastructure and residence base construction.

2. Increase the alluvium amount from Tien River for the sake of soils improvement and fertile matters for plants.

3. Prepare the schemes for the cooperation with the Cambodian Government, and propose the requests to the MRC by which the Mekong River Flood Planning is currently implemented.

(2) Requirements

The Overflow Control System is involved in the regions of the Upper Basin, in the constructions of flood prevention in the Lower Basin, in Water Transportation, population distribution, and boundary security. These are to be ensured:

1. Respectability to the Agreement on Sustainable Development in the Mekong River Basin.
2. Non-increase of inundation depth in the lower part of Vam Co river, including flood peak and time of inundation, in order to improve the inundation situation in this area.
3. Constant combination with branches in transportation, construction and national defence in forming and distributing the flood control constructions.
4. Appropriation with governmental investment in the next stage.

(3) CRITERIA FOR DESIGNING.

- The designed flood water level is the highest water level in 1961, and correlative to the probability of 2% (in 50 years) at Tan Chau station at which the water level is +5.28 m.
- Designed tidal water level: tidal water level in 1994 – the year when the average tidal water level is high and it combines the daily, monthly and yearly tidal regimes.
- Rainfall in the interior field: P= 10%.

(4) IDENTIFICATION OF STRUCTURE GROUPS IN THE FLOOD CONTTROL SYSTEM

1. Tu Thuong Flood Pressure mitigating structures (group I);
2. Structures for Flood Drainage into Tien River (group II);
3. Tan Thanh – Lo Gach Flood control and conduct structures (group III);
4. Structures for Conducting flood water to West Vam Co River (group IV).

(5) CONTENTS OF THE SELECTED APPROACH.

Group 1: Tu Thuong

- Constructing a spillway and a bridge at the milestone no.1 with a spillway length of 200 meters and bridge length of 238 m. Rehabilitating 2 bridges Tra Du and Nam Hang with 372-m total length

Group II: Flood Draining into Tien River

- Enlarging 2/9 canal, Thong Nhat, Khang Chien, Binh Thanh canals: b=10m, z=-2.0m. Ba Rang, Doc Vang Ha, Doc Vang Thuong canals: b= 30m, z= -3.0m; total length:129,465m.
- Constructing 10 spill-bridge on the roads: Southern Hong Ngu, Dong Tien, An Phong My Hoa – total length: 1,920 m and 59 bridges for rural transportation.
- Constructing 2 August flood control dike systems on the canal routes.

Group III: Tan Thanh – Lo Gach structure

- Constructing the Tan Thanh - Lo Gach flood preventing route with a length of 42,825m, b=9m, z= 6.7 – 6.3m.
- Re-excavating Tan Thanh–28 canals for flood conducting, irrigating and draining with total length of 42,325m, b=32 -24m, -3.00m.
- 5 flood control gates : 2/9, Khang Chien, Binh Thanh, Thong Nhat, Cai Cai with total width for water draining:140m;
- 5 flood preventing gates - water intakes for irrgation, width: 35m, elevation: -3.00 m
- Constructing residential base in Southern area of Tan Thanh-Lo gach canal with total length of 43

km, width: 13m, Constructing dike system for August flood control in Northern area of Tan Thanh –Lo Gach canal, b=2m.

Group IV: Flood draining into West Vam Co River:

- Enlarging 2 canals: Song Trang (b=20m, z=-3.00), and Hai Tam(b=24m, z=-3.00), with total length of 26,491m.
- Constructing 9m-wide road surface on eastern bank of Hai Tam canal and flood control dike system on western bank of Song Trang canal (b= 7m).
- Constructing residential base on western bank of Song Trang canal (width:13 m) and August flood control dike on another banks of the 2 canals.

  Total investment cost for the approach: **VND billion 605**

(6) ANALYSIS ON EFFECTIVENESS OF THE APPROACH

Technical effectiveness of the structure system is determined by the hydraulics mathematical model in the Mekong Delta:

Water Level

Effects by the increasing and decreasing of water level in comparison to the case of no flood control structures (Aoo). There are 2 influenced regions of the structure: the upper region: (where the water level rises high), and the lower region of the structure (where the water level is low) as follows:

Unit: Cm

Locations	AOO Water Level			Disparity of water level		
	(1)	(2)	(3)	(1)	(2)	(3)
Thong Binh	281	524	351	3	21	0
Upper Thong Nhat	310	527	325	4	16	0
Tan Thanh	241	457	315	-13	-28	-11
Tram Chim	257	425	299	-16	-18	-15
My An	134	311	218	-5	-16	-7

Remark:(1): Mid-August (2): September – October. (3): Late November.(-): decreased water level in comparison to A00.

Total Water Quantity from the Approaches

Unit: 10^9 m^3

Location	Total quantity Aoo	Disparity
Into Ñ.T.M	***57.66***	
Tu Thuong	14.77	-5.01
Hong Ngu – Long Khot	36.91	-1.70
Hong Ngu – Dong Tien	5.98	8.07
To Tien and Vam Co rivers	***63.34***	
Tu Thuong	14.77	-5.01
Through QL 30	14.61	11.26
Through QL 1	16.35	-2.30
Through Tan An	13.89	-1.39
Through East Vam Co	3.72	-0.62

(7) ANALYSIS ON ECONOMICAL EFFECTIVENESS.

1. Agricultural Production

a. Direct effects in the catchment

The flood control structure system in accordance with the completion of structures in interior field will bring the with the direct benefit of agricutural production to the catchments where the canals locates. The benefit areas, here, includethe canals and their catchments: Tan Thanh-Lo Gach, 2/9, Khang Chien, Thong Nhat, and Binh Thanh, with total area of 93,177 ha. Current agricutural land area in1996 is 54,940 ha, and in the future: 64,924 ha. Gross Product from the Agricultural Development Approach by 2010: VND 367 billion. Net profit: VND 137.5 billion.

b. Indirrect effects:

The flood control system with the structure system in the Dong Thap Muoi support for the agriculture development target by 2010 (*Report on Agriculture Development in the Mekong Delta, August, 1998)*

- Gross agricultural products from the approach :VND 6,741 billion
- Gross agricultural products :VND 10,540 billion
- Net profit :VND 1,264 billion
- Profit from flood control structures (9%) :VND 114 billion

c. Agricutural added profit :VND 281 billion

d. Effects by lowering water level**.**

Acccording to the results of hydraulic calculation, when the flood control system works, flood water level changes: In the upper catchment of the structrure, the water level rises, and water level decreases in the lower part. This variation of water level leads to the changes in construction quantity of transportation and residential base in the Dong Thap: Profit from the structure in total investment of Dong Thap Muoi: VND 1.1 billion.

(8) The results from calculation on economic criteria:

- Discount rate: 12%.
- Time of projection (flood control structure): 50 years
- Assessment on the sensibility of the approach in cases: increasing construction price (10%), and decreasing agricultural products (10%), the progress of main structure construction: 6 years

Economic Criteria for selected approach*:*

IRR	= 17%	NPW	= VND 324 billion
(B/C)	=1.3	T	= 6 years

D.4.2 Project B: Flood Control on Southern Nguyen Van Tiep

(1) The Extent of Project Area.

The boundary of the Project Area is defined by the Nguyen Van Tiep canal, Nguyen Tan Thanh canal and the Tien River, with a total area of 140,185 ha.

The major feature of this area is that it is under influence of *both flood and tidal wade inundation*. Flooding level in the area ranks in medium standing (1.0 m), and is under the strong dispersion of flood drainage in the Dong Thap Muoi, which includes floodwater draining and ASS washing. In the area, there include 3 studied projects on hydraulics: West Cai Lay, East Cai Lay and Cai Be projects. The major requirement s for irrigation in these areas are: flood draining and preventing, improving main, secondary and third canals, and developing irrigation within interior field to improve irrigation and drainage conditions.

(2) Solutions

Flood control

The area of southern Nguyen Van Tiep canal, according to the viewpoints from the Flood Control Planning in the Mekong Delta, is the shallow inundation area and this area can be resolved with complete flood control without any impacts on other areas. In addition, the flood draining amount from Dong Thap Muoi into Tien River, which occupies 50% of that in Dong Thap Muoi, is to be solved at the end of third crop (A-W crop) and beginning of first crop (W-S crop). Otherwise, inundation by tidal wade also needs to be solved in time of flood draining in W-S crop, in consideration of the coincide of this period with spring waters period in the year.

Floods have been bringing about many losses for agricultural production, infrastructure constructions and various constraints to people's living. And vice versa, they also create numerous benefits, which are an diversifying source of alluvium and abundant aquatic resources. And floods are also considered as a cleansing utensil for the field…Therefore, flood control is to assure the top limitation of its negatives and to expose its positives. According to the Flood Control Planning for the Mekong Delta in Short-term stage, which was approved by the Government on 21/6/1999: For the Southern area of Nguyen Van Tiep canal (SNVT), for a long-term target, complete control of flood is to be done in order to retain a fixed agricultural production, and to protect people's lives and properties as well as the infrastructure constructions without causing any bad impacts on environment and eco-system.

For an immediate task, flood control is to be ensured of the safety for residential areas, infrastructure constructions, fruit gardens, triple paddy crop and up-land crop cultivating areas. The controlling of flood will be implemented with an appropriate installation of main drainage canal system, dike systems, and water gates in order to form closed regions which can completely control floods and drain a flood discharge of Max 3,900 m^3/s – from the Dong Thap Muoi into Tien River as proposed in the Flood Control Planning for the Mekong Delta.

Draining, ASS cleansing

Southern area of NVT canal, which has a fairly dense canal system, locates nearby the Tien River and is under strong influence of tidal wave regime from the East Sea (South China Sea). The average lowest water level of tidal wave in months of the year is lower than land level (at My Thuan station, Tien River). Just in the period of late August to late October, the average lowest water level is 0.5 m higher than land level, so that it is propitious time for exploiting the tidal wave for draining and land field cleansing for W-S and S-A crops. Otherwise, the Project Area is transmitting most of floodwater amount from Dong Thap Muoi region.

Irrigation Water Intake and Fresh Water Supply

Solution for the present issue of water intake is improving main, secondary, and third canals, developing dike systems, culverts, interior field structures for the sake of increasing water source and strengthening the ability of tidal wave utility to expand by-gravity irrigated area; at the same time, developing the pumping system in areas of non by-gravity irrigation and half by-gravity irrigation. Water supply for people's living will be separately accomplished in accordance with Rural Fresh Water Program, and the source is surface and underground water (mainly is surface water). Individually, that of the Go Cong project needs the consideration on exploiting underground water, especially for Go Cong Dong district – which meets with the sea.

Settlement Areas and Rural Transportation System.

The inhabitants in the Mekong Delta, as well as in the Project Area, have a custom of residential settling along canals and main roads. Most of residential clusters have formed for a long time and become stable. The conditions and environment of their living, however, are still insufficient, especially in inundated areas. The solutions for rural development, thus, are:

- Developing residential areas and population concentrations in accordance with Urbanization Program.

- Improving living environment for rural residents by raising housing base, improving hygienic conditions, and developing rural transportation.

(3) Technical Criteria for calculation.

Flood control

Based on the Flood Control Planning for the Mekong Delta – Short-term stage, flood level in 1961 - with probability of 2-3%, tidal wave in 1994 (unfavorable) and rainfall in interior field (10%) are selected as the criteria for calculations on approaches. Constructions for residential protection and infrastructures are ensured to overpass the flood level in 1961. For agricultural production, the probability of 10% is selected (equivalent to the flood level in 1978).

Irrigation

To ensure with rainfall's probability of 75%.

Drainage

To ensure draining with rainfall's probability of 10%.

(4) Floos control.

a. Selected Approach

- Complete flood control (year round) for the whole Southern area of NVT canal and setting-up of 20 main flood draining canals. Dividing into 44 closed dike units, which control flood from Bao Dinh canal to Phong My and average area of 4,700 ha for each dike unit. Each dike unit has an ability of appropriately regulating water in the interior field and taking advantage of tidal wave for irrigation and drainage. Particularly, for the areas along Nguyen Van Tiep canal, drainage pumps are used.

Dimensions of main flood draining canals in the approaches

No.	Canal	L_{canal} (km)	Bottom Elevation (m)	B_{bottom} (m) (selected appr.)
1	Ca Duc	5.00	-3	15
2	Cai Quanh	15.00	-4	60
3	Duong Thet	8.00	-4	20
4	Cai Beo	20.00	-3	25
5	Canal 307	18.70	-3	25
6	So Mot (307- Co Co)	22.00	-3	25
7	Nguyen Van Tiep B	28.00	-3.5	20
8	Canal 28	30.00	-4	60
9	Canal 5	26.00	-3	15
10	Canal 6	20.94	-3	20
11	Canal 7	17.98	-3	15
12	Canal 9+8	18.55	-3	20
13	Canal 10 - Phu An	25.91	-3	20
14	Ba Rai 12	28.00	-3.5	15
15	Thanh Nien – Ong Muoi	15.60	-3	Present condition
16	Ba Ky –Ba Tra	16.00	-3	Present condition
17	Cau Sao - Thuoc Nhieu	15.90	-3	Present condition
18	Nguyen Tan Thanh	29.00	-4	25
19	Sau Au –Xoai Hot	16.50	-3	Present condition
20	Cho Bung	12.00	-3	10

b. Results from mathematical calculation in the approaches.

- Mathematical model of flood is calculated with proposed water level as of 1961, tidal wave of 1994, and rainfall's probability of 10 %;
- Mathematical model of irrigation for W-S crop is in 1-18, February;
- Mathematical model of irrigation for S-A and S-S crops is in 15 April – 15 May;
- Mathematical model of acid sulfate cleansing is in 15-30 June.

The above mathematical calculations are on the cases for present condition recovering and the approaches. The calculation results for the cases are summarized as main points as below:

Mathematical calculation model for flood draining : This calculation aims to identify the flood draining ability of main canals in the Southern area of NVT canal – in the condition of draining away a Max discharge of 3,900 m^3/s from the center of Dong Thap Muoi to main canals in southern NVT canal's area, and with a calculation period of 20th July – 25th November, in terms of water level and discharge in the cases of present condition and approaches.

(5) Irrigation and Drainage

Present Condition:

Variation value of Max water level along main canals in project areas runs as followings: in Southern Cao Lanh: 3.04m – 3.30m, in Cai Be-Cai Lay: 1.6m – 3.0m, and in Chau Thanh (from Ba Rai 12 canal to Rach Chanh canal): 1.6 – 2.7m. The flow into Project Area: 4,390 m^3/s, total amount: 21.95

billion m^3; flow to Tien River, over a part of Highway No. 30: 1,912 m^3/s, total amount: 8.6 billion m^3; flow over Road No.1: 2,849 m^3/s, total amount: 13.81 billion m^3. Then, the discharge of water flowing into Tien River is 4,761 m^3/s, with total amount of 22.49 m^3. This means, rainfall originated from the southern area of NVT canal (SNVT) is around 0.45 billion m^3, which occupies 2.5%. When the overflow controlling structures (from the boundary into the Dong Thap Muoi) are proposedly applied, the discharge of flood water into SNVT is reduced to 3892,3 m^3/s with total amount of 19.43 m^3. In comparison to present condition case, the water level along Nguyen Van Tiep canal is reduced: 5 –10 cm in Cai Quanh – Duong Thet section, 15 – 29 cm in Cai Beo – My Phuoc Tay section, and 3 – 6 cm in My Phuoc Tay - Rach Chanh section.

Approaches:

For Phong My – My An section, in the selected approach (IIb), the Max water level is 1-3 cm increased. For Canal 5 – Cho Bung – Ben Chua section, in all approaches, the Max water level is 6-27 cm reduced. Max discharge into SNVT, in all approaches, runs from 3,902 to 3,986 m^3/s with a total amount of 19.77 – 21.95 billion m^3. The changing of water level in interior field dike unit runs as followings: In July, August, when floodwater is less influencing on Project Area, the draining ability of dike system is fairly good. The water level in the field is still low, and the possibility of inundation is in particular circumstances. In some low-lying fields, the best inundation depth is 40 cm. In mid-September, the inundation depth in areas along Nguyen Van Tiep canal is around 60 cm. From late October to earlier November, due to the influence of tidal wave, some field units along Tien River are drained by gravity. And for the remaining, pumps are used for draining away – inundation depth is around 40 – 80 cm. At the end of November, it reduces by 30 – 55 cm. It is necessary to take note, that is in SNVT area, there is no possibility of by-gravity drainage for any designed constructions, in late October and earlier November (except for several interior units along Tien River).

Max water level at several locations

Location	Position in network	Max water level in the approaches (m)		Comparing to present condition approach (cm)
		HT	IIb	IIb
Ca Duc	519	3.25	3.26	1
Cai Beo canal's s.p.*	530	3.12	3.13	1
S.p. of Canal 307	533	3.11	3.14	3
My An	536	3.17	3.18	1
S.p. of Canal 5	538	3.17	3.11	-6
S.p. of Canal 7	544	3.00	3.00	0
My Phuoc Tay	554	2.73	2.67	-6
My Phuoc	559	2.50	2.35	-15
Ben Chua's s.p.	561	2.04	1.86	-18

*S.p.: start point, Performance of water level in interior field, in the approaches:

- In July and August, when floodwater is less influencing on Project Area, the draining ability of dike system is fairly good. The water level in the field is still low, and the possibility of

inundation is in particular circumstances. In some low-lying fields, the highest inundation depth is around 60 cm. In mid-September, the inundation depth in areas along Nguyen Van Tiep canal is around 60 cm. In this period, water level in interior field mostly unchanged in the approaches.

- In October and November, when the tidal wave water level is high, there is less possibility of by-gravity drainage, except for riparian units. In other units, the inundation depth gradually ranges in 30-80 cm, toward interior field. At the end of November, the inundation depth in interior units is from 30 to 50 cm.

- The first approach is using vertical main canals for direct draining into Tien River through gates, in order to take advantage of the lowest water level for draining by gravity. The second is using horizontal main canals for draining into vertical main canals. Based on the calculation results, the latter is found most favorable, inundation depth is 15-26 cm decreased. This discrepancy, however, only occur in units which are near Tien River, less changes to others in interior field.

Mathematical calculation model on ASS cleansing: The SNVT canal area is uninfluenced with tidal wave whose amplitude is gradually decreasing toward interior field. In beginning of June, Max water level varies in 1 - 1,9 m.

Average water level in main canals, calculated with Max in 5 days, drainage in 7 days, is found 30-50 cm lower than land level. This is fairly favorable to floodwater draining and ASS cleansing. Via calculation, the 7-day average discharge flowing into SNVT area is 164.1 m^3/s and the discharge over National Road: 282.1 m^3/s and Rach Chanh Gate: 68.6 m^3/s.

The construction items in the SNVT canal area include:

- 18 main flood drainage canal, for both irrigation and drainage, with total length of 356 km;
- Secondary canals: 136 km;
- Third canals: 714 km;
- Gates (B= 2 m - 15 m): 225 units;
- Dike: 1,199 km;
- D12 pump: 10,410 units, including added 4,247 units.
- Excavated soil: 27,761,962 m3;
- Constructed soil: 31,486,408 m3;
- Concrete: 89,859 m3;
- Stone: 86,472 m3;
- Total cost: VND 1,125 billion.

(6) The effectiveness of the approach

Flood control

The irrigation planning approach has proposed the flood control for the whole cultivated areas on

Southern NVT canal. Residential areas are fully and thoroughly protected by systems of dike, embankments, water gates, culverts and the irrigation system within interior field. This does not include the Northern part of NVT canal. Particularly, more than 30, 000 ha of high-value fruit gardens and nearly 14,000 ha of pine apple, sugar cane are to be protected.

Irrigation and Drainage

In the approach, the objectives is set to ensure: irrigation for the whole cultivated area, drainage for fruit garden areas, triple paddy crop, residential areas and people's living. And secondary and third canal systems, which have an adequate ability of meeting given demands on water supply, are to be laid out. Especially, water supply for Bao Dinh project is to be ensured, as presently salinity has encroached over My Tho.

Economic effectiveness

The economic quotas are calculated by models, through analyzing and classifying the data base system of economic analysis. The calculated outputs has reflected that the economic quotas of the proposed approach are effective (B/C =1.27 , IRR= 16.8 , NPV= VND 1,019 billion). Proposed quotas from the approach are relatively at high level. Even in case of 20% investment increase and 10% profit value, the economic quotas are also acceptable. This displays the feasibility of the approaches. The feasibility of the approaches, due to the positive affects, is displayed on these following fields:

- For transportation: In the extent of complete flood control, the constructing of infrastructure system, especially road system, retains some advantages. And the decreasing of water level in dike units reduces 30-50% of investment and cost for infrastructure constructions in comparison to the case of non-projection.

- Favorable conditions for strengthening and developing agricultural production are earned. And full-year flood control is stably ensured with triple crop production, in which 98,000 ha area is targeted by 2010. 40, 000-ha area of perennials is be endowed with stable development conditions, that tend to high specialization.

- According to the expected land use approach II, as when the project is operated and its effectiveness is brought into play stably, the paddy yield is increased - which will mainly increase the gross production of plantation and livestock breeding from VND 2,200 billion to VDN 4,600 billion in 2010, with VND 2,400 billion increased.

- Maximum reduction of losses by floods. In case of non-projection, losses by floods increase frequently. The higher economic development growth runs the bigger loss

For aquatic products: The proposed approach has reduced fishery yield of natural aquaculture. However, flood controlling gives the favorable conditions for aquatic production.

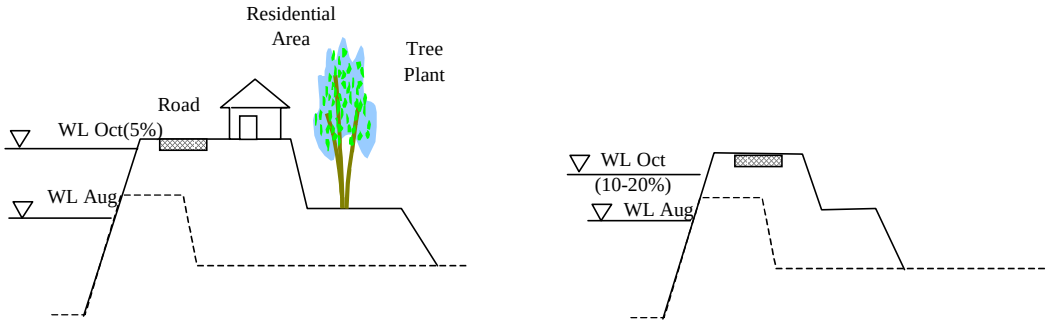
Other potencies

Beside the aboves, the construction of irrigation structures in the approaches also gives the development conditions of culture, society, cultural standard, tourism, etc. and the improvement of eco-environment, and avoidance of pollution caused by floods. In the SNVT canal area, there remains a 42,000-ha area of Bao Dinh project, which is mainly for salinity prevention and fresh water conduction.

D.4.3 Project C: Small Dike System Improvement

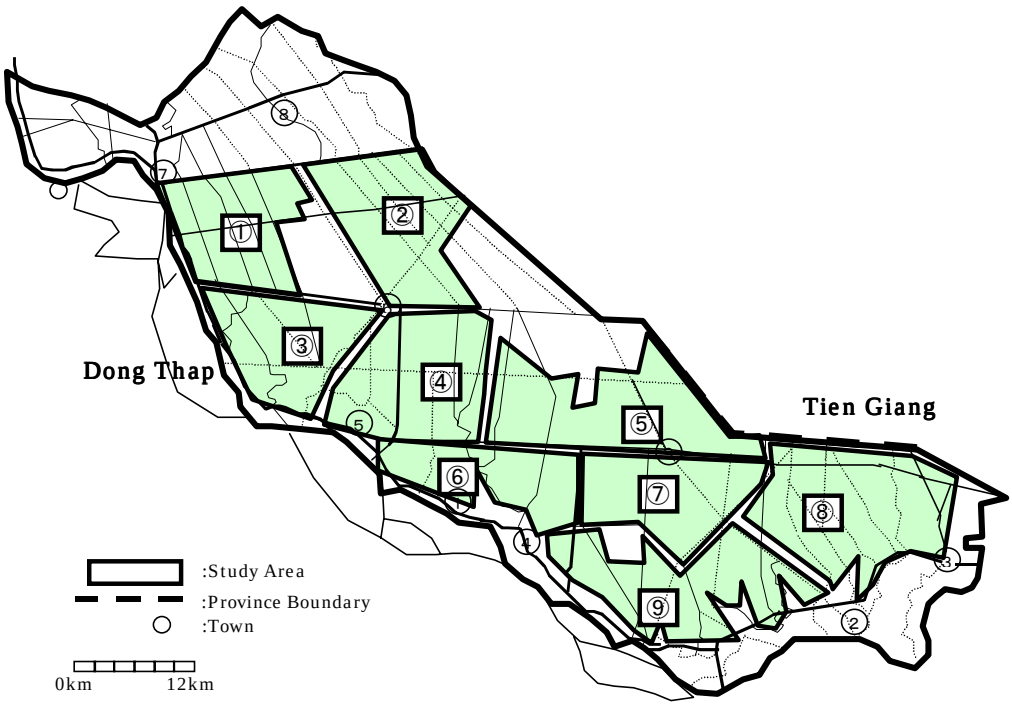
With improvement of small dike system, installation of bridges, strengthening of farmer's organization and applying of rotational inundation control, the residential, forest, and other areas will be prepared, rural road net work will be improved, irrigation and drainage system will be established and inundation will be controlled without any big impacts on the outside area. The improvement of rural living conditions and increase of rice production will be expected.

Main compornents
Improvement of small dike: heightening 0.2 to 1.2 m, width 0.6 to 4.2 m total length 2,900 m related structures (spill way, culverts, control gates), gravel pavement
Irrigation and drainage system (104systems):irrigation system (pump, canal, diversion work), drainage system (pump, canal)
Installation of bridge: bridge for car access 26 bridges, bridge for bike passing 329 bridges
Strengthen of farmers organization: 9 combined organization will be established based on 202 dike units



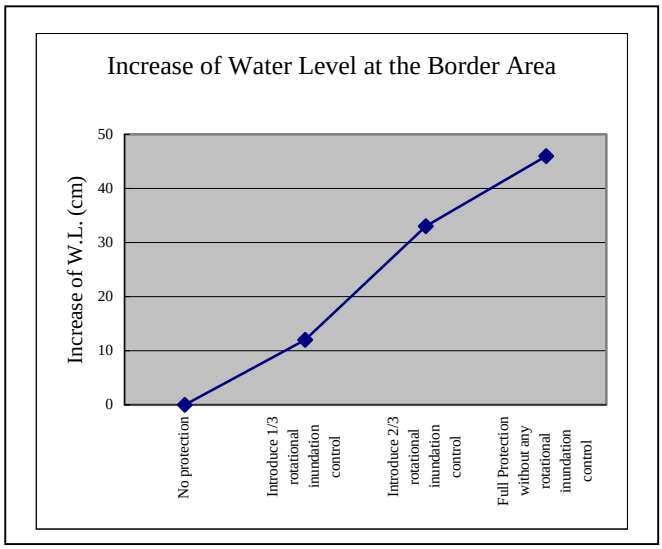
Standard of Dike

The area for Zone B and C can be divided into 9 project areas based on the present conditions of inundation, existing infrastructures, acid sulfate soils, cropping pattern, etc. as shown below.



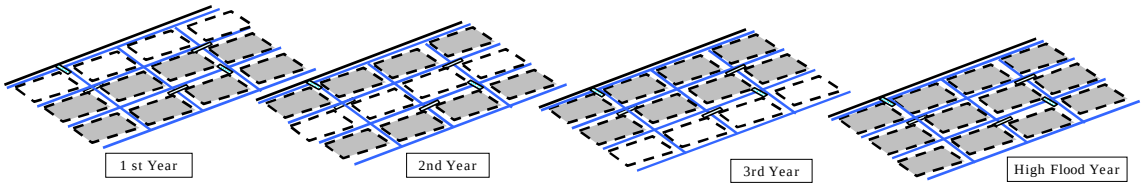
Block									
Number of dike systems	19	18	20	33	31	20	23	34	29
Total area (ha)	16,221	14,517	16,271	21,153	20,220	10,450	13,680	19,794	14,448
Benefited area (ha)	12,977	11,614	13,017	18,228	17,482	8,360	10,944	17,843	11,559
Dike length （km）	267	206	387	345	343	251	321	340	347
Mean Heightening (m)	1.2	1.4	1.1	1.1	1.0	0.5	0.5	0.5	0.3

The hydrological analysis using mathematical model was done for the study on the influence of increasing of water level with this project. As the results, the maximum high water level is expected at northern part of Tan Hong (boundary area with Cambodia), 46 cm of increasing of water level is calculated with non-inundation control for all area. With non-inundation control for 30 % of total area, the increasing of water level will be around 10 cm and this increase of water level will



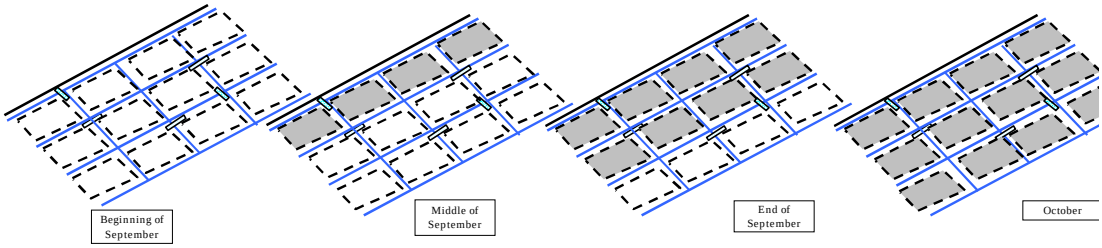
not cause any serious influence to existing structures.

Therefore, based on 30 % non-inundation control, the rotational inundation control system is proposed. For the high flood such as one time for 10 years, all area must be inundated. Based on this idea, the project was explained in the meetings such as public hearing and the idea was agreed by beneficiaries in the medium inundation area.



Rotational Control in Medium Inundation Area

However, in shallow inundation area, an alternative idea in which the inundation is controlled rotationally in September and the inundation is made in all area in October was suggested by the beneficiaries. After confirming the hydrological analysis, it was decided to apply this idea.



Rotational Control in Shallow Inundation Area

The comparison of characteristics among each blocks are summarized below;

Area	Medium inundation area（zone B）					Shallow inundation area (zone C)			
Block	①	②	③	④	⑤	⑥	⑦	⑧	⑨
Influence for rural living conditions large=3,middle=2,small=1	3	3	2	2	2	1	1	1	1
Constrains for cropping large=3,middle=2,small=1	3	3	3	3	2	1	1	2	1
Damage from inundation large=3,middle=2,small=1	2	2	2	2	1	3	3	3	1
Influence from acid sulfate soil small=3,middle=2,large=1	2	1	2	2	1	3	3	3	3
Relation with main canal simple=3,middle=2, cmplicate=1	3	1	1	3	3	1	3	3	1
Influence for environment small=3,middle=2,large=1	1	1	3	3	3	3	3	3	3
Total	14	11	13	15	12	12	14	15	10

Based on this comparison, those blocs can be classified into following 4 categories. As the

constructions of Block ① and ② will make increasing of water level at boundary area, these constructions are better to be done after discussion with the Government of Cambodia.

Blocks for implementation at first stage:④⑧
Blocks for second stage：③⑦
Blocks for third stage：⑤⑥⑨
Blocks for after discussion with Cambodia : ①②

D.4.4 Implementation Plan

The problems of implementation of projects are summarized below;

Project A	The increase in water level at border line with Cambodia is estimated at 25 cm and the decrease in water level at south part of dike road is expected as 17 cm in August. As the gates will be opened in September and October, a large change of water level on peak inundation time is not expected. However, as impacted area is quite large, impacts on water level, discharge amount, water quality, etc. should be studied. The KOICA study team carries out the study on flood control master plan for Mekong River basin including Cambodia area now and it is necessary to make F/S based on the results of this study.
Project B	The decrease in water level at middle inundation area in October is expected as about 10 cm but approx. 15 cm of water level increase is estimated in shallow inundation area. Since the area of impact of this project is quite large, it is necessary to make F/S based on the study results of KOICA team.
Project C	With rotation inundation control with 30% non-inundation, in October the increase in water level is expected as 11 cm at boundary area and also less than 10 cm at other areas. According to the discussion with KOICA study team, any big problem is not expected considering 20 cm of difference of water level between 50% and 20% of probability. Therefore, it is not necessary to wait for the KOICA study results. Furthermore, the project components will be able to adjust through the F/S. However, the farmers' agreement and strengthening of farmers' organization are required for introduction of rotational inundation control system and it is necessary to study more about socio-economic environment.

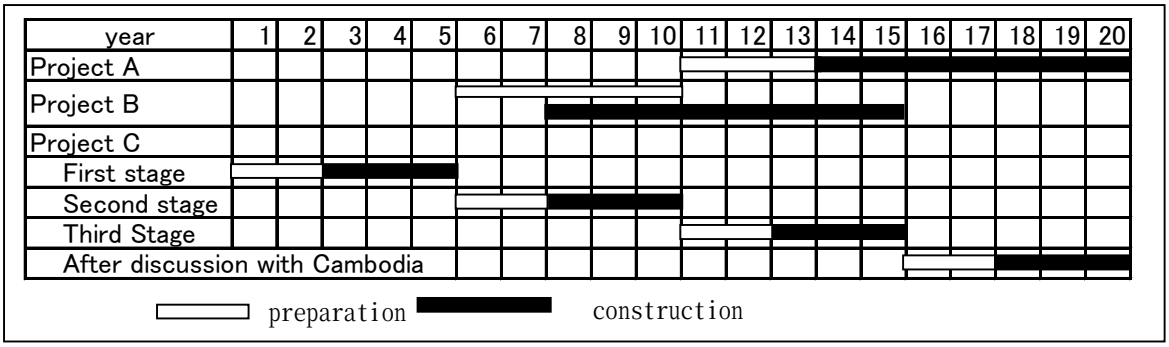
Based on these conditions, the implementation plan is studied and the results are summarized below;

Project A: After confirming the results of KOICA study team, F/S should be carried for 1 year. The discussion will be required with Cambodian government based on the study results. After that, detailed design and tendering for 2 years and construction for 7 years will be required.

Project B: After confirming the results of KOICA study team, F/S should be carried for 1 year. After that, for each main canal, detailed design and tendering for 1 year and construction for 1 year will be required. Then 2 years will be required for 1 canal. Total period is estimated as 10 years.

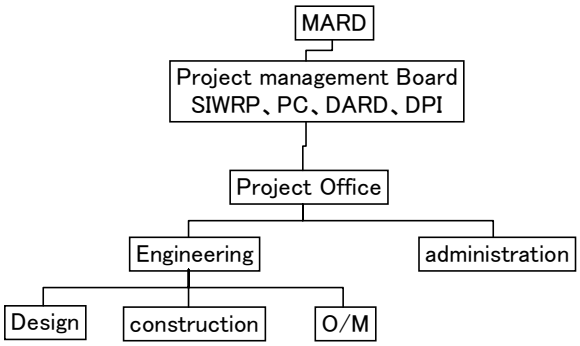
Project C: For each block, 3 months for F/S, 1 year for detailed design and farmers' agreement will be required. 3 years for construction period is expected considering stabilization of embankment and transportation of materials. The total period is 5 years. 9 blocks is divided into 4 groups as shown below;

First stage：④⑧、Second stage：③⑦、Third stage：⑤⑥⑨,
After discussion with Cambodia : ①②

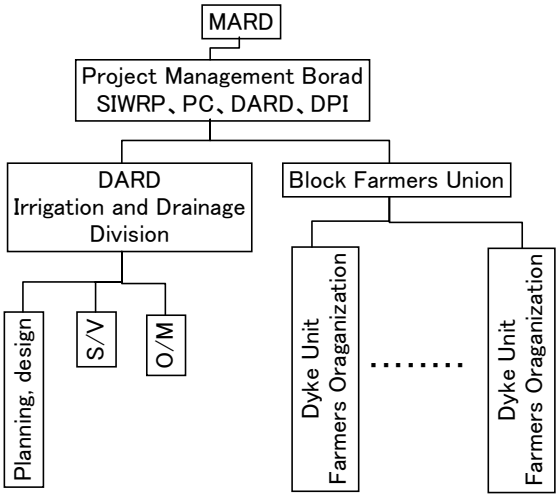


D.4.5 Implementation and O/M Organization

Implementation and O/M organizations for project A and B should be established as shown in the figure. The new project office will be required under the management board which consists of SIWRP and other related agencies. The human resources for staffing will be expected from SIWRP and other related agencies.



Organization structure for Project A and B



Organization for Project C

The project management board is also required for Project C. Under the project management board, the sections of planning/design, construction S/V, O/M of irrigation and drainage division of DARD will work for preparation, construction and O/M respectively. The private consultants will be available for assisting the work. The rotation inundation control plan and distribution of payment for farmers will be decided by each

block farmers union which consists of farmers organizations of each dike unit. The operation of gate control, collection of management fee, etc. will be operated by staff of related commune PC under management of DARD O/M section. The farmers organization of dike unit will consist of existing farmers collectives which are managing the O/M of irrigation and drainage system as water users association now. DARD will support for strengthen and unifying of farmers organization.

D.4.6 Project costs

The costs of projects are estimated as shown below. Estimated EIRR for the Project A and B and estimated FIRR for the Project C are also shown for the reference.

Project Costs

Project	Project Cost		O/M Cost		Reference
	Billion VND	(million US$)	Million VND/year	(thousand US$/year)	
Project A: Flood Control on Boundary Area	1,654.5	(118.2)	2,545.5	(181.8)	EIRR14%
Project B: Flood Control on Southern Nguyen Van Tiep	2,163.6	(154.5)	3,818.2	(272.7)	EIRR14%
Project C: Small Dike System Improvement	1,793.0	(128.1)	66,268.3	(4,733.4)	
①	210.4	(15.0)	7,186.8	(513.3)	
②	185.9	(13.3)	6,350.5	(453.6)	
③	217.1	(15.5)	7,415.3	(529.7)	
④	288.5	(20.6)	9,856.0	(704.0)	
⑤	270.5	(19.3)	9,239.0	(659.9)	
⑥	115.2	(8.2)	4,868.2	(347.7)	
⑦	154.1	(11.0)	6,509.7	(465.0)	
⑧	217.5	(15.5)	9,190.0	(656.4)	
⑨	133.8	(9.6)	5,652.7	(403.8)	

D.5 Hydraulic Analysis on Rotational inundation Control

D.5.1 Objectives

The objective of the hydraulic study is to obtain the internal and external hydrological/hydraulic influence caused by the implementation of the small dike system improvement project. And it is also expected to find an appropriate solution for mitigating adverse effects by this analysis. The influence shall be evaluated by the change of water level inside and outside of the projected area in comparison between case of present condition and the cases of applying dike system with different levels of rotational inundation control system.

D.5.2 Methodology of Hydraulic Study

(1) Basic Concept for Hydraulic Study

The hydraulic influence to the internal and external area was evaluated by comparing the water level before and after the project introduction. Those hydraulic conditions were obtained by applying a mathematical simulation model called VRSAP Model.

(2) General Information of VRSAP Model

VRSAP is acronym of the "Vietnam River Systems and Plains", a program for mathematical modeling of one-dimensional hydrodynamic motion and transport dispersion of mixed substances (salinity, acidity, bio-chemical materials, etc.). An algorithm of implicit finite difference scheme to solve one-dimensional Saint-Venant equations and advection dispersion equation is applied for a complex network of rivers, canals, and sewers.

The VRSAP model has been used in a number of local and nation-wide water control studies in Vietnam, such as:

- The project of Salinity Intrusion Studies in the Mekong Delta, supported by Australia through the Interim Mekong Committee from 1981 to 1991;
- The Eco-development Planning and the study of Pre-feasibility of Water Control in the Quan Lo Phung Hiep area, Mekong Delta, Vietnam, supported by the Mekong Secretariat and CIDA, Canada;
- The Mekong Delta Master Plan project supported by UNDP and studied by NEDECO, the Netherlands from 1990 to 1993. In this Project, the VRSAP model has been used to simulate the flood flow and the low flow including salinity intrusion in a network of over 900 segments, 800 nodes and 300 plains;
- The study of drainage of Stormy Rain Water and Salinity Intrusion in Ho Chi Minh City, carried out by the Planning Institute of Ho Chi Minh City in 1993;
- A series of water resources development project in the Mekong Delta and Dong Nai basin since 1987; and
- The study of flood control planning for the Mekong Delta, a state high priority study of the Vietnamese Government.

(3) Simulation of Present and Future Conditions

For simulation of the future conditions, using rainfall, tide and flood in 1994 which correspondent with probability of 20%.

At the existing condition, most of dikes are constructed based on August inundation water level and farmland are inundated in September and October. Assuming that inundation in the farmland is completely controlled by dike system based on flood correspondent with probability of 20%, therefore the water level outside of dike and surrounding areas will be raised. If the inundation is controlled by the rotational inundation control, some of farmland will be non-inundated at their cropping period without serious influences on surrounding areas. In some years of big flood (probability is higher than 20%), all of the farmland will be inundated as the same condition at existing condition but rural road network is still safely protected.

The hydraulic simulation computing was conducted for seven cases as follows:

- Case-1: Simulation of the present condition.
- Case-2: Applying dike system without rotational inundation control system (full flood protection) for the study area.
- Case-3: Applying dike system with two third (2/3) non-inundation for the study area.
- Case-4: Applying dike system with one third (1/3) non-inundation for the study area.
- Case-5: Applying dike system with two third (2/3) non-inundation for the southern part of Nguyen Van Tiep canal and one third (1/3) non-inundation for the remain area.
- Case-6: Applying dike system without rotational inundation control system for the southern part of Nguyen Van Tiep canal (full flood protection) and applying dike system with one third (1/3) non-inundation for the remain area.
- Case-7: Applying dike system for the study area with one third (1/3) non-inundation but only for the area southern part of Dong Tien canal, the upper part of Dong Tien canal keep as the existing condition.

D.5.3 Results of Hydraulic Simulations

Without Rotational Inundation Control System (Case-2)

Water level in the upper part near the national boundary is strongly affected with water level increases from 14cm to 46cm. In the middle part (from Hong Ngu canal to Nguyen Van Tiep canal), water level increases from 4cm to 26cm and in the lower part (southern part of Nguyen Van Tiep canal) water level increases from 2cm to 10cm. In the area outside of the study area, at the upper part of Moc Hoa, water level increases from 2cm to 12cm and the lower part water level decreases from 2cm to 14cm. This case makes serious increase of water level at the national boundary, therefore it can not be acceptable.

Rotational Inundation System with Two Third (2/3) Non-inundation (Case-3)

Water level in the upper part near the national boundary is still strongly affected with water level increases

from 8cm to 30cm. In the middle part (from Hong Ngu canal to Nguyen Van Tiep canal), water level increases from 2cm to 18cm and in the lower part (southern part of Nguyen Van Tiep canal) water level decreases from 2cm to 10cm. In the area outside of the study area, at the upper part of Moc Hoa, water level increases from 2cm to 6cm and the lower part water level decreases from 2cm to 10cm. In this case, water level at the national boundary is still increasing more than 20cm, therefore it also can not be acceptable.

Rotational Inundation System with One Third (1/3) Non-inundation (Case-4)

Water level in the upper part near the national boundary increases from 4cm to 12cm. In the middle part (from Hong Ngu canal to Nguyen Van Tiep canal), water level increases from 2cm to 8cm and in the lower part (southern part of Nguyen Van Tiep canal) water level decreases from 2cm to 6cm. In the area outside of the study area, at the upper part of Moc Hoa, water level increases less than 2cm and at the lower part, water level decreases from 2cm to 6cm. In this case, water level at the national boundary is still increasing but less than 12cm with the limited area, therefore it can be acceptable.

No Application of Dike Improvement for Block-1 and 2 (Case-7)

In case-7, applying dike system for the study area with one third (1/3) non-inundation but only for the area southern part of Dong Tien canal, the upper part of Dong Tien canal keeps as the existing condition. In this case, the increased water level inside and outside of the study area is less than 10cm and has not any changes water level at the national boundary.

For case-5, case-6, in the study area, applying dike system with one third (1/3) non-inundation for the upper part of Nguyen Van Tiep canal, for the southern part of Nguyen Van Tiep canal applies rotational inundation control system with different levels. The results can be discussed in the followings:

Rotational Inundation System with Two Third (2/3) Non-inundation for Shallow Inundation Area (Case-5)

In case-5, applying dike system with two third (2/3) non-inundation for the southern part of Nguyen Van Tiep canal and one third (1/3) non-inundation for the remaining area. In this case, water level in the upper part near the national boundary is increasing from 4cm to 12cm. In the middle part (from Hong Ngu canal to Nguyen Van Tiep canal), water level increases less than 10cm and in the lower part (southern part of Nguyen Van Tiep canal) water level increase 2cm to 8cm near the Nguyen Van Tiep canal and decreases from 2cm to 6cm in the remain area. In the area outside of the study area, at the upper part of Moc Hoa, water level is not change and at the lower part, water level decreases from 2cm to 4cm.

Without Rotational Inundation Control System for Shallow Inundation Area (Case-6)

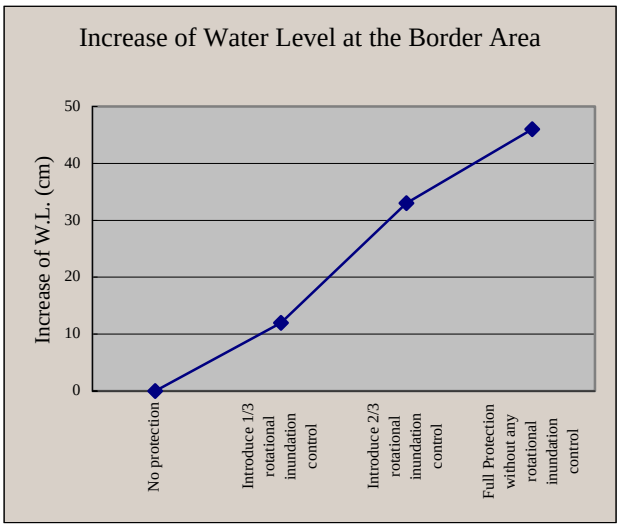
In the Case-6, applying dike system without rotational inundation control system for the southern part of Nguyen Van Tiep canal (full flood protection), the remaining area applying dike system with one third

(1/3) non-inundation. In this case, water level in the study area increases from 4cm to 22cm, the maximum increased water level occurs at My An and it's surrounding area by effect from the full flood protection for the southern part of Nguyen Van Tiep canal. In the upper part of the study area near the national boundary, the maximum increased water level is 12cm with limited area, most of the upper part the increased water level is less than 10cm. For the outside of the study area, the upper part water level increases 2cm to 4cm and for the lower part water level decreases 2cm to 6cm.

The results of the hydraulic simulation are shown in Table D.5.1 to D.5.2 and Fig D.5.1 to D.5.8.

D.5.4 Conclusion of Hydraulic Study

- The hydrological simulation was conducted with the actual flood condition of the 1994 flood, which was considered as the 10 to 20 % probability flood and had the character that flood started earlier than usual year so that damage of agricultural production was severe.
- The introduction of the complete protection of the M/P area without any rotational inundation control system will increase 46 cm of water level at the Cambodian border area of country, and it is not acceptable from the environmental aspect. The introduction of the 1/3 rotational inundation control system is required as to reduce the impact up to 12 cm increase.



- The 12 cm increase of water level of the 1/3 rotation system is the peak value and the area observed more than 10 cm increase is limited to several square km. This water level up-rising will not give any change to the economic activity and living condition in the above area. In addition, the increase of water level is not observed in the mainstream of the Tien River. That means the impacted area is limited and the adverse effect to the upper reach by the project can be ignored. This kind of influence is considered acceptable.
- The introduction of complete protection without any rotation in the shallow inundation area will cause the water level increase in the medium inundation area. The increase of water level was

observed as 22 cm at the peak along the An Phong My An Main Canal. If the inundation control is made by pouring water into dike unit in the order from the beginning to the end of September, the adverse effect to the upper reach can be dissolved.

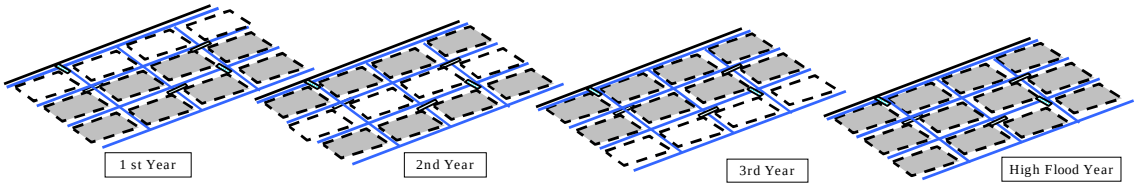
- The external area of the east, the water level during the flood season will be decreased by the project as a result of indirect effect without any adverse effect.

D.5.5 Proposal of Rotational Inundation Control System

In accordance with above result, the following ideas of rotational inundation control systems are proposed to mitigate adverse effect to external area.

For Block-4 (the rotational inundation control system in the medium inundation area)

The "area concerning" rotational inundation control system is proposed for this area. In this idea, the whole area will be protected from flood up to the end of August so that the second crop will be free from flood damage and the production and quality will be stabilized. After that, 1/3 of the whole dike unit will be protected continuously for cultivating third crop, and the remaining 2/3 of dike unit will be inundated. The three crops area will be rotated one after another by year. After harvesting

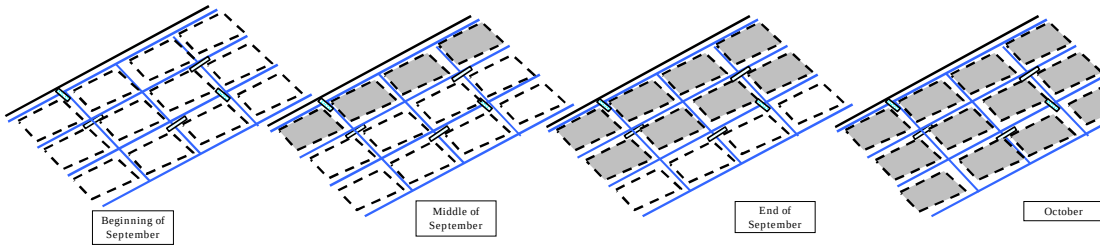


Rotational Control in Deep Inundation Area

the third crop in the three crops area, farmers in each dike will decide to introduce water into the dike or not by themselves.

For Block-8 (the rotational inundation control system in the shallow inundation area)

The "time concerning" rotational inundation control system is proposed for this area. Dike units are inundated in order from the beginning to the end of September to mitigate adverse effect to the external area. The whole area will be protected from flood up to the beginning of September. The 1/3 of dike units are poured at the beginning of September and another 1/3 units will be poured at the middle of September. Finally, the remaining 1/3 will be poured at the end of September. In this idea, the risk of flood damage will be different between each group and the risk intensity will be rotated, that is to say the group of the first pouring still have comparatively high risk for flood than the group of the last pouring. The order of pouring will be rotated one after another by year.



Rotational Control in Shallow Inundation Area

D.6 Recommendations

- As large impacted area is expected for Project A and B, it is necessary to make F/S based on the results of KOICA Study Team.
- The environmental impact on water level, discharge amount, water quality should be studied for Project A and B. In addition, the discussion with Cambodian Government will be required for Project A
- The impacted are for project C will be small. However, it is necessary to study on environmental impact. And it is necessary to study for reduction of impact in the F/S.
- The rotational inundation control system should be require for Project C. Therefore, the it is necessary to study for obtaining of farmers agreement, strengthen of farmers organizations and O/M system.