SOUTHERN INSTITUTE OF WATER RESOURCES PLANNING
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
THE GOVERNMENT OF SOCIALIST REPUBLIC OF VIETNAM

THE PROJECT FOR CLIMATE CHANGE ADAPTATION FOR SUSTAINABLE AGRICULTURE AND RURAL DEVELOPMENT IN THE COASTAL MEKONG DELTA IN VIETNAM

FINAL REPORT (PRIORITY PROJECT)

APRIL 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC., JAPAN
NEWJEC Inc., JAPAN

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CHAPTER 1 OVERVIEW OF THE STUDY

Submitted herewith is the Final Report, describing priority projects as a part of the outputs made under "Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta in Vietnam (the Project)". The project has produced master plan in the context of climate change for sustainable agriculture and rural development as stated in the title, and the plan is elaborated in the first volume of the main report. The master plan has identified total 31 projects/ programs as summarized in a development framework, out of which priority projects were identified.

1.1 Rationale of establishing the Master Plan

There is a global issue, i.e., climate change, which in most cases entails global warming. Global warning raises sea water level as is well known. Therefore, the Mekong Delta where the altitude is just over the sea level is believed to be greatly affected. Not just waiting for the consequences, the Government has embarked on a programme to cope with the climate change. The program is called National Target Program to Respond to Climate Change (NTP-RCC) with a target year of 2020.

Climatic change adaptation is now on the table in each and every sector, and so does the agriculture and rural development sector. An Action Plan Framework was already established covering the agricultural and rural development sector (2008-2020), and thus the Government urges the concerned authorities of agriculture and rural development sector to formulate a tangible development plan which can cope up, or otherwise to live alongside, with the climate change. With this background, the Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta was commenced, and produced the master plan through a series of survey/study, simulation, vulnerability assessment, etc.

1.2 Overview of the Master Plan

In view of the impacts from the climate change, it has been agreed in the Scope of Works prior to the commencement of this Project to present 'Climate Change Adaptation Solutions' for sustainable agriculture and rural development in the coastal areas in the Mekong Delta as the main objective of this Project. Taking this statement into consideration, development vision in the Project area – future scope of the development – was proposed as;

"*Population's livelihood and life are sustained by adapting to and coping with climate change based upon a variety of structural and non-structural development interventions*".

To formulate any master plan, there should be guiding principles which can be the development strategies towards realizing the development vision aforementioned. This guiding principle should refer to the nature of the present situation of the Project area and also should take into account the future prediction on the climate change. Keeping those in mind, following 5 guiding principles were set to achieve the above proposed development vision;

1) NO Regret Investment,
2) Flexibility in planning and investment,
3) Balanced structural and non-structural intervention,
4) Priority setting in the pipeline of vast number of projects, and
5) Early warning system establishment (saline intrusion).

Time Framework should be defined, composed as it is of short, medium and long terms, when preparing any development plan. To define short, mid and long term frame, the Master Plan prepared under this Project referred to the existing development plans including national socio-economic development plan as well as climate change related frameworks in Vietnam. Following development

stages were proposed:

- Short-term: from 2013 to 2020, 8 years
- Mid-term: from 2021 to 2030, 10 years
- Long-term: from 2031 to 2050, 20 years; namely, totaling the terms to 38 years

Master Plan formulation was based on a series of participatory workshops inviting government officers and held at village level. Summing up all the works done in the workshops together with contributions by the JICA Team, a prioritized development framework was finally presented together with project/program description in a simplified project design matrix (PDM). Development framework can be a guide when and where the Vietnamese government should carry out development activities in the coastal areas of Mekong Delta because the framework provides with concrete development components, those priorities by issues related to climate change and by area (province) at which what projects should be carried out.

Framework presented in the master plan is a tree structure which starts with development vision, and is cascaded to climate change issue prioritized, adaptation and/or coping strategy and finally down to the projects/ programs. The Project area covers 7 coastal provinces, and therefore the framework should also relate those projects/ programs with the province. Given the relationship we can know which project/ programme should be implemented in which province with first priority, 2nd priority, and so on, making development intervention sound according to the nature of the provinces and increasing the efficiency in fund allocation as well.

Development framework was so established by taking into consideration what were aforementioned as well as based on the JICA team's consideration. The issues were identified as Saline Water Intrusion, Drought, Sea level Rise, Flood, Change of Rainfall Pattern, Temperature Rise, which are all related to climate change and arranged according to the priority from the top to the bottom of the framework. In addition, 'Common Issues' was placed at the bottom row of the framework. Under 'Common Issues', such projects dealing with cross cutting issues, e.g. capacity building were proposed. Also, some projects may not fall under any of climate change issues but still be needed according to the people's need. These projects were also listed under 'Common Issues'.

In the end, the master plan identified total 30 projects/ programs with priorities. The priorities were placed at the level of issue, strategy, project/ program, and in terms of relationship between those projects/ programs and the provinces where the projects/ programs are to be implemented. The development framework further indicates; 1) nature either by structural or by non-structural, 2) project implementation period, and 3) project cost. In addition all the projects/ programs identified in the following were described in a simple form of project design matrix (for the detail, see the Master Plan Report, Chapter 4).

CHAPTER 2 PRIORITY PROJECT IDENTIFICATION

2.1 Selection Criteria

The master plan formulated has identified total 30 projects/ programs with different levels of priorities. Out of those identified projects/ programs, total nine priority projects were firstly recommended as long listed projects by taking into account the results of vulnerability assessment on the climate change, results of in-depth studies, discussions with relevant officers, etc. Out of the nine priority projects, total four projects were further selected as short listed projects, namely, top priority projects. Following are the criteria referred to in selecting the priority projects (for detail, see the Master Plan Report Chapter 5).

1) Priority projects should be in accordance with those projects proposed and given higher priorities in the framework of the Master Plan of this Project,
2) Priority projects should primarily refer to those ones already identified/planned by relevant provinces as priority project, and also refer to the projects proposed in the water resources master plan 2011 (SIWRP),
3) Priority projects should primarily be of model, which represents measure(s) of adaptation to and/or coping with issues induced by climate change,
4) Priority projects should be planned in view of examining not only structural measures but also non-structural measures, and
5) Priority projects should be viable in financial term and economic term, and also justified from different view points, i.e. technical soundness, institutional soundness in the areas of operation and maintenance, social and environmental soundness.

2.2 Long Listed Priority Project Selection

Priority projects were firstly long listed and then short listed for the feasibility study. The projects were classified into 2; structural and non-structural ones, and the former structural ones were further categorized into 2; sub-sector targeted project and regional (area specific) project. In fact, there may be a difficulty of segregating structural and non-structural projects for some projects since structural projects usually include non-structural components to some extent. However, the Master Plan focused on the major component, whereby if a project included construction work which needed certain level of investment, it was categorized in structural project.

The Master Plan Project proposed the projects as long listed priority projects (see Figure 2.2.1); namely, 6 structural projects and 3 non-structural projects, and the 6 structural projects are further categorized in 2 sub-sector targeted projects and 4 regional (area specific) projects.

Sub-sector targeted Project (Structural):

1) Saline Intrusion Prevention Sluice Gate Construction Project (Sub-sector approach)
2) Seashore Protection and Improvement Project (Sub-sector approach)

Regional Project (Structural):

3) North Ben Tre Polder Area Improvement Project
4) Tra Vinh Fresh Water Recruitment Project
5) Bac Lieu Coastal Area Water Management Project
6) Ca Mau Flow Mobilization Project (including water management non-structural measure)

Non-structural Project:

7) Cropping System Improvement Program toward Climate Change Adaptation
8) Capacity Development Project for Flow Water Management in Mekong Delta
9) Sustainable Shrimp Culture Promotion Program

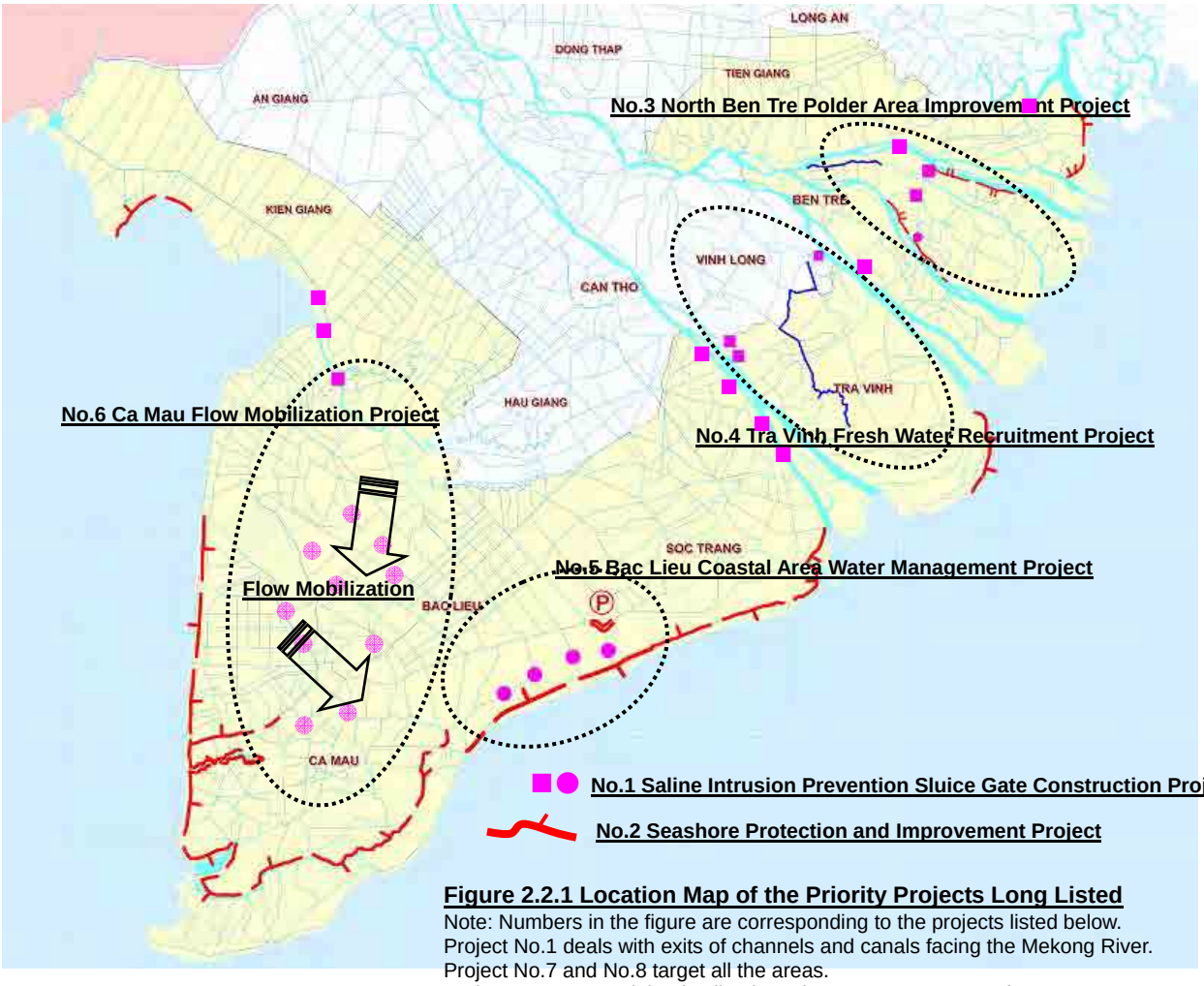


Figure 2.2.1 Location Map of the Priority Projects Long Listed
Note: Numbers in the figure are corresponding to the projects listed below.
Project No.1 deals with exits of channels and canals facing the Mekong River.
Project No.7 and No.8 target all the areas.
Project No.9 targets inland saline intrusion areas, near coastal areas.

2.3 Short Listed Priority Project Selection

Of the aforementioned 9 long listed projects, the Master Plan further recommended the following 4 projects as the short listed priority projects; 2 for structural projects which are composed of one sub-sector targeted project and one regional project, and 2 for non-structural projects;

Structural (Sub-sector and Regional project):

1) Saline Intrusion Prevention Sluice Gate Construction Project (sub-sector project)
4) Tra Vinh Fresh Water Recruitment Project (regional project)

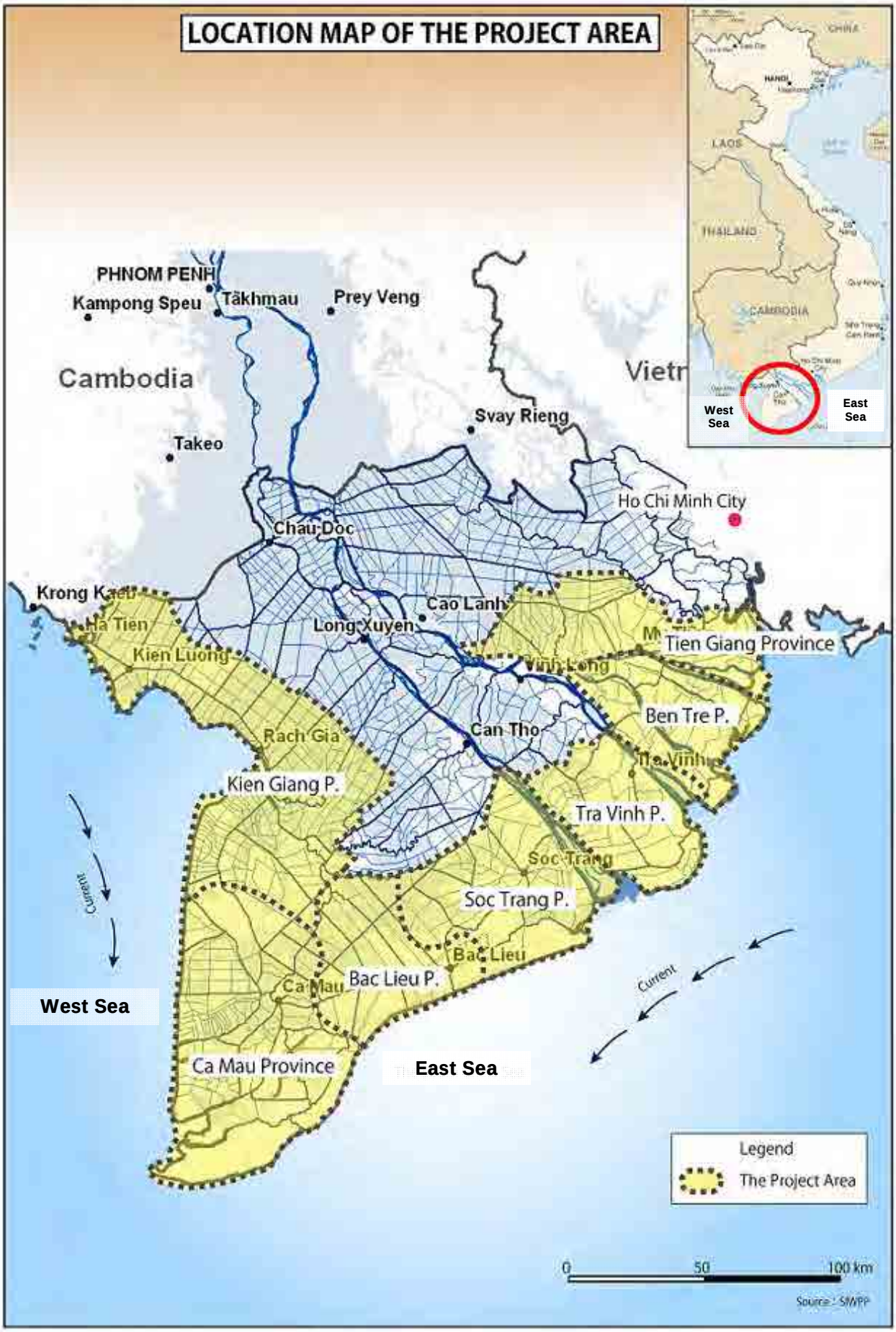
Non-structural Project:

7) Cropping System Improvement Program toward Climate Change Adaptation
8) Capacity Development Project for Flow Water Management in Mekong Delta

Feasibility level examination is carried out for above 2 structural priority projects while the 2 non-structure projects are undertaken detail design planning in the following parts of this Report.

PART II

SALINE INTRUSION PREVENTION SLUICE GATE CONSTRUCTION PROJECT


LOCATION MAP OF THE PROJECT AREA
CHINA
HANOI
LAOS
THAILAND
CAMBODIA
West Sea
East Sea
PHNOM PENH
Kampong Speu
Takhmau
Prey Veng
Cambodia
Svay Rieng
Takeo
Ho Chi Minh City
Chau Doc
Krong Kaeu
Ha Tien
Kien Luong
Cao Lanh
Long Xuyen
Tien Giang Province
Vinh Long
Ben Tre P.
Can Tho
Rach Gia
Tra Vinh P.
Kien Giang P.
Soc Trang
Soc Trang P.
Bac Lieu
Bac Lieu P.
Ca Mau
Ca Mau Province
Current
West Sea
East Sea
Legend
The Project Area
0
50
100 km
Source : SIWRP

EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Master Plan formulated under 'Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta in Vietnam' has identified total 9 priority projects (long list project), and out of them 4 projects were short-listed for feasilibty examination and/or detail project designing. One of the 4 short listed projects is Saline Intrusion Prevention Sluice Gate Construction Project, which is composed of two major components; one is sluice gate construction and the other is rehabilitation of existing sluices.

1.2 In national plans, it is stated to keep the paddy production and increase the aquaculture products in the next five years. However, it is expected that, by the year 2050, temperature rises by 1.0 degree Celsius; annual rainfall increase 3.0%, concentrating only during rainy season; and sea level increases by 31 cm under climate change 2 scenario. As a result, yield losses are expected due to the increased temperature, saline intrusion and also inundation to be caused by increased rainfall. To cope with the foreseeable problems, the project is proposed to make cropping systems suitable to such an environment being affected by climate change issues.

2. THE PROJECT AREA

2.1 The Project area, 7 coastal provinces, is located along the coastal line of the Mekong Delta as is called. Provincial population in the Project area varies from 867,800 being the minimum in Bac Lieu to about 1.7 million being the maximum in Kien Giang while the area from 2,295 km^2 to as much as 6,346 km^2. Total population for the Project area arrives at 9.02 million, sharing about 52% of the whole Mekong Delta population, while the total area comes to 24,631km^2 equivalent to about 61% of the total Mekong Delta area. Population density is thus estimated at 366 persons/km^2. This population density is relatively high, for example, as compared with the national average of 263 persons per km^2.

2.2 Mekong Delta's economy is agriculture dominated. The Project area's overall economic structure is; 48% by primary sector, 23% by secondary sector, and 29% by tertiary sector. The share of the primary sector, represented by agriculture, in the Project area is higher than that of Mekong Delta, 41%, and by far higher than that of whole county, which is only 21%. The Project area and whole Mekong Delta have been achieving higher growth ratios than whole country. The growth ratio of the whole country has been about 5 – 8 % per annum while those of the Project area and Mekong Delta have been much higher, e.g. over 10% in most of the provinces.

2.3 Air temperature in Mekong delta shows relatively high value as compared to other parts of Vietnam and its annual average is about 27 Celsius degree. Generally, mean annual air temperature in the eastern area is a little lower than that of the coastal and southwest areas (except Vung Tau) by about 0.4 Celsius degree or more. The highest mean annual air temperature shows up in Rach Gia with 27.6 Celsius degree while the lowest is 26.7 Celsius degree in Ca Mau. The highest monthly average air temperature ranges between 28 Celsius degree and 34 Celsius degree; April, just prior to the onset of rainy season, is the hottest month and December shows the coldest air temperature in a year.

2.4 Rainfall starts rising from May and keeps increasing, and then it peaks in October. After October, it starts descending quickly, and the minimum monthly rainfall shows up in February. About 90 % of the total annual rainfall falls in this rainy season. Mean annual rainfall varies from 1,300 to 2,300 mm depending on place. The maximum annual rainfall is recorded at Phu Quoc Island, located about 80 km westward from the northern tip of King Giang province, with 3,067 mm while that of mainland shows lower values, for example, 2,366 mm in Ca Mau. Northeast and internal areas have less annual rainfall; it is around 1,350 mm (such as 1,349 mm at My Tho, 1,360 mm at Chau Doc, 1,356 mm at Cao Lanh and 1,544 mm at Can Tho).

2.5 As for the paddy cropping calendar in the Project area, there are four major seasons, among which summer-autumn paddy (May-August) and winter-spring paddy (December-February) constitute the major part of paddy production in the Project area. In rain-fed areas where irrigation water is barely available, paddy is planted only during the rainy season. In this case, if the area is heavily flooded toward mid to end of rainy season, only summer-autumn paddy (early rainy season paddy) is cultivated once while in areas not affected by flood, autumn-winter paddy is also cultivated.

2.6 Looking at the paddy production of the Project area in 2010, Kien Giang produced by far paddy in the Project area (3,485,000 tons), which is in fact 2nd largest production in the Mekong Delta after An Giang (3,692,000 tons). The 3rd biggest production was made in Dong Thap province. Kien Giang, An Giang and Dong Thap provinces are located in the most upper reach of the Mekong River within Vietnam. On the other hand, coastal provinces except for the Kien Giang have relatively less production of paddy. For example, Ben Tre province shows the least production by 368,000 tons, followed by Ca Mau (504,000 tons) and then Bac Lieu (849,000 tons), which are all in line with the land use pattern.

2.7 As is well known, aquaculture production in the Mekong Delta by far surpasses the production of other regions. In fact, the overall aquaculture production by Mekong Delta (1,940,181 tons) shares as much as 72% of the national production (2,706,752 tons) in 2010. With regards to the aquaculture production of fish, the intensive production areas can be seen in the upper-mid parts of Mekong Delta, and yet the Project area still produces total 530,612 tons of aquaculture fish. Per-capita production of aquaculture fish in the Project area is estimated at 59 kg, which is far bigger than the national per-capita production of 24 kg only.

2.8 On top of that, the aquaculture shrimp production in the Project area by far exceeds those of other regions including mid-upper parts of Mekong Delta. The total production of aquaculture shrimp in 2010 came to 331,760 tons while that of national level was 450,364 tons. It means the Project area produced as much as 76%, approximately three-quarters, of the national production. Per-capita production of the aquaculture shrimp arrives at 36.8 kg per annum while those of other provinces and regions remain less than 5 kg per capita per annum only.

2.9 Shrimp culture in Vietnam may be divided into four: intensive, semi-intensive, semi-extensive and extensive. While the extensive system shares 90% of the total cultivated area in the Mekong Delta, it shares only 43% in terms of the production. On contrast, the semi-intensive system, which shares only 8.2% of the area, produces 35.5% of the whole production. Similarly, while the intensive system shares only 1.8% of the area, it produces as much share as 21.1% of the total production, that is, “intensive”, composed of semi-intensive and intensive, systems produces nearly half of the production with only 10% of the land.

3. CLIMATE CHANGE AND IMPLICATIONS

3.1 According to long-term observation data, temperature in Mekong delta is in an increasing trend: 0.7 degree Celsius of increase in annual mean temperature in the past 30 years, corresponding to global warming. Sunshine hours per annum maintain, however, a decreasing trend: approximately 500 hours, or 20%, of decrease over the past 30 years, which correspond to the increasing trend of rainfall, although the trend of rainfall differs among the measuring stations and the period. With respect to water levels in the East Sea, West Sea and Mekong River, continuous increases are observed at all the places: 15 cm over the past three decades—meaning 5 cm of increase per decade for both East and West Seas.

3.2 With reference to a climate change simulation, it is expected that the mean annual temperature

(1980-1999) would increase by 1.0 degree Celsius by year 2050. Annual rainfall is expected to increase; monthly rainfall in October is projected to increase by more than 20% by year 2100 for the scenario B2. With regard to sea level, biggest sea level rise would occur in A2 scenario amongst scenarios B1, B2, and A2, wherein it is expected to increase by 31 cm by year 2050 and as much as 103 cm by 2100. The trend of sea level rise is quite exponential up until year 2100 for all the scenarios.

3.3 By the climate change so far having taken place and expected to occur, a range of damages are caused or to be caused. Typical problematic issues, as constraints and difficulties to farmer households on the ground, are as follows according to the results of simulation and vulnerability assessment:

- ✓ *Damage by saline intrusion*: A substantial impact of saline intrusion appears in Bac Lieu, and Ca Mau provinces where a large extent of area is affected by saline water 20g/l of saline content. Having been affected by a lack of freshwater from Mekong River, productions of paddy and fruits undergo pronouncing amount of loss in monetary value. For example expected loss of fruits in Ben Tre province ranges from 3 trillion to 7 trillion VND.
- ✓ *Damage by inundation*: The level of inundation hits the peak in September to October. Although flood from Mekong River is not so sever in coastal provinces, Kien Giang and Tien Giang provinces are subjected to inundation. The most vulnerable commodity is vegetables, followed by paddy, fruits and shrimp. Essentially, fruits are more susceptible to inundation than paddy; but as they are usually planted in higher land, paddy is as a result at higher risk.

4. DESIGN OF THE PROJECT

4.1 Priority on the climate change issues was identified by series of workshops for villagers and government officers; and saline water intrusion and drought (shortage of fresh water) were the top priority issues. Sluice gates construction is considered as one of infrastructural interventions to protect coastal area from saline water intrusion and to secure fresh water intake from the Mekong River.

4.1 Sluice Construction Project

4.2 Total 68 numbers of large scale sluices have been identified in the project area (coastal 7 provinces). Selection of these sluices were based on “Master Plan for irrigation projects in the Mekong Delta in the context of climate change and sea level rise (2011)” prepared by SIWRP and approved by the government on September 25, 2012.

4.3 The project requires quite huge investment, total USD 1.06 billion and it is quite difficult to implement within a short period of time. Sea level rise is expected in future but it does not increase immediately. This project therefore divides implementation period into four stages covering up to 2050; the first term is from the present to 2020, the second term from 2021 to 2030, the third one from 2031 to 2040, and the last one is from 2041 to 2050.

4.4 Priority is given to the area where saline water intrusion is already observed. Total number of sluices in the first term is 18 sharing 27% of total sluices. During the following second period from 2021 to 2030, the targeted sluices are located at the areas where saline intrusion is expected till 2030. The total number of sluices is 26 (38%). High tide prevention sluices along coastal line are planned to implement in the following term from 2031 to 2040 with 25% share (17 sluices). Sluices in flood inundation are selected to implement from 2041 to 2050; number of sluice being 7 (10%).

4.5 Even if an increase of water level by climate change takes place in future, the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level

rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard). These views are applicable also in other areas in Mekong Delta.

4.2 Sluice Rehabilitation

4.6 A total of 69 sluices are identified to be rehabilitated in the project area, which sluices area sluices are constructed from 1984 to 2011; the width of these sluices is equal or more than 10 m. Invested cost by the Vietnamese government for this rehabilitation comes to approximately 22 billion VND (about USD 1.1 million) per sluice, which is about 6.3% of newly constructed sluice

4.7 Organizations under DARD have been rehabilitated sluices every certain years and interval between rehabilitations is in many cases every 5years. Project period is divided into three terms, the first term is from 2013 to 2015, the second term starts from 2016 and continue until 2020, the final term begins in 2021 and it ends in 2025, total 13 years period. A priority is given to such sluices which are close to rehabilitation period or heavily rusted.

4.8 Since sluices are usually constructed in saline intrusion areas, corrosion of iron parts of sluice causes a problem. Normal steel gates will be replaced by stainless type in the project to avoid corrosion. The first term requires about 25% of whole project cost within 3 years. The second term shares 52%, the last term needs 23% of total rehabilitation cost.

5. EVALUATION OF THE PROJECT

5.1 On the economic evaluation, overall EIRR for 68 sluices construction showed 16.8%, higher than the opportunity cost of 12% in Vietnam. If project is divided into four terms 2013-2020, 2021-2030, 2031-2040, and 2041-2050, estimated EIRR for saline intrusion prevention came to 18.6%, 13.5%, 14.9%, and 11.6% respectively. Even though the project in the last term does not exceed he opportunity cost of 12% in Vietnam, the sluice under this term has the main purpose of flood prevention; benefit of both saline intrusion prevention and flood prevention will make EIRR increase over 12%.

5.2 On the environmental issue, except for resettlement, the proposed project does not give severe adverse impact on the surrounding environment. Some impacts such as noise and air pollution may take place during construction period; however, these impacts are limited and temporary, and still possible to mitigate by available measures to be taken by contractor(s).

5.3 On the resettlement, numbers of households to be relocated will be many. The legal frame of resettlement in Vietnam is well developed where each PPC has its original unit price of compensation considering local conditions together with the national level regulation. The system has been functioning, so that the resettlement required under the project could be managed

5.4 On the technical issue, there are no specific difficulties for implementing the project and in addition materials to be used under this project are common and available in Vietnam. Therefore, the project is technically feasible to implement, and in addition the construction schedule is not tight taking into account actual similar practices in Mekong delta. Further, each responsible office to implement and manage this project has enough human resources with similar experiences, whereby construction and management thereafter could well be done.

6. CONCLUSION AND RECOMMENDATIONS

6.1 As for resettlement and land recovery, it is recommended to pay further attention to the people

to be affected; e.g. application of WB policy 4.12 is recommended in addition to the existing resettlement frame to increase opportunity for the affected persons to participate in the preparation of the resettlement plan, and to minimize a gap between market price and prescribed price of land compensation. In sum, it is recommended to involve the persons to be affected at an earlier stage and also to fill the gaps between the prices.

6.2 Preparation of resettlement plan and its implementation shall be commenced in advance of proposed project period because there are a lot of procedures for resettlement implementation and it take quite long time until its completion.

6.3 It is recommended to implement the sluice construction by ODA assistance while the rehabilitation of sluices by the Vietnamese government budget. This is because; impact of climate change, especially saline intrusion coupled with sea level rise, is an urgent issue in the Ben Tre and Tra Vinh provinces. To prevent the saline intrusion at an early stage of time, it is thought to be better to seek assistance from donor(s) taking into account budgetary constraint for the Vietnamese government. On the other hand, sluice rehabilitation work is regular works by Water Resource Management Company, and the work shall be continued without end.

CONTENTS (SLUICE CONSTRUCTION)

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AHDNS	Acute Hepatopancreatic Degenerative Necrotic Syndrome
AMSL	Above Mean Sea Level
AusAID	Australian Agency for International Development
B/C	Benefit Cost Ratio
CP	Counterpart
DARD	(Provincial) Department of Agriculture and Rural Development
DONRE	Department of Natural Resources and Environment
DPC	District People's Committee
EU	European Union
ERR	Economic Rate of Return
FAO	Food and Agriculture Organization
FY	Fiscal Year
GDP	Gross Domestic Products
GOJ	Government of Japan
GOV	Government of Vietnam
GCM	Global Climate Model (or General Circulation Model)
GSO	General Statistical Office
HDI	Human Development Index
IAS	Institute of Agricultural Science for Southern Vietnam
ICB	International Competitive Bidding
IDA	International Development Association
IDMC	Irrigation and Drainage Management Company
IMC	Irrigation (and Drainage) Management Company, under DARD
IMF	International Monetary Fund
IMHEN	Institute of Metrology, Hydrology and Environment
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IRR	Internal Rate of Return
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau (German government-owned development bank)
MARD	Ministry of Agriculture and Rural Development
MBV	Monodon Bacuro Virus
MDG	Millennium Development Goal
M&E	Monitoring and Evaluation
MKD	Mekong Delta
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
MRC	Mekong River Commission
NACA	Network of Aquaculture Centres in Asia-Pacific
NCB	National Competitive Bidding
NPK	Nitrogen, Phosphate, Potassium
NPV	Net Present Value

O&M	Operation and Maintenance
PCR	Polymerase Chain Reaction
PRA	Participatory Rural Appraisal
PRECIS	Providing Regional Climates for Impacts Studies (a regional climate model system)
PCM	Project Cycle Management
PPC	Provincial People's Committee
RCM	Regional Climate Model
RIA No.2	Research Institute for Aquaculture, No.2 (located in Ho Chi Minh City)
SIWRP	Southern Institute of Water Resources Planning (the CP organization)
SIWRR	Southern Institute of Water Resources Research
SWOT	Strengths, Weaknesses, Opportunities, and Threats
Sub-NIAPP	Sub-national Institute of Agricultural Planning and Projection
GIZ	(Deutsche) Gesellschaft für Internationale Zusammenarbeit

UNIT CONVERSION

1 meter (m)	=	3.28 feet
1 kilometer (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
1 acre	=	0.405 ha
1 inch (in.)	=	2.54 cm
1 foot (ft.)	=	12 inches (30.48 cm)
1 ac-ft		1233.4 cum

CURRENCY EQUIVALENTS (AS AT DECEMBER 2012)

US$ 1.00	=	VND 21,053 (TTB)
US$ 1.00	=	82.11 Japanese Yen (TTB)
VND 1.00	=	0.0039 Yen

VIETNAM FISCAL YEAR

January 1 to December 31

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MAIN REPORT

CHAPTER 1 INTRODUCTION

The highest priority was given to the issue of 'saline intrusion' in the coastal 7 provinces taking into account the results of villagers' and officials' workshops, discussions with relevant officers, vulnerability assessment results on the climate change, and the results of in-depth studies, etc. Agriculture cannot be thrived under saline intrusion. This chapter therefore discusses necessities and importance of the program for saline intrusion prevention sluice gate construction.

1.1 Rationale of the Project

Sea level has been rising with certain extent in the last several decades according to IPCC 4th assessment report (2007)[1]. Global average sea level has risen at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003 and at an average rate of about 3.1 [2.4 to 3.8] mm per year from 1993 to 2003. Around the Mekong delta, sea level rise has been recorded; the record shows continuous sea level rise with an average of approximately 15 cm in 30 years. It means about 5 mm per year; a bit higher pace than that quoted in the IPCC 4th assessment report. This sea level rise gives gradual but strong impact on product/activities of agriculture and aquaculture in the coastal areas of Mekong delta.

In 2002, Balai barrage construction project was completed in Ben Tre Province and it has been protecting 88,500ha of farm land from saline intrusion. However, strong demand for fresh water in dry season causes unexpected water level decrease in the canals of North Ben Tre area. The water level decrease in the canals works in increasing water inflow from the Mekong River[2], and then, much saline water also flows easily into the canals.

Upstream side of North Ben Tre area does not have any sluices to prevent saline intrusion. Thus, saline water comes from upstream side of the area and causes severer saline intrusion than ever before. This fact implies that just one large barrage cannot control saline water intrusion for whole canal networks, so that integrated water resource management should be considered to be one of effective solutions for the control of saline water intrusion into canal-networks. Here, numbers of sluices have to be operated according to monitoring results of saline content and water level along the Mekong River.

Extension of saline water intrusion can be examined from the simulation results. Affected area by saline water intrusion in Mekong delta will increase in future; however, there are still many canals without having sluices at the estuary points. Due to construction necessity of many sluices, prioritization is essential before budget allocation and whereby implementation arrangement in order to maximize investment effectiveness. This study will be helpful to support in making plans for prioritization of sluice construction according to the results of simulation and field surveys.

1.2 Objectives of the Project

The objective of the project is to construct sluices according to schedule based on priority for the purpose of protecting areas from saline water intrusion in the Mekong delta. Numbers of sluice construction candidates are planned in the coastal Mekong delta, however it is quite difficult to implement them all simultaneously because of the huge budget necessity. Sluice gates can control saline water intrusion along Mekong River and keep fresh water inside of canal networks.

Since saline water intrusion occurs from estuary of Mekong River and extends towards upstream, this is why construction implementation of sluice gates shall proceed from downstream to upstream direction. Sea level rise accelerates tendency of saline water intrusion to upstream area, so that stable

[1] An Assessment of the Intergovernmental Panel on Climate Change (IPCC; November 2007), Climate Change 2007: Synthesis Report

[2] Some bank-slide or failures are reported after Balai barrage construction along An Hoa canal at upper side of Ben Tre polder (source: the chief of Gial Hoa commune on 15 September 2012, interviewed by the Study Team).

and scheduled construction implementation is required. There are numerous canals in the Mekong delta, among those some canals are located in lower part of the delta; these canals do need sluice gates to control tidal effect.

Construction plan is basically formulated based on the results of both simulation for saline water intrusion and site survey. Recorded data and climate change simulation have defined high risk of saline intrusion onset of sea level rise. The sea level rise around the Mekong delta has arrived at certain level and an average sea level rise is approximately 5 cm per decade. Future prediction done by IMHEN shows 30cm sea level rise in 2050 under B2 scenario. These data and prediction imply further area expansion of saline water intrusion in future, so that there is necessity of urgent construction of sluice gates with appropriate plan and schedule.

A procedure aforementioned is rather theoretical but actual conditions have already progressed to quite serious situation. Saline intrusion has been confirmed at many farming places in the Mekong delta, while sluices are not yet constructed at most large canal mouths. This is why priority is emphasized on sluice gate construction and it is reported from coastal seven provinces. Once high content of saline water intrudes into these canals, almost all crops will be damaged at once. Thus, this program has to be implemented based on appropriate plan; sluices shall be constructed with adequate budget allocation. In addition to this, appropriate maintenance works shall be planned and implemented for existing sluices.

1.3 Implementing Organizations

Institutional structure relating to this program is shown as Figure 1.3.1. In principle, Ministry of Agriculture and Rural Development (MARD) is the primary institute that governs the entire sectors including sluice gate construction, operation, management, and maintenance. For sluice construction implementation, there is clear demarcation according to budget sources. If budget comes from Vietnamese government, Department of Construction Management (DCM) deals with projects. If a project is provincial scale, Department of Agriculture and Rural Development (DARD) is the implementing organization while DCM handles a regional project such as the project concerns two or three or more provinces.

In case of foreign budget such as ODA projects, CPO controls all projects and there are three candidates to implement the project depending on budget and area scale. If budget is small and provincial scale, DARD is usually appointed as an implementation organization for the project. If a project scale is medium and regional scale in Mekong Delta, Permanent Representative Office under DCM acts as an implementation organization. In case of a project with large budget and regional scale, Central Project Office unit 10 for Mekong Delta handles project implementation.

From start to completion of projects, DCM has to monitor projects' implementation procedure in terms of policy, laws, and decrees on investment and technical aspects of Vietnamese government. A project implementation organization has to be monitored by DCM on such as; procurement procedure of engineers and contractors, budget disbursement procedures, approval and mandate, technical procedures, and others. Without approval by DCM, each project implementation organization cannot receive and disburse project budget.

Historically, Mekong delta development has started from canal network development for waterway extension purpose. This is because there are dense canal networks throughout the delta. Waterway transportation shares about 70% of total freight in the delta, so that the waterway transportation still plays important role in the regional economy. Ministry of Transportation (MoT) is the responsible organization to control waterway transportation and navigation. Therefore hydraulic projects require mutual coordination with MoT. At the central level, MoT is responsible for all aspects of navigation and transportation. At the regional level, there are several branch offices for this purpose in Mekong

delta.

DARD and peoples' committee at provincial level have different responsibilities and authorities. In general, DARD is responsible in technical matters, while peoples' committee takes care of management aspects. For example, peoples' committee maintains an authority in budget allocation within the province; the department drafts a construction implementation plan or a specific project plan, and submits it to peoples' committee for approval.

As for the coordination between implementation organization and controlling organization such as DARD and the MoT, provincial council functions as a coordination body in which the representative from the provincial peoples' committee chairs the meetings. As provincial council is connected to the prime minister's office of the central government, issues such as related policies, decisions and orders can be reflected into the provincial policies through the discussions by provincial council.

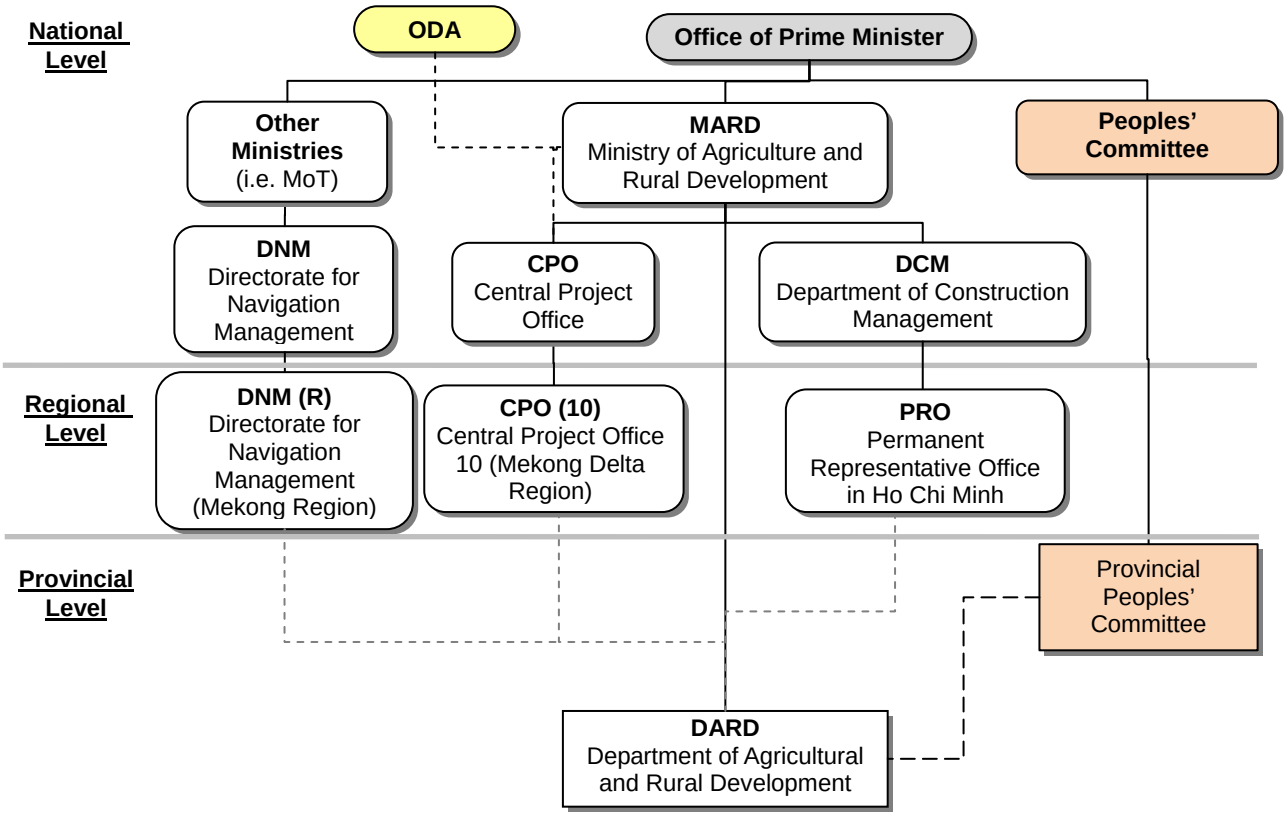


Figure 1.3.1 Governmental Agencies for Sluice Construction in Mekong Delta

Source: SIRWP

For project implementation, responsible organization has to address climate change issues both for planning and implementation. Since required budget becomes large for sluice gate construction, budget allocation plan becomes quite important. Prioritization shall be given in accordance with regional environmental condition; saline water intrusion situation should be revised at least every 5 years. Climate change affects the area of saline intrusion, the fresh water available area, and farming practices. Thus, climate change will be a key issue for the project planning, and whereby it shall be revised within certain time period in order to keep budget allocation efficiently.

1.4 Project Area

Mekong Delta covers Can Tho city and 12 Provinces. The provinces targeted by this project are 7 coastal provinces among these 12 provinces; namely, Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau and Kien Giang. The total Project area is 24,631km^2, about 61% of the total area of

Mekong Delta (40,519 km^2)[3]. The population of the 7 provinces is estimated at about 9 million, which shares about 52% the total population of 17.3 million of the Mekong Delta (2010) and population density comes to 366 persons/km^2, a relatively high density as compared to the national average of 263 persons per km^2.

1.5 Project Scope

Table 1.4.1 Area and Population of the Project Area

Province/ Region	Area, km^2	Population (2010)	Pop. Density Persons/km^2
Tien Giang	2,484	1,677,000	675
Ben Tre	2,360	1,256,700	532
Tra Vinh	2,295	1,005,900	438
Soc Trang	3,312	1,300,800	393
Bac Lieu	2,502	867,800	347
Ca Mau	5,332	1,212,100	227
Kien Giang	6,346	1,703,500	268
Total Project Area	24,631	9,023,800	366
Total Mekong Delta	40,519	17,272,200	426
Whole Country	331,051	86,927,700	263

Source: Statistical Year Book of Vietnam 2010 (General Statistics Office)

Mekong Delta has a history of canal development networks since its initial development stage under Nguyen dynasty. Canal network runs throughout the delta and canals cross the border of provincial administration. The program area itself is in coastal seven provinces; this is why tidal regime and Mekong river discharge affect the program area with saline intrusion as well as flood inundation. At this moment, saline intrusion is the most concerned issue for villagers in the program area. In order to protect the area against saline water intrusion, sluice gate establishment is given high priority to have sustainable development in agriculture. After the gate construction, gate operation has to be guaranteed with proper maintenance of the facilities. This program has therefore the following scope:

1) To establish a plan for major sluices which can control water flow in the main canals of seven coastal provinces in accordance with simulation results for sea level rise and saline water intrusion,
2) To prioritize the implementation of new sluice gate construction in accordance with climate change scenario and possible budget allocation,
3) To establish a plan for rehabilitation works for existing sluices which need, e.g., replacement of gates according to the observation by field survey, and
4) To prioritize rehabilitation works for existing sluices taking into account the necessity of budget preparation.

Even though program area is composed of coastal seven provinces, it may need to consider the neighboring upstream provinces for sluice gate planning. Sometimes saline water may intrude from an upstream province, and therefore sluice gate has to be constructed in such upstream province. In addition to this, fresh water may need to be introduced from upstream provinces, for which some sluice gates may have to be constructed at the canals in the upstream for the purpose of fresh water intake control.

1.6 Priority in Relevant Programs and Plans

There is an overarching Vietnamese development strategy; Socio-economic Development Strategy for the period 2011 – 2020. Under this strategy, every 5 year development plan is formulated and further climate change related programs and plans were established. Major climate change related program is the national Target Program to Respond to Climate Change (NTP-RCC). It has the target year of 2020. Under the NTP-RCC, there are relevant development sector action plan frameworks, also established in the rural and agriculture sector in Vietnam. It is called Action Plan Framework of Rural and Agriculture Sector (2008-2020). Following sections brief the contents of those strategy and plans:

[3] Source: Statistical Year Book of Vietnam 2010 (General Statistics Office of Vietnam)

1.6.1 Socio-Economic Development Strategy for the Period 2011 - 2020

The Congress of Vietnam communist party revised the Socio-Economic Development Strategy for the Period 2011-2020 and the prime minister approved it in January 2011. Agriculture is one of important sectors in Vietnam, and then, it is described in 'main objectives of economic development'; agriculture shall develop toward modern, effective, and sustainable directions; the agriculture in Vietnam has advantage of tropical features and the sector is required to quickly increase output and export turnover of agricultural products to improve income and living standards for farmers and to firmly ensure national food security.

It also mentions that aquaculture is also a part of comprehensive agriculture development in accordance with the plan focusing on products that shall have strength and high value. In order to achieve such development, appropriate scientific technology and facilities are required in breeding and production of aquaculture. Aquaculture sector shall keep its productivity, quality, and competitiveness as well as it shall meet requirements on food safety. Building up the Vietnamese aquaculture to reach advanced level in the region, it shall need to foster the application of advanced science and technology in production and processing, so that the region can improve develop the socio-economic condition.

In order to materialize those strategies, development direction is also indicated that it shall pay attention to the development of industry that serves agriculture and rural areas. It emphasize to take advantages of tropical agriculture to develop the massive production of goods with high productivity, quality, effectiveness and competitiveness, to encourage the gathering of cultivated land to develop households' camps, farms and agricultural enterprises that are suitable with the scope and conditions of each region, to keep close control of conversion of agricultural land, especially from land for rice cultivation to land used for other purposes, with the assurance of benefits of rice planters and rice planting localities.

For the delta area, it describes that it shall develop high-tech agriculture. It shall establish areas for concentrated goods manufacturing based on reorganization of agricultural production and application of technical advances. The strategy further maintains that it shall undertake planning for large areas specializing in rice cultivation as goods and strengthening rice intensive cultivation. Huge amount of rice is produced over Mekong delta, and the coastal area is not an exception. However, extensive paddy area is now at risk of saline intrusion due mainly to sea level rise.

In order to fulfill the above development strategies, prevention of saline water intrusion is in fact essential for rice farming development, and fresh water supply and brackish water control are also indispensable issues. Sluice gate construction can be considered to contribute to achieving the strategy by adapting to and/or coping with present and future climate change, especially in the form of saline intrusion associated with sea level rise.

1.6.2 National Target Program to Respond to Climate Change (NTP-RCC)

NTP-RCC was approved by the prime minister on December 2, 2008, and the strategic objectives are to assess climate change impacts on sectors and regions in specific periods and to develop feasible action plans to effectively respond to climate change in the short-term and long-term period so as to ensure sustainable development of Vietnam. The standing agency is the Ministry of Natural Resources and Environment, which is in charge of collaboration with relevant agencies and institutions.

The NTP-RCC maintains that tasks to respond to climate change must be integrated into development strategies, programs, plans, planning in all the sectors and at all levels; into legal documents and policy institutions; into development of legal documents and their implementation. The NTP-RCC is planned to implement over the country in three phases such as; first phase (2009-2010) as starting-up stage, 2) second phase (2011-2015) as implementation stage, and 3) third stage (after 2015) as

development stage.

To achieve the objectives, there are 9 concrete tasks e.g. assessment of climate change extent and impacts, identification of measures to respond to climate change, awareness raising and human resources development, enhancement of international cooperation, etc. Of them, Task-8 urges relevant authorities to develop their own Action Plan of the ministries, sectors, and localities to respond to the climate change. Given the Task-8, MARD has also formulated the Action Plan covering rural and agriculture sector in responding to the climate change.

1.6.3 Action Plan Framework of Rural and Agriculture Sector (2008-2020)

Responding to the Task-8 in the Target Program to Respond to Climate Change (NTP-RCC), MARD has formulated the Action Plan Framework for Adaptation and Mitigation of Climate Change of the Agriculture and Rural Development Sector Period 2008 – 2020. The general objective is to enhance capability of mitigation and adaptation to climate change to minimize its adverse impacts and to ensure sustainable development of the agriculture and rural development sector.

Pursuing the general objective, there are 7 specific objectives; 1) develop a policy system integrating climate change in sectoral development programs, 2) develop an action plan and propose support policies for the climate change affected regions, 3) strengthen capacity of research and forecast of climate change, 4) strengthen international cooperation, 5) develop human resources, 6) enhance awareness of relevant stakeholders, and 7) ensure equal benefit sharing for rural communities in implementing climate change mitigation and adaptation.

Since it is an action plan, there is a list of concrete activities to respond to the climate change. Activities are summarized in 5 areas as; 1) to conduct the communication and information program to disseminate knowledge and experiences to enhance people's awareness on climate change impacts, 2) to develop human resources and conduct studies to develop and consolidate scientific foundation for providing solutions for climate mitigation and adaptation, 3) to develop policy system, integrating climate change in sectoral development program, 4) to promote international cooperation in mitigation and adaptation, and 5) to carry out priority activities for implementing mitigation and adaptation.

In connection with above 5 priority projects, there are some concrete program plans such as 1) strengthening of standing office's capacity (office of climate change adaptation chaired by the department of personnel), 2) formulation of national standard and technical criteria, 3) conduct of research and planning programs for climate change adaptation and mitigation, 4) tree planting program for wave protection of sea dyke system, 5) upgrading of water resource system, dyke protection system, storm and flood control system, 6) rural infrastructure consolidation program, and 7) establishment of disaster management support organizations. Most of them are now under implementation either by the government or in collaboration with relevant donors.

Taking into account the above 2 plans; National Target Program to Respond to Climate Change (NTP-RCC), and Action Plan Framework of Rural and Agriculture Sector (2008-2020), measures to adapt to and cope with climate change in agriculture sector is highly needed. One of the structural measures is to construct sluice gates and also rehabilitate existing sluice gates in order to prevent saline intrusion from coming into agricultural production areas. Therefore, the proposed programme is highly in line with the above 2 national plans.

CHAPTER 2 THE PROJECT AREA

Chapter 2 discusses the project area; seven coastal provinces of the Mekong delta. Agriculture production in the coastal area is affected by the Mekong River flow as well as by tidal regime. Mekong River originates in the Tibet Plateau and flows in the mountainous regions of Yunnan Province of China, and then it goes through Myanmar, Laos, Thailand, and Cambodia. Then, it finally flows into Vietnam, and out to the East Sea of Vietnam. The project area is located at the most downstream of the river. The area used to have nine estuaries[4] up to about 100 years ago, and it used be called as nine dragons' area (Cuu Long area).

2.1 Location and Salient Feature of the Project Area (Coastal Mekong Delta)

2.1.1 Spatial Settings

The Project area, 7 coastal provinces, is located along the coastal line of the Mekong Delta. The delta lies at the most southern part of Vietnam, bordering on Cambodia at its upstream, or north-western, side. The delta area is located immediately to the south-west of Ho Chi Minh City, roughly forming a triangle stretch from My Tho in the east to Chau Đoc and Ha Tien in the northwest, down to Ca Mau and the East Sea at the southernmost tip of Vietnam, and including the island of Phu Quoc about 70 km westwards away from the northern tip of Kien Giang province. The land stretches from 08 degree 20 minutes to 11 degree 00 minutes (237 km) in north latitude and from 103 degree 50 minutes to 106 degree 45 minutes (290 km[5]) in its east longitude.

The Mekong Delta is a flood plain and thus presents generally very flat topography. It is classified as flat area with the majority having an average elevation only from 0.7 to 1.2 m except for some hills in the north-western delta province of An Giang. Along the border with Cambodia, the terrain varies from 2.0 to 4.0 m, and then gradually lowers into the central plains with an elevation from 1.0 to 1.5 m, and then only 0.3 to 0.7 m in the coastal areas. Given this very low altitude especially near the coastal area, sea water tends to intrude during low water season, say, from January to May.

2.1.2 Area and Demography

The Project area covers 7 coastal provinces among the total 12 provinces of the Mekong Delta. Table 2.1.1 summarizes the area and demography by province in the Mekong Delta and also by regions in Vietnam. As indicated, provincial population in the Project area varies from 867,800 being the minimum in Bac Lieu to about 1.7 million being the maximum in Kien Giang while the area from 2,295 km^2 to as much as 6,346 km^2. Total population of the Project area arrives at 9.02 million, sharing about 52% of the whole Mekong Delta population, while the total area comes to 24,631km^2 equivalent to about 61% of the total Mekong Delta area. Population density is 366 persons/km^2, which is relatively high, for example, as compared with the national average of 263 persons per km^2.

As for the population growth ratio, it is not high ranging from only 0.05% in Ben Tre province to 1.28 % in Bac Lieu province with an average of 0.51% for the whole Project area. The population growth ratio of whole Mekong Delta arrives at 0.42% close to that of the Project area. Nationwide population growth ratio comes to a higher one, i.e. 1.05%. As compared to other areas, population growth ratio of the Mekong Delta is obviously low. The relatively low population growth ratios of the Project area as well as for the Mekong Delta may be attributed to high out-migration trend as indicated

[4] There are two major branched of Mekong river in Vietnam; one is Tien River (Mekong River) with six branches and their estuaries are Cuu Tieu, Cua Dai, Ba Lai, Ham Luong, Co Chien and Cung Hau. The other one is Hau River (Bassac River) with three branches and their estuaries are Dinh An, Tran De, and Bat Tha but Bat Tha has been filled up about 100 years ago (Source: SIWRP).

[5] Excluding Phu Quoc island, the mainland delta extends over an distance of about 230km from west-east direction.

in the most right column of Table 2.1.1.

Table 2.1.1 Land and Demography of the Project Area as compared with Other Areas

Province/ Region	Rural Districts	Population (2010)	Area, km2	Pop. Density, P/km2	Pop. Growth Rate, %	Net-migration
Tien Giang	8	1,677,000	2,484	675	0.25	-0.2
Ben Tre	8	1,256,700	2,360	532	0.05	-12.9
Tra Vinh	7	1,005,900	2,295	438	0.27	-4.1
Soc Trang	10	1,300,800	3,312	393	0.59	-10.0
Bac Lieu	6	867,800	2,502	347	1.28	-10.6
Ca Mau	8	1,212,100	5,332	227	0.41	-27.3
Kien Giang	13	1,703,500	6,346	268	0.89	-8.7
Total/Average: the Project Area	60	9,023,800	24,631	366	0.51	-10.1
An Giang	8	2,149,500	3,537	608	0.09	-8.3
Can Tho	4	1,197,100	1,402	854	0.71	-1.7
Hau Giang	5	758,600	1,601	474	0.09	-6.9
Vinh Long	7	1,026,500	1,479	694	0.14	-13.4
Dong Thap	9	1,670,500	3,375	495	0.23	-6.7
Long An	13	1,446,200	4,494	322	0.69	-3.5
Total/Average: Mekong Delta	106	17,272,200	40,519	426	0.42	-8.4
Red River Delta	95	19,770,000	21,063	939	0.77	0.5
N. Midlands & Mountain	119	11,169,300	95,339	117	0.87	-3.9
N. Central & Central Coastal	140	18,935,500	95,885	197	0.42	-5.7
Central Highlands	52	5,214,200	54,641	95	1.66	-0.3
South East (including HCM)	41	17,272,200	40,519	426	2.95	19.9
Whole Country	553	86,927,700	331,051	263	1.05	-

Source: Statistical Year Book of Vietnam 2010 (General Statistics Office of Vietnam)

2.1.3 Meteorology

1) Temperature

Air temperature in Mekong Delta shows relatively high value as compared to other parts of Vietnam and its annual average over Mekong Delta is about 27°C (see Figure 2.2.1); annual accumulation of daily average air temperature is stable over years and it counts at about 9,800°C. Generally, mean annual air temperature in the eastern area is a little lower than that of the coastal and southwest areas (except Vung Tau) by about 0.4 °C or more. The highest mean annual air temperature shows up in Rach Gia with 27.6°C while the lowest is 26.7°C in Ca Mau within the Mekong Delta (refer to the Figure 2.1.1).

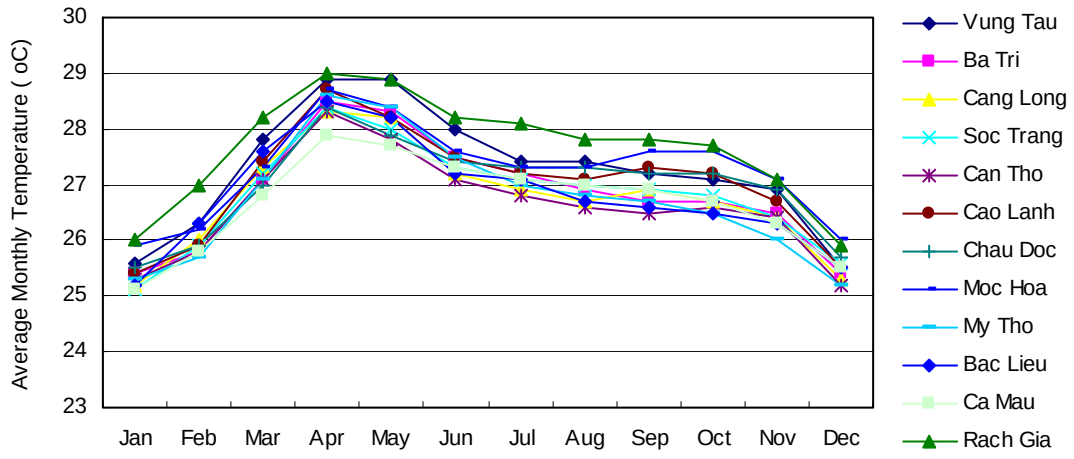


Figure 2.1.1 Average Monthly Air Temperature at Major Locations in Mekong Delta

Source: Southern Institute for Water Resources
Note; Record periods are different by station; mostly 1978 – 2010

The highest monthly average air temperature ranges between 28°C and 29°C; and April, just prior to the onset of rainy season, is the hottest month and December shows the coldest air temperature in a year. It is only about 3.0°C difference between the highest and the lowest averages of monthly air temperature at the same place shown in the above figure. The maximum monthly air temperature sometimes rises to 31°C - 38°C, and then, the minimum average monthly air temperature descends to as low as 22°C - 26°C. Average daily air temperature usually fluctuates in a range between 6°C and 10°C by station.

2) Rainfall

In the Mekong Delta, rainfall stations are distributed quite evenly through the region. Meteorological data are available mostly after 1978, 3 years after the end of the war when the IMHEN started systematic data collection. The maximum annual rainfall is recorded at Phu Quoc Island, located about 80km westward from the northern tip of Kien Giang province, with 3,067 mm while that of mainland shows lower values, for example, 2,366 mm in Ca Mau. Northeast and internal areas have less annual rainfall; it is around 1,350 mm (such as 1,349 mm at My Tho, 1,360 mm at Chau Doc, 1,356 mm at Cao Lanh and 1,544 mm at Can Tho) as shown in the Figure 2.1.2.

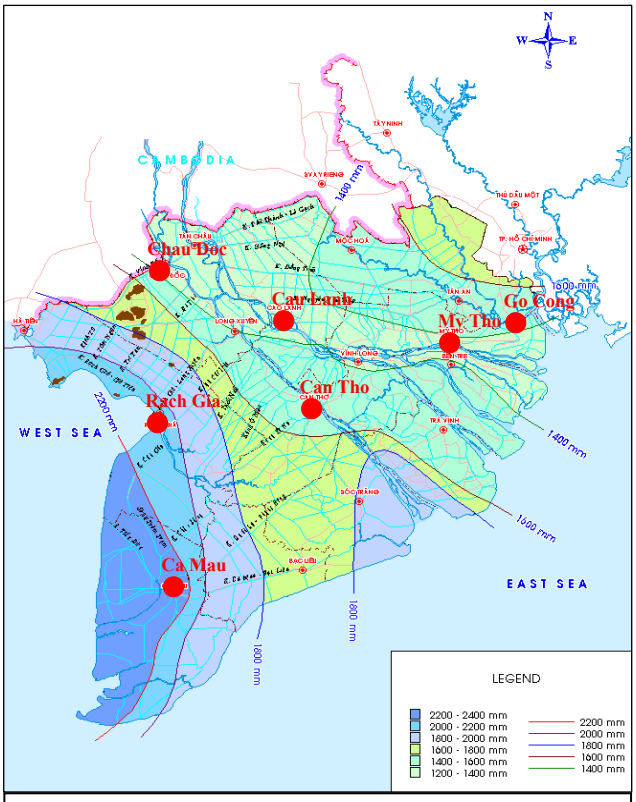


Figure 2.1.2 Annual Average Rainfall Counters
Source: SIWRP

Figure 2.1.3 shows the mean monthly rainfall for the major 18 stations in the Mekong Delta. As is shown, the mean monthly rainfall starts rising from May and keeps increasing, and then it peaks in October. After October, it starts descending quickly, and the minimum mean monthly rainfall shows up in February. From this monthly rainfall distribution, it can be observed that about 90 % of the total annual rainfall is in the rainy season; and thereby the rain in the dry season shares only about 10%.

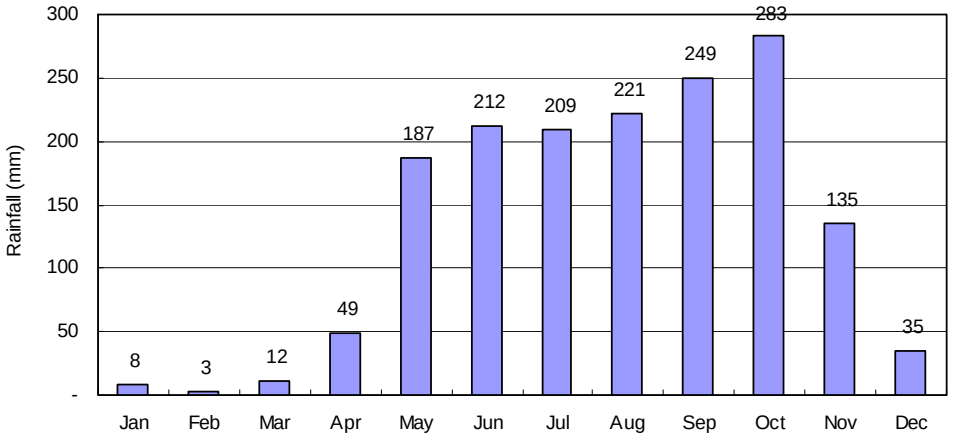


Figure 2.1.3 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month
Source: Southern Institute for Water Resources Planning

2.1.4 Hydrology

1) Runoff

Water resource in the Mekong Delta is of course the Mekong River, which is also a key regional resource in Southeast Asia for not only agriculture sector but also fisheries and power generation sectors. The River is the world's 8th largest in discharge, annual discharge of 400 billion cubic meter, 12th largest in length (4,350 km), and 21st largest in drainage area (795,000 km^2). Note that the 400 billion cum was estimated as the annual mean discharge based on the average daily discharges recorded at Kratie station established in Cambodia from 1985 to 2010, and other data were derived from 'Flood and Salinity Management in the Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Fiona Miller and Bach Tan Sinh'.

The Mekong meets Tonle Sap River at a point of west of Phnom Penh, and then is divided into the Tien and Hau Rivers. The River discharge at Tan Chau station on the Tien River is 3-5 times larger than that of Chau Doc station on the Hau River. The Vam Nao, which connects both rivers 20 km downstream of Tan Chau and Chau Doc stations, conveys water from the Tien River to the Hau River, augmenting the flow of Hau River downstream from this point.

Figure 2.1.4 Map of the Lower Reaches of Lower Mekong River Basin (After Kratie Station)

The Tien River branches into six tributaries and the Hau River into three tributaries and together they form what is called in the Vietnamese language the "Nine Dragons" (Cuu Long). With these 9 estuaries and also a dense canal network, the Mekong Delta shows very much complicated hydraulic network. The development of the dense canal network started about 300 years ago, and through the French colonial era to date, extensive canal network with some control gates have been established.

Flood season starts from July and ends in December, and during this period the areas from the Tonle Sap River in Cambodia to the East Sea of Vietnam are covered with water. A large part of the Delta, especially upstream and midstream parts of the Delta, is very much inundated from both the overflow from the Mekong River and rainfall while downstream of the delta is less affected by floods. Due to the effect of the tropical monsoon, flood flows are about 25-30 times greater than those of dry season which takes place between March and April.

The flooded area ranges from 1.2 to 1.4 million ha in years of low and medium flooding, and goes up to around 1.9 million ha in years of high flooding[6]. It is reported by MARD that about 50 % of the Mekong Delta experiences flooding and these areas are also susceptible to serious damages by floods about every 5 years. The floods are associated with prolonged deep inundation, causing river bank

[6] Flood and Salinity Management in ht Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Filna Miller, and Bach Tan Sinh.

erosion and transportation difficulties, which altogether disrupt economic activities to a greater extent.

On the other hand, during dry season sea water intrusion takes place and saline water comes to upstream from all the estuaries of the Mekong tributaries. During the dry season, the flow discharges in the Mekong River are at their lowest, especially in March and April, and the saline water intrudes into the lower to as far as mid parts of the Mekong Delta. All the coastal provinces are thus susceptible to saline intrusion during dry season. It is reported by MARD that approximately 1 million ha of agricultural lands are affected by tidal flooding and 1.7 million ha (about 45% of the delta area) by salinity intrusion[7].

2) Discharge and Water Level

Mekong River Commission (MRC) has been monitoring water level of the Mekong River at different places and converting them into discharge. Among the monitoring stations, Kratie is located about 300 km upstream from the border with Cambodia. Though this Kratie is located deep in Cambodian territory, it hydrologically represents the starting point of lower parts of the Lower Mekong Basin, from which flood and inundation takes place. It means that simulation models undertaking Mekong Delta's flood inundation as well as saline intrusion should start from this point of Kratie. With this fact, discharge data at Kratie has often been referred to in many literatures.

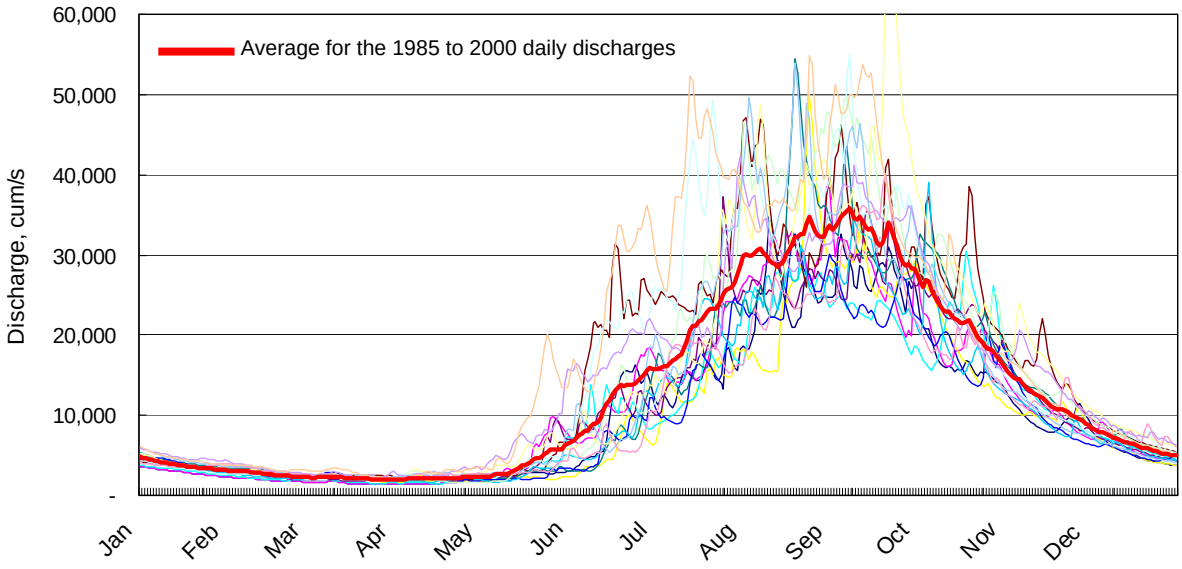


Figure 2.1.5 Daily Discharge Data Recorded at Kratie Station from 1985 to 2000
Source: Mekong River Commission
Note; Thick line shows the average of the discharge from 1985 to 2000

Figure 2.1.5 shown above is the long term daily discharge data from 1985 to 2000 at the Kratie station with the thick line being the average. As is shown, flood season starts from June, or sometimes from late May, and ends in December. During the peak flood season, the daily discharge goes over 30,000 cum/s, and in some years it reaches 40,000 cum/s and sometimes even over 50,000 cum/s. As for the average discharge during the flood season, it starts going over 30,000 cum/s from around mid August and stays there, being more than 30,000 cum/s, till late September. The average discharge peaks at around 35,000 cum/s in early September.

On the other hand, dry season's discharge remains very low. At the beginning of January, the daily discharge marks around 5,000 cum/s and continuously decreases towards the end of dry season. The

[7] Flood and Salinity Management in ht Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Filna Miller, and Bach Tan Sinh.

average daily discharge goes down to less than 3,000 cum/s in February, and further down to less than 2,000 cum/s from late March to early April. After that, the reverse starts in as early as April, but the discharge in April still stays just over 2,000 cum/s. In May, the average daily discharge is now increasing quickly, starting from about 2,300 cum/s at the beginning of May and goes to 6,500 cum/s at the end of the month.

There are two gauging stations in the upper most reaches of Mekong River near the border with Cambodia; Tan Chau on Tien River and Chau Doc on Hau River. These gauging stations monitor water levels at every hour interval, and can estimate daily discharges based on rating (Q-H) curves established for the river sections with the daily averaged water level. However, the estimation of discharges during the dry season is greatly influenced by back-water effect; namely, whether the measurements are taken during a rising or falling stage on the hydrograph. Thus, quality of the discharge data during the dry season may not be as accurate as those estimated at an upstream station, like the one at Kratie station.

With this in mind, Figure 2.1.6 shows the discharges for the both stations for years from 2000 – 2008 except for 2007. The discharges are very different between the 2 stations: much more flow in Tan Chau station than Chau Doc station. While the flood season's discharge at Tan Chau station goes over 20,000 cum/s, the discharge at Chau Doc station remains at around 7,000 cum/s. Totaling the both discharges, the average peak discharge during flood season arrives at about 28,000 cum/s. This discharge is lower than that of Kratie (about 35,000 cum/s), and this is because of the existence of the Great Lake in Cambodia. During flood seasons, a great deal of river water reverses to the Great Lake via Tonle Sap River.

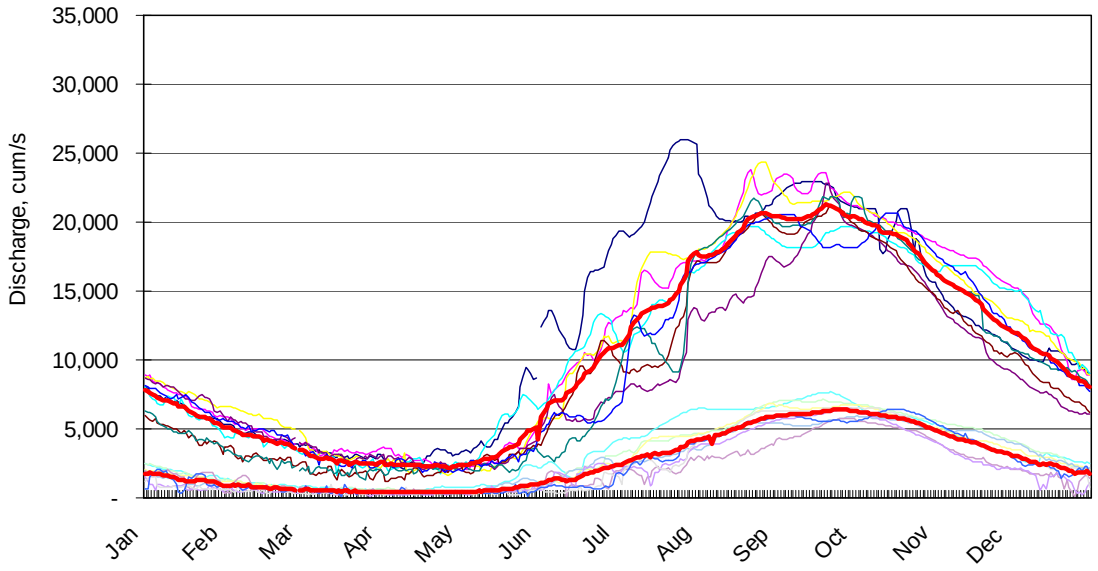


Figure 2.1.6 Daily Discharge at Tan Chau Chau Doc Stations

Source: Mekong River Commission;
Note; Lower group lines are for Chau Doc station, upper group lines are for Tan Chau station,and the bold lines sholw respective average discharge.

Instead, the Great Lake discharges the stored water back into the Mekong River during dry season. This discharge from the Great Lake augments the dry season flow at Tan Chau and Chau Doc stations. The total discharge of the 2 rivers at the beginning of January is about 10,000 cum/s while that of Kratie station is only about 5,000 cum/s, about half of it. During the driest season, April and May, the total discharge of the 2 rivers stays at around 3,000 cum/s, while that of Kratie station drops to about 2,000 cum/s (about two-third). It means that the Great Lake works in mitigating the flood magnitude in Mekong Delta during flood seasons while augmenting the freshwater during the dry seasons.

2.1.5 Irrigation and Drainage Network

Irrigation and drainage networks in the Mekong Delta originate in waterway and its total length arrives at approximately 4,785 km. The waterway network connects major cities each other, e.g., Phnom Penh, Kampong Cham[8], Ho Chi Minh City, My Tho[9], Vinh Long, Cao Lanh[10], Can Tho and Long Xuyen[11] and East Sea, and then, it plays a vital role in the economy and human life of the area. There are three types of inland navigation in the Mekong Delta: local movement by 10 - 15 ton boats; inter-city movement by 15-600 ton ships; and inter-country movement by 600 - 3,000 ton barges or barge convoys, normally comprising one tugboat and three barges of 250 to 300 tons each (source: UN 2001)[12]. These waterways can act as irrigation and drainage network at the same time.

1) Canal Networks

Waterway network in Mekong Delta had been developed for navigation purpose at the beginning period in Nguyen dynasty as aforementioned, and then drainage function and irrigation function were added from those days in French colonial time. In nowadays time, canals provide multifunctional services and are classified into several levels as follows;

Table 2.1.2 Classification of Canals in Vietnam

Canal Type	Main	Level 1	Level 2	Level 3
Bottom Width (m)	15m= <	10m	6 – 8m	2 -3m
Bottom Elevation (MSL m)	- 3m	- 3m	- 1.5m	- 1m

Source: Southern Institute for Water Resources Planning

Classification mentioned above can not always apply to all the canals in Mekong Delta because features of canals differ from one place to the others. Sometimes it is difficult to classify an intermediate type of canal. According to a statistics of SIWRP, total length of canals in Mekong Delta is estimated at over 90,000 km; this length is over twice circles of the Globe. Canal network in each area is summarized by type[13] as follows (for the areas, refer to the following figure);

Table 2.1.3 Canal Networks in Mekong Delta

Canal Type	Whole Mekong		Plain of Reeds		Long Xuyen Quadrangle		Ca Mau Peninsula		Trans Bassac	
	Project	L (Km)	Project	L (Km)	Project	L (Km)	Project	L (Km)	Project	L (Km)
		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)
Area(km^2)		38,143		8,131		4,989		16,922		8,101
Main Canal	133	3,190	45	1,068	20	450	36	633	32	1,039
		0.08		0.13		0.09		0.04		0.13
Canal Level 1	1,015	10,961	343	3,116	44	606	428	5,294	200	1,945
		0.29		0.38		0.12		0.31		0.24
Canal Level 2	6,556	26,894	2,187	6,742	1,100	3,100	3,297	13,689	1,072	3,363
		0.71		0.83		0.62		0.81		0.42
Canal Level 3	35,640	50,019	3,400	7,200	1,213	4,274	7,467	16,692	24,773	21,853
		1.31		0.89		0.86		0.99		2.70
Total	43,344	91,064	5,975	18,126	2,377	8,430	11,228	36,308	26,077	28,200
		2.39		2.23		1.69		2.15		3.48

Source: Southern Institute for Water Resources Planning
Note: Trans Bassac means the area located in between Tien and Hau Rivers.

[8] Phnom Penh is the capital of Cambodia and Kampong Cham is located about 90km north of Phnom Penh.
[9] My Tho is the capital of Tien Giang province.
[10] Cao Lanh is the capital of Dong Thap province.
[11] Long Xuyen is the capital of An Giang province.
[12] "Guidelines for the Harmonization of Navigation Rules and Regulations, Volume 1. Aids to Navigation", UNITED NATIONS, New York, 2001
[13] Usually in statistics, the main canals and level 1 canals are counted as main canals, and level 2 canals and level 3 canals are grouped together into level 2 canals. According to SIWRP, construction of medium and small scale canals is required for the purpose of improving drainage capacity.

Trans Bassac, the area between Tien River and Hau River, is represented with much more waterway density than that of other areas with 3.48 km/km^2, which is mainly composed of Level 3 canals. Vinh Long province is known as confluence area between river flow and tidal water, and thus 2-way water flow, back and forward, in this area has created many natural channels than those of other areas. Level 3 canals in this area are therefore developed from natural canals in many cases and its density, with 2.70 km/km^2, shows rather high value than other areas (0.86 – 0.99 km/km^2).

Figure 2.1.7 Location of the 4 Hydraulic Areas
Source: Southern Institute of Water Resources Planning

On the other hand, Long Xuyen Quadrangle, northern part of An Giang and Kien Giang provinces, shows less density of waterway network. There is a hilly area at the northern area of An Giang province, so that canal network was hardly developed in this hilly area. In addition to this, large scale drainage canals were developed and renovated in recent years in order to drain flood water from Mekong River during rainy season.

Water level change in Mekong Delta differs by place; downstream side water level fluctuates more than that of upstream side influenced by tidal fluctuation. There is difference of mean water level amplitude with two times or more by areas between upper part and downstream part of Mekong Delta. Observed water level amplitudes in April 2008 are shown below, from which one can see about 1 meter fluctuation at the most upstream parts of Mekong Delta, and about 1.5 to 2.0 m at around mid parts of the Delta, and more than 2 m to over 2.5 m at the downstream parts of Mekong Delta;

Table 2.1.4 Observed Mean Water Level Amplitude in April 2008

Tien River	Tan Chau	Cao Lanh	My Thuan	My Tho	Vam Kenh
Amplitude (cm)	100	150	185	218	236
Hau River	Chau Doc	Long Xuyen	Can Tho	Dai Ngai	My Thanh
Amplitude (cm)	115	147	195	265	250

Source: Southern Institute for Water Resources Planning

2.2 Major Economic Activities (Agriculture and Aquaculture)

Mekong delta itself has a name so-called “rice bowl”; rice production is dominantly practiced in flooded areas which are central parts of the delta. In the coastal area, a quite unique land use is invented; paddy-shrimp alternation farming is a quite characteristic farming system that paddy is cultivated during rainy season and shrimp is grown in dry season according to salt content level in water in the surrounding canal networks. In addition, fruit farming in Mekong delta is popular and famous that some of provinces are well-known. It can be said that coastal area of Mekong delta shows unique and diversified farming systems.

2.2.1 Agriculture

There used to be single paddy crop area over such flooded area of the Mekong delta but it has turned to double or triple paddy cropping area after introduction of new varieties of paddy, mainly short maturity variety. Coastal areas are affected by sea water intrusion whereby paddy cultivation is limited mostly during rainy season only. However, there is another type of farming in this coastal area. An

example is a combination of paddy production (in rainy season) and aquaculture especially shrimp (in dry season), which is seen in many place of the Program area; this combination practice can be carried out in a same farm plot.

1) Land Use

Referring to the statistical data for Rural, Agricultural and Fishery Census (2006), difference of land use types in each province is clarified. A ratio of agricultural land use in the project area as well as Mekong Delta is much higher than other areas of the Country. While 55% and 63% of the area is used for agricultural purposes in the project area and Mekong Delta respectively, only 29% is used in the whole Country, which is far greater than any other regions including the Red River Delta (36%).

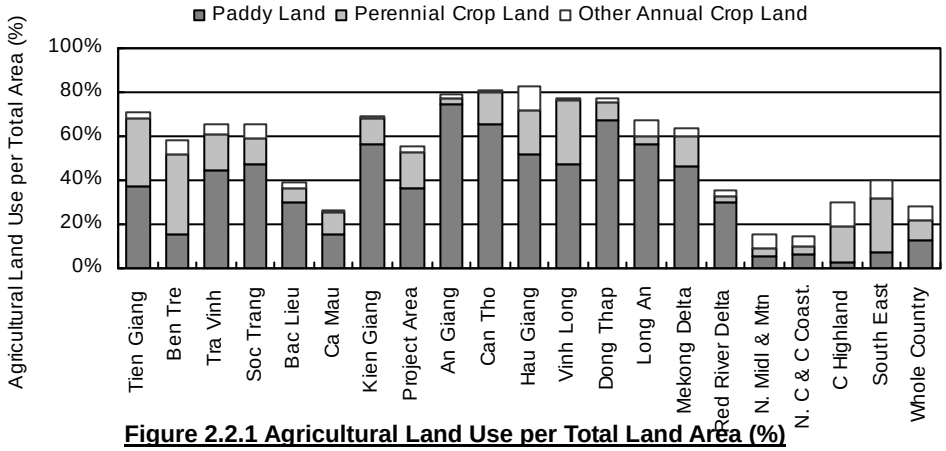


Figure 2.2.1 Agricultural Land Use per Total Land Area (%)

Source: Rural, Agricultural and Fishery Census, Data in 2006

Among the provinces in the project area and also in the Mekong Delta, there are also some variations. At glance is that the share of agriculture land in the project area is relatively smaller than those of Mekong Delta's other provinces which are mostly located in upper reach of the River. This is because of the availability of fresh water essential for agriculture more in the upper provinces of Mekong River. The share of the agricultural land use in most of the provinces ranges around 50% to 80%, while Bac Lieu and Ca Mau, coastal 2 provinces, resulted in only 39% and 27%. It probably reflects the large aqua-cultural area for those two provinces.

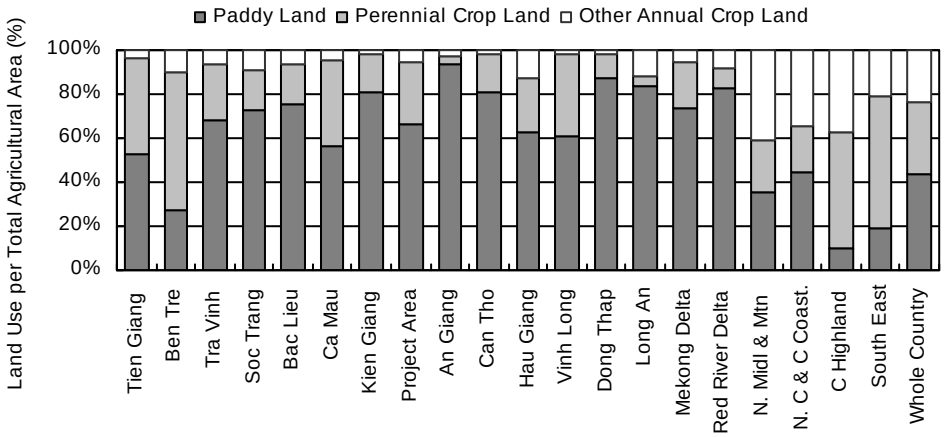


Figure 2.2.2 Agricultural Land Use per Total Agricultural Area (%)

Source: Rural, Agricultural and Fishery Census, Data in 2006

Looking at the percentage of land uses in paddy, perennial crops and other annual crops per agricultural land of each province, there are also some geographical differences. Figure 2.2.2 shows percentages of paddy in the Program area (66%) and in the whole Mekong Delta (75%) are fist of all higher than that of whole Country (44%), which is after that of the Red River Delta (83%). Among the provinces of the project area, Kien Giang (83%) was the highest in the paddy land, which was

followed by Bac Lieu (75%) and Soc Trang (73%). On the other hand, paddy area of Ben Tre (27%) was quite limited followed by Tien Giang (53%), suggesting that the most of agricultural areas in Ben Tre province, also followed by Tien Giang province, are now planted with perennial cops i.e. fruits.

2) Cropping Calendar

Paddy cropping in the Mekong delta has four major seasons: winter-spring, summer-autumn, autumn-winter and spring-summer. Among the four cropping seasons, summer-autumn paddy (May-Aug) and winter-spring paddy (Dec-Feb) constitute the major part of paddy production in the Program area. A typical cropping in the coastal areas is the combination between paddy cultivation and brackish shrimp culture. In addition, such combination has some diverse conditions; irrigation water, fresh water and schedule of other crops or commodities (e.g. brackish shrimp, fresh water shrimp, freshwater fish).

Two cropping of winter-spring (dry season) paddy and summer-autumn (rainy season) paddy can be organized only where irrigation water is available for the dry season. In some cases, three cropping of paddy can be also possible in such areas of northern part of Soc Trang province near Hau River and upper part of Tra Vinh province. In rain-fed areas where irrigation water is barely available, paddy is planted only during the rainy season.

Table 2.2.1 Major Cropping Calendar in Project Area

Land Use Type	Month												Remarks
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Irrigated land use													
2 paddy crops (WS-SA)	WS					SA					WS		Shallow flooded areas
2 paddy crops (WS-SA) + Fish						Fish							Shallow flooded areas
3 paddy crops (WS-SA-AW)	WS					SA		AW			WS		Shallow flooded areas
Perennial crops (e.g. fruits)	Planting												Shallow flooded areas
Rainfed land use													
1 paddy crop							SA						Saline intrusion areas
1 paddy crop + fish							Fish						Saline intrusion areas
2 rainfed paddy crops (SA-AW)						SA		AW					Saline intrusion areas
1 paddy crop (SA) - Shrimp	Shrimp						SA					Shrimp	Saline intrusion areas
Shrimp culture (1 or 2 crops)		Shrimp 1st						Shrimp 2nd					Saline intrusion areas

WS: Winter - Spring paddy; SA: Summer-Autumn paddy; AW: Autumn - Winter paddy
Source: Southern Institute of Agricultural Planning and Investment (2011)

Salinity is usually seen as a harmful feature to paddy production and it is often prevented by dikes and sluice gates. Yet, some farmers have chosen the way to adapt to this kind of extreme environment rather than coping against it by introducing brackish shrimp culture during dry season. Though shrimp culture entails high risk of diseases when the culture continues intensively without consideration on environment, it can fetch better income than paddy cultivation in most cases. As a result, those farmers who introduced brackish shrimp culture can maximize its profitability.

3) Paddy Production

The major agriculture production in the Program area and the Mekong Delta is paddy. The paddy production has been on an increasing trend and in 2010 the total production reached 9,618,000 tons for the Program area and 21,570,000 tons for the Mekong delta total. In the same year 2010, the paddy

production of the whole County was 39,989,000 tons. It means the Program area produced 24% of the country's production and that of Mekong Delta shared as much as 54%.

Looking at the provincial production of 2010, Kien Giang produced by far paddy in the Program area, which is in fact 2nd largest production in the Mekong Delta after An Giang. The 3rd biggest production was made in Dong Thap province. Kien Giang, An Giang and Dong Thap provinces are located in the most upper reach of the Mekong River within Vietnam. On the other hand, coastal provinces have relatively less production. For example, Ben Tre shows the least production by 368,000 tons, followed by Ca Mau (504,000 tons) and then Bac Lieu (849,000 tons), which are all in line with the land use pattern.

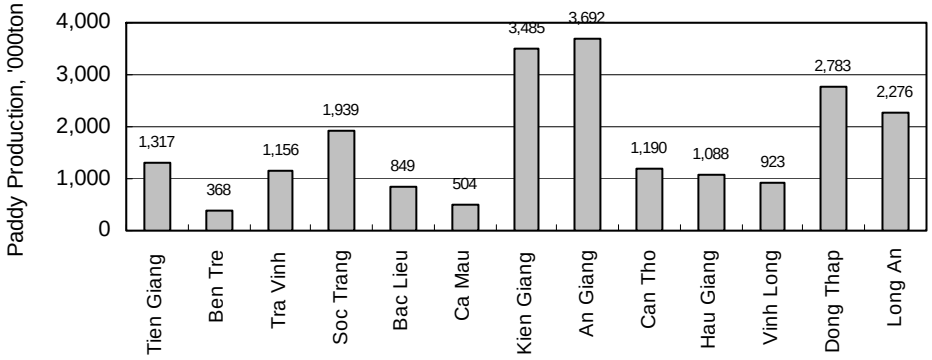


Figure 2.2.3 Paddy Production by Province in the Mekong Delta

Source: Rural, Statistical Year Book 2010, GSO

2.2.2 Aquaculture

Overall coastal areas of the Delta are characterized as brackish shrimp (Penaeus monodon) cultivation area under the condition that saline water intrusion takes place. Table 2.2.2 summarizes the aquaculture production in the Mekong Delta as compared with other parts of the Country. As is well illustrated, the aquaculture production of the Mekong Delta by far surpasses the production of other regions. In fact, the overall aquaculture production by Mekong Delta (1,940,181 tons) shares as much as 72% of the national production (2,706,752 tons).

Table 2.2.2 Aquaculture Production (2010) in the Mekong Delta as Compared with Other Regions

Province/ Region	Aquaculture Production, ton	Per-capita Aquaculture Production, kg	Aquaculture Production of Fish, ton	Per-capita Aquaculture Production of Fish, kg	Aquaculture Production of Shrimp, ton	Per-capita Aquaculture Production of Shrimp,kg
Tien Giang	120,188	72	87,925	52	12,833	7.7
Ben Tre	168,148	134	122,150	97	30,485	24.3
Tra Vinh	82,777	82	53,824	54	20,944	20.8
Soc Trang	98,493	76	37,490	29	60,830	46.8
Bac Lieu	143,725	166	65,370	75	68,003	78.4
Ca Mau	235,550	194	117,216	97	103,900	85.7
Kien Giang	97,673	57	46,637	27	34,765	20.4
Program Area	946,554	105	530,612	59	331,760	36.8
An Giang	279,773	130	276,941	129	916	0.4
Can Tho	172,360	144	172,331	144	22	0.0
Hau Giang	44,430	59	43,482	57	15	0.0
Vinh Long	135,181	132	135,089	132	16	0.0
Dong Thap	331,373	198	327,757	196	1,727	1.0
Long An	30,510	21	23,751	16	6,661	4.6
Mekong Delta	1,940,181	112	1,509,963	87	341,117	19.7
Red River Delta	406,280	21	309,573	16	16,422	0.8
N. Midlands & Mountain	67,909	6	65,673	6	367	0.0
N. Central & Central Coastal	177,397	9	86,725	5	71,292	3.8
Central Highlands	20,603	4	20,252	4	68	0.0
South East	94,382	5	67,379	4	21,030	1.2
Whole Country	2,706,752	31	2,058,465	24	450,364	5.2

Source: Statistical Year Book of Vietnam (2011)

With regards to the aquaculture production of fish, the intensive production areas can be seen in the upper-mid parts of Mekong Delta, and yet the project area still produces total 530,612 tons of aquaculture fish. Per-capita production of aquaculture fish in the project area is estimated at 59 kg, which is far bigger than the national per-capita production of 24 kg only. Note that the population employed in estimating the per-capita production is the total number of people in the respective provinces or regions (not the population engaged in the aquaculture).

As is well known, the shrimp production in the project area by far exceeds those of other regions including mid-upper parts of Mekong Delta. The total production of aquaculture shrimp in 2010 was 331,760 tons while that of national level was 450,364 tons. It means the project area produced as much as 76%, three-quarters of the national production. Per-capita production of the aquaculture shrimp arrives at 36.8 kg while those of other provinces and regions remain less than 5 kg per capita only.

2.2.3 Shrimp Culture by Category

In the coastal area of Mekong Delta, a lot number of shrimp culture firms can be seen. Shrimp culture had started in the early 1970's in brackish water area. Shrimp culture in Vietnam is divided into two major categories: intensive and extensive, and those may further be divided into four: intensive, semi-intensive, semi-extensive and extensive, although they have some variations. In the coastal Mekong Delta, intensive shrimp culture shares only 10% in terms of the area cultivated as indicated in Figure 2.2.4; remaining one are all for extensive systems according to Research Institute for Aquaculture No.2[14].

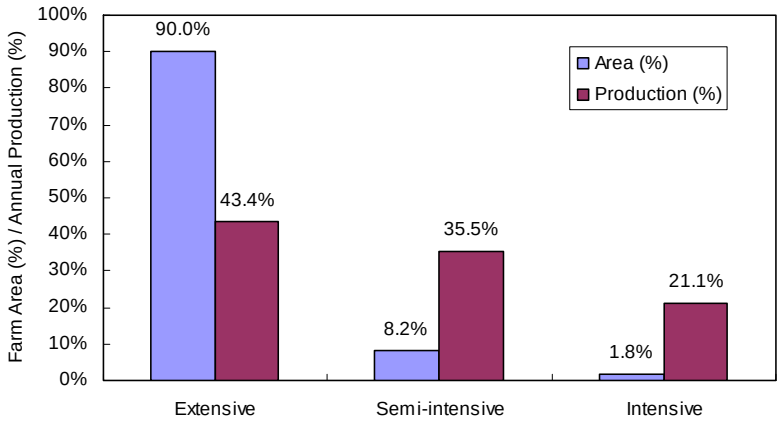


Figure 2.2.4 Shares in Area Cultivated and Production of Shrimp by Category

Source: The Status, Challenge and Perspective of Black Tiger Shrimp (Penaeus monodon) Farming in the Mekong Delta, Vietnam, Research Institute for Aquaculture No.2, MARD, 2008

As shown above, while the extensive system shares 90% of the total cultivated area in the Mekong Delta, it shares only 43% in terms of the production. On contrast, the semi-intensive system, which shares only 8.2% of the area, produces 35.5% of the production. Similarly, while the intensive system shares only 1.8% of the area, it produces 21.1% of the total production, that is, "intensive" systems produce nearly half of the production with only 10% of the land.

Extensive system has less impact to environment, although it on the other hand results in quite low productivity. According to records by Research Institute for Aquaculture No.2[15], annual yield of the shrimp production under the extensive system is estimated at around 200-300kg/ha. On the other hand, production of the semi-intensive system reaches 1.5-3.0 ton/ha and the intensive system comes to as high as 5.0-7.0 ton/ha and even more.

[14] The Status, Challenge and Perspective of Black Tiger Shrimp (Penaeus monodon) Farming in the Mekong Delta, Vietnam, Research Institute for Aquaculture No.2, MARD, 2008

[15] The Status, Challenge and Perspective of Black Tiger Shrimp (Penaeus monodon) Farming in the Mekong Delta, Vietnam, Research Institute for Aquaculture No.2, MARD, 2008

2.3 Climate Change Impact on the Coastal Mekong Delta Area

This sub-chapter discusses past trend of climate, future climate change based on simulation results by PRECIS[16] model (a high resolution regional climate change simulation model), flood and saline intrusion simulation, and then carries out vulnerability assessment under climate change.

2.3.1 Temperature and Rainfall Change

1) Past Trend in Temperature

Long term climate data were collected at such 4 stations as Vung Tau, Can Tho, Ca Mau, and Rach Gia over a period from 1978 to 2008 or 2009 (refer to Figure 2.3.1 for the stations). Figures 2.3.2 shows long term trend of annual mean air temperature at the 4 stations of Vung Tau, Can Tho, Ca Mau, and Rach Gia.

Figure 2.3.1 Location of the 4 Meteorological Stations

Annual mean temperature ranges approximately from 26.5 °C to 27.5 °C by station and sometimes goes up over to 28.0 °C. Annual mean maximum temperature shows bigger range of fluctuation by station and so does the annual mean minimum temperature. In general, the annual mean maximum temperature ranges from 31 °C to nearly about 34 °C while the annual mean minimum temperature does 22 °C to over 24 °C.

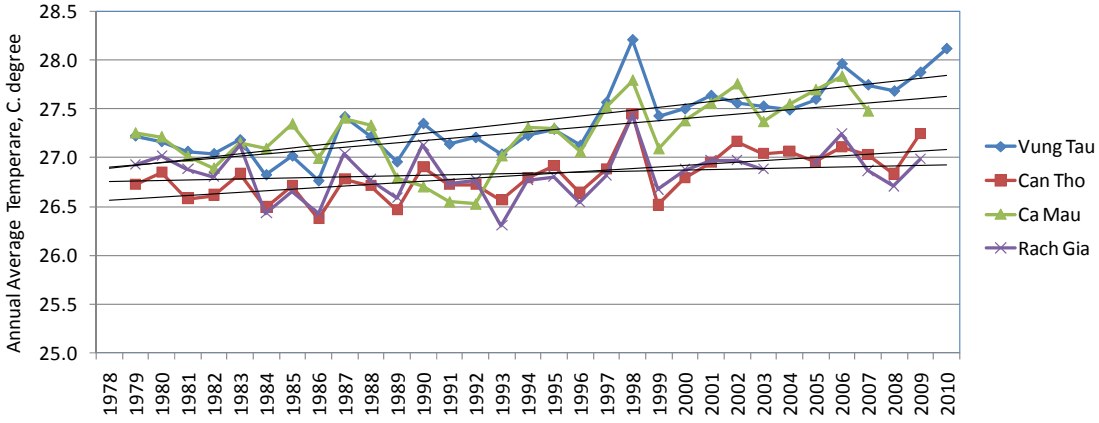


Figure 2.3.2 Annual Mean Temperature at 4 Major Locations in Mekong Delta

Source: Southern Institute for Water Resources, Sub-Institute of Hydrometeorology and Environment

One obvious observation from the long term trend is the increase in the temperatures for all the 4 stations. Though these annual mean temperatures fluctuate by year, we can see an increase trend over years for all the 4 station. The rate of increase can be said about 0.7 °C, about 1.0 °C, and about 1.0 °C for annual mean over the period of about 30 years. This increase trend could be corresponding to global warming.

2) Future Prediction of Temperature

Figure 2.3.3 shows isolines of mean annual temperature rise at year 2050 under climate change

[16] PRECIS stands for 'Providing Regional Climates for Impacts Studies', which is a regional climate model system whose resolution is 25-30 x 25-30 km, much higher resolution than GCM.

Scenario B2 in terms of percentage against the average annual mean temperature of 1980 – 1999. The mean annual temperature in future would rise by having two poles; one in Ca Mau and the other in Ho Chi Minh area. The least temperature rise area lies in north-western area of Mekong Delta including Kien Giang Province.

Figure 2.3.4 shows change of mean annual temperature for overall average of Mekong Delta simulated under three scenarios of B1, B2, and A2. The temperature rise was estimated in percentage against the average temperature of the period from 1980 to 1999. The mean temperature increases continuously though the increase for scenario B1 seems to curve down toward year 2100. The mean annual temperature is expected to rise by about 1 ^{o}C in year 2050 for the 3 scenarios and by 1.4 ^{o}C to as much as 2.7 ^{o}C in year 2100 depending on the scenario.

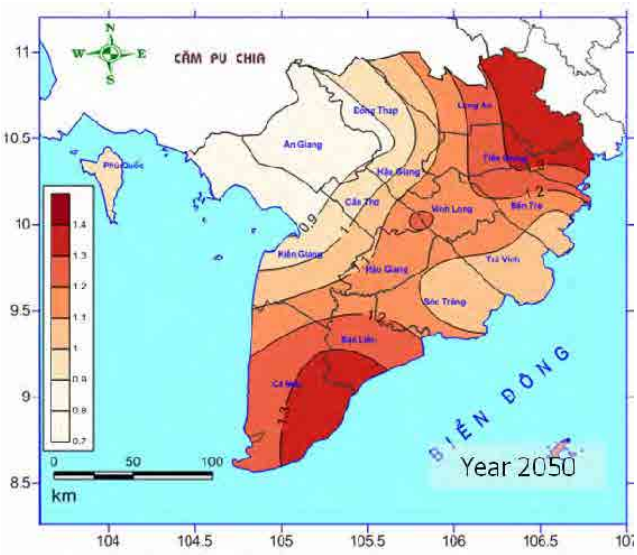


Figure 2.3.3 Mean Annul Temperature Rise at Year 2050 in Percentage under Scenario B2

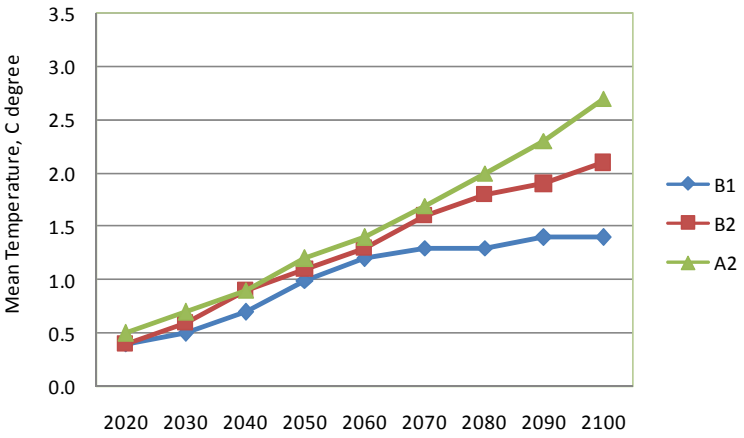


Figure 2.3.4 Mean Annul Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS simulation

3) Past Trend in Rainfall

Following figure shows long term trend of annual rainfall for the 5 meteorological stations of Can Tho, Ca Mau, Rach Gia, My Tho, and Vung Tau. The figure reveals that the annual rainfalls for the 3 stations of Ca Mau, Rach Gia, and My Tho have been increasing while the rest of the 2 stations show a reverse trend, though there are fluctuations by year.

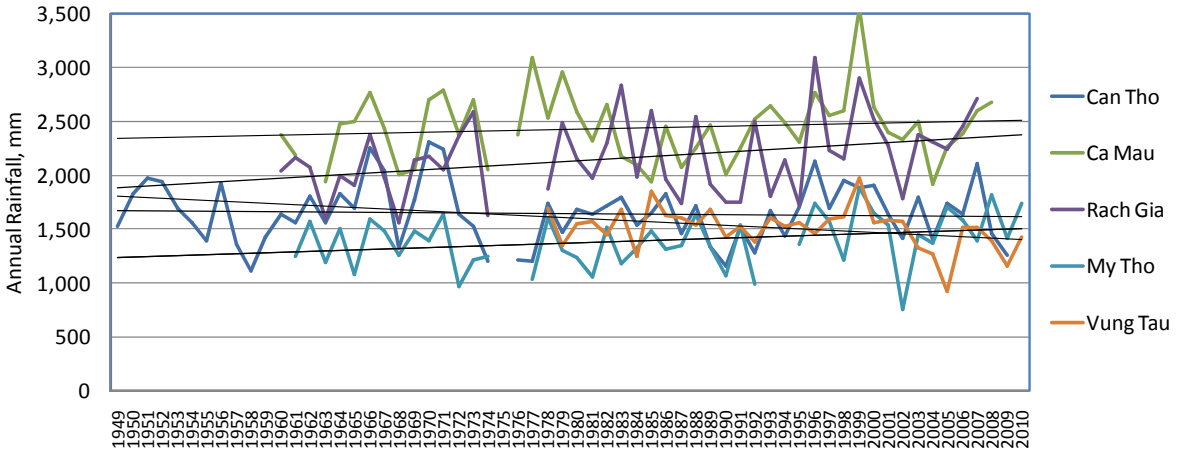


Figure 2.3.5 Long Term Trend of Annual Rainfall for 5 Stations in Mekong Delta

Source; Sub-institute of Hydrometeorology and Environment, SIWRP

4) Future Prediction of Rainfall

Figure 2.3.6 shows simulated annual rainfall change in percentage at year 2050 under climate change Scenario B2 against the average annual rainfall between 1980 and 1999. The figure shows overall rainfall increase over the Mekong Delta with a pole at northern part of the delta where Dong Thap province is located. It is found that Ben Tre province to Soc Tran province via Tra Vinh province will have more rainfall in future along the coastal zone, while inner parts of Tien Ginag, Ben Tre and whole of Ca Mau provinces will have less increase of rainfall.

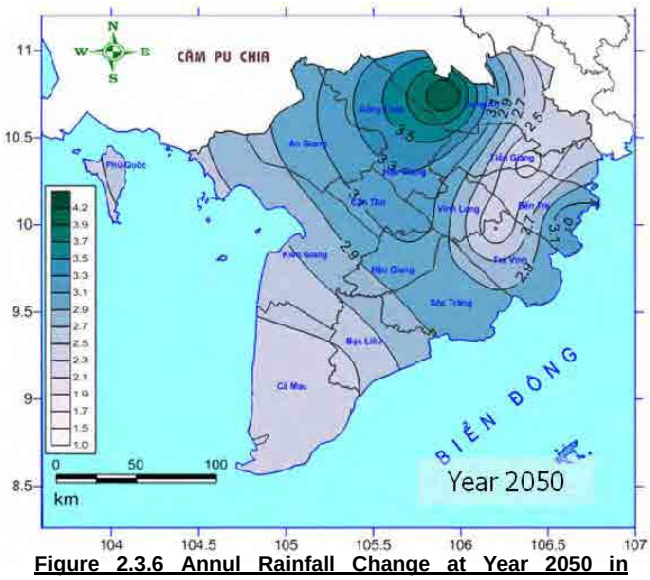


Figure 2.3.6 Annul Rainfall Change at Year 2050 in Percentage under Scenario B2

Figures 2.3.7 show monthly rainfall change for the B2 scenario against the average of between 1980 and 1999. The change of the monthly rainfall fluctuate by month; during dry season the change falls in a negative range meaning the dry season rainfall in future becomes less than the past. In March, rainfall is expected to decrease by 30% at year 2100.

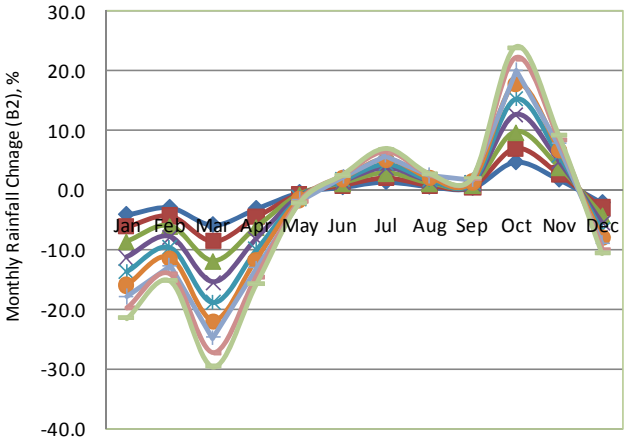


Figure 2.3.7 Monthly Rainfall Change in Mekong Delta under Scenario B2, Source; PRECIS simulation

On the other hand, during rainy season the monthly rainfall is projected to increase in future. The increase during rainy season shows up in July and October. July is still early part of the rainy season while October is almost end of the rainy season where usually the highest amount of monthly rainfall is recorded. In October, monthly rainfall is projected to increase by more than 20% at year 2100. It can be said in future, it is projected that the rainfall tends to increase especially at the end of rainy season.

2.3.2 Saline Water Intrusion associated with Sea Water Level Rise

1) Past Trend in Sea Water Level

There are water level stations in the East Sea at Vung Tau and West Sea at Rach Gia; long term trend of mean annual water levels is summarized in the following figures. The recorded period covers from 1982 to 2011 for the Vung Tau and Rach Gia, say about 30 years. As is shown, the 2 stations show continuous increasing trend, and the sea level rise for Vung Tau and Rach Gia stations arrives at an average of approximately 15 cm over the recorded period of about 30 years. It means that the sea levels for the both East and West Seas has been increasing with an average sea level rise by approximately 5 cm per decade.

In fact, IPCC 4th Assessment Report reported that the average sea level rise from 1993 – 2003 was 3.1 cm + & - 0.7mm by satellite observation, whereby about 4 cm rise at maximum may be suggested, which is corresponding to the 5 cm rise per decade recorded in the above East and West Seas. In other

areas of Vietnam, e.g., Hon Dau (Red River Delta area, north Vietnam) shows about 4 cm rise per decade from 1960 – 2005, and Son Tra (Da Nan, central Vietnam) does 2.1 cm rise per decade.

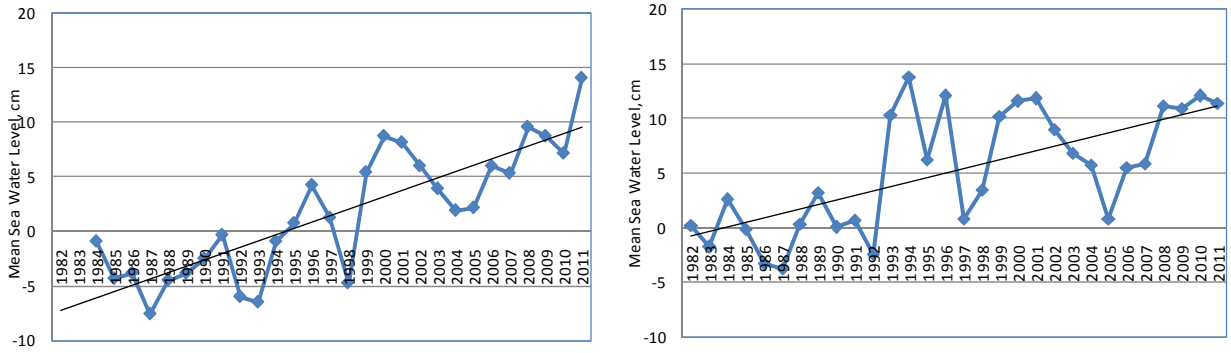


Figure 2.3.8 Past Sea Water Level Trend at Rach Gia (left) in West Sea and at Vung Tau (right) in East Sea

Source; Data obtained from SIWRP graphed by the Project Team

2) Future Prediction of Sea Water Level

Figure 2.3.9 shows the sea level rise of Mekong coastal area by scenario. It is shown that high green gas emission scenario, A2, shows the biggest sea level rise as 31 cm at year 2050 and as much as 103 cm at year 2100. Scenario B1 shows the lowest sea level rise; 27 cm at year 2050 and 70 cm at year 2100. The trend is somewhat exponential for all the scenarios, meaning that increase ratio becomes more towards 2100.

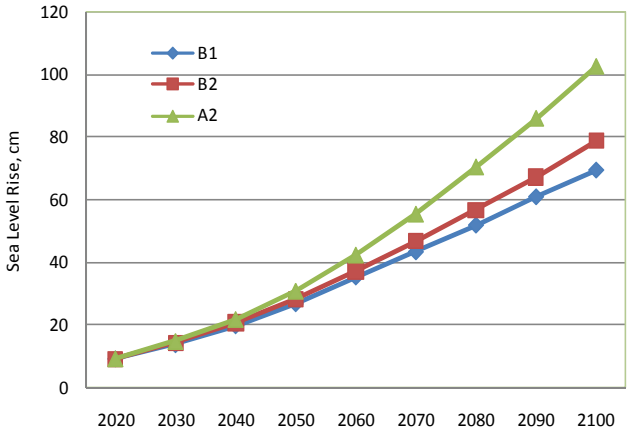


Figure 2.3.9 Sea Level Rise of Mekong Coastal Area under 3 Scenarios, Source; PRECIS simulation

3) Impact on Crop Production by Saline Water Intrusion under CC

Saline intrusion primarily affects crop production, reducing the yield and when the salinity reaches certain level crops can hardly grow. Examination of the impact caused by saline intrusion focuses on paddy being the primary concern, fruit, vegetables and forest (Melaleuca). There are experiments and researches which show relationships between salinity level and the reduction of the yield.

Following table summarizes the relationships to be taken into the assessment of damage loss under saline intrusion. R. S. Ayers and D.W. Westcot (1989) [17] presented tables regarding crop tolerance against saline content in irrigation water and yield loss in percentage for some selected crops including paddy.

Saline tolerance of paddy is summarized in Figure 2.3.10 where total yield loss is estimated to take place at 4.9g/L of saline level in irrigation water. Damage index is thus calculated from the average at each range of saline content level in the Table 2.3.1, namely, yield damage at a range of 2.5 – 4 g/L of

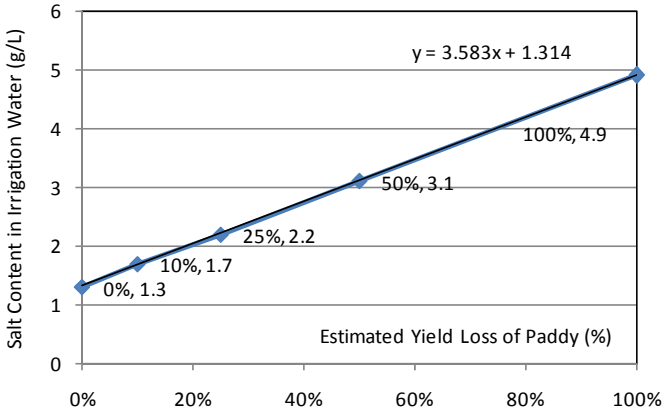


Figure 2.3.10 Paddy Yield Loss against Irrigation Water Salinity

Source; Ayers & Wescot (1989), FAO, modified by Project Team

[17] R. S. Ayers and D.W. Westcot (1989), Water quality for agriculture, FAO Irrigation and Drainage Paper, 29 Rev. 1, 1989

saline level is estimated at 54% which is the average between 33% (salt content at 2.5g/L) and 75% (salt content at 4g/L), and likewise damage 17% is estimated for the range of salt content 1.0 – 2.5 g/L.

Table 2.3.1 Damage Index for Saline Water Intrusion

No	Items	Salinity Level (g/L: PPT)							Remarks
		<0.5	0.5 – 1.0	1.0 – 2.5	2.5 – 4	4 – 10	10 – 20	>20	
1	Paddy	0%	0%	17%	54%	100%	100%	100%	FAO
2	Fruit	0%	0%	19%	55%	100%	100%	100%	FAO
3	Vegetable	0%	0%	29%	71%	100%	100%	100%	FAO
4	Forest (Melaleuca)	0%	0%	0%	0%	50%	100%	100%	SIWRP

Source: JICA Project Team

4) Saline Water Intrusion and Yield Loss/Damage

Figure 2.3.11 shows the salinity level change by month under the case of dry year (DY) 1998 Mekong River discharge with the 30 cm sea level rise, equivalent to year 2050's expected rise under climate change scenario B2. The figure indicates;

1) Most of the coastal areas are affected by large extent of saline water intrusion except for Kien Giang province where there are already numbers of saline water prevention sluice gates in operation.
2) The province most affected is Ca Mau province as expected, excluding a small area located in western-mid area where paddy fields are well protected by saline water prevention sluice gates.
3) The Mekong River discharge sharply affects decrease of saline content level at the coastal areas of Tien Giang, Ben Tre, Tra Vinh, and Kien Giang provinces; saline content level in these areas decreases in June while other areas keep nearly the same condition as being in April at such areas of Soc Trang, Bac Lieu, Ca Mau provinces.

Figure 2.3.12 indicates the change (damage) in terms of percentage and monetary value by province. As shown in the figure, in terms of percentage change, Ca Mau province comes first except for year 2100 case, followed by Ben Tre, Bac Lieu, Soc Trang, and Tra Vinh. In terms of monetary change (damage), Ben Tre province shows the biggest loss, which is due to the loss of valuable fruit production, and followed by Soc Trang, Ca Mau, Kien Giang and Tra Vinh.

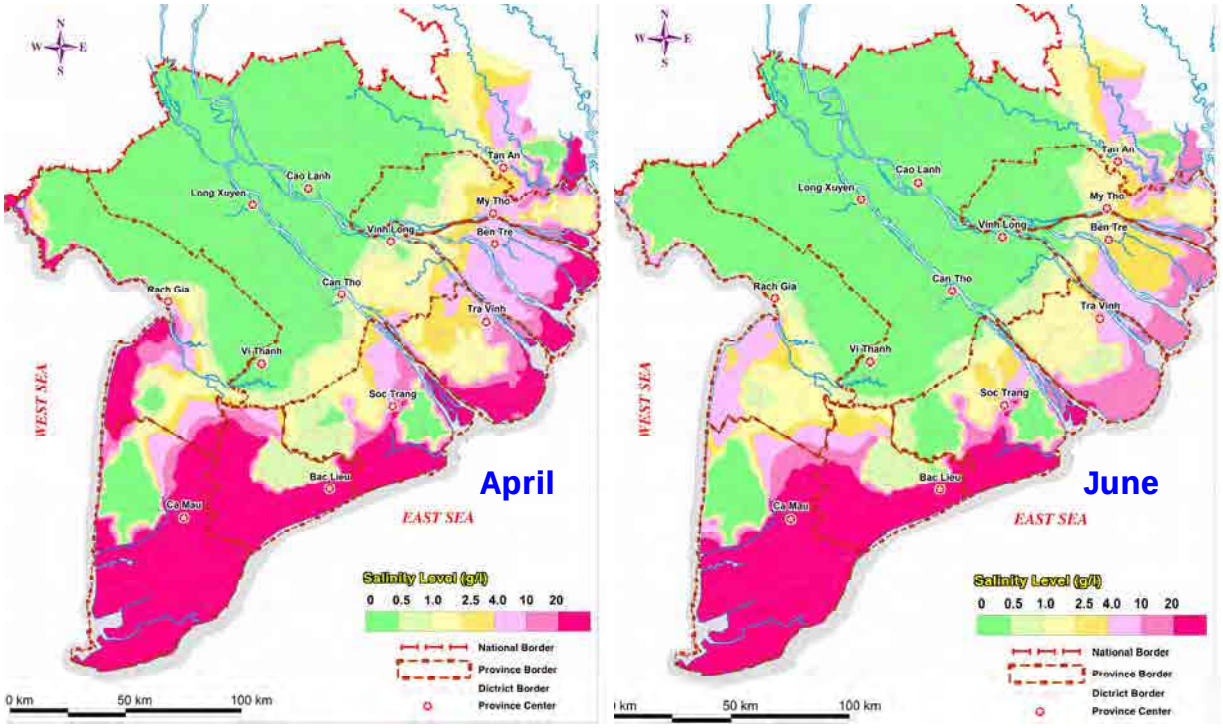


Figure 2.3.11 Saline Isolines of Driest Month (left: April) and Beginning of Flood Month (right: June)

Source; the Project Team

Note: Salinity intrusion simulation covers January to July, for which the results only April and June are presented above with April being the severest months, with June being the beginning of Flood season.

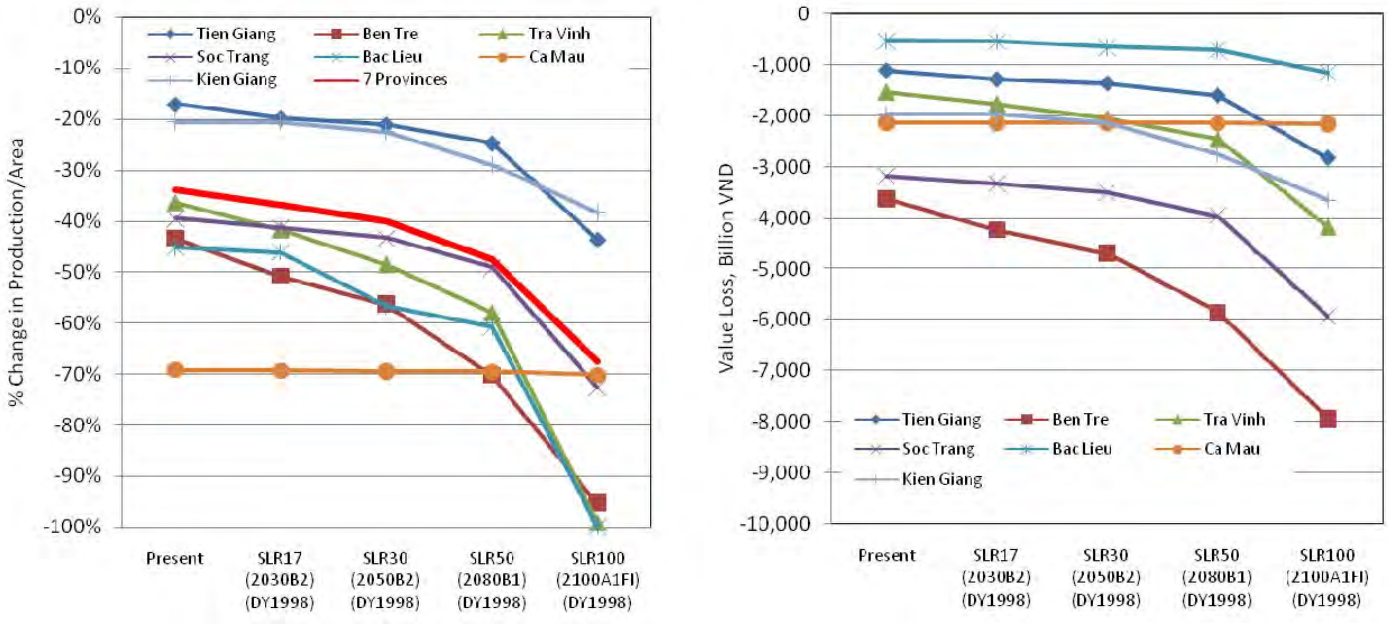


Figure 2.3.12 Predicted Production Loss by Saline Water Intrusion in Percentage (left) and in Price (right) for DY 1998 Discharge by Province

(DY 1998 MR Discharge with Different SRL, Source; the Project Team)

2.3.3 Flood Intensification associated with Sea Water Level Rise

1) Damage Indexes under Flood Inundation

Flood inundation affects crop production and gives some damage to infrastructure such as houses and road. Damage index for flood inundation established in this section referred to the relevant research results including those by IAS-South Vietnam, SIWRP and also actual flood damage records in Mekong Delta in 2011. Interview and field investigation were done in provincial offices, commune office, and to farmers in Dong Thap and Tien Giang provinces which are generally prone to receive flood inundation. Table 2.3.2 shows the damage indexes in percentage corresponding to flood inundation depth;

Table 2.3.2 Damage Index for Flood Inundation

No	Items	Inundation depth (meter)							Remarks
		0.00 - 0.25	0.25 -0.50	0.50 -0.75	0.75 -1,00	1,00 -2,00	2,00 -3,00	>3,00	
1.1	Paddy (10 days inundation)	10%	29%	37%	46%	63%	100%	100%	IAS-SV
1.2	Paddy (over 10 days inund'n)	10%	50%	100%	100%	100%	100%	100%	IAS-SV
2	Fruit (3 weeks inundation)	10%	100%	100%	100%	100%	100%	100%	Study Tm
3	Vegetable (1 day inundation)	10%	100%	100%	100%	100%	100%	100%	Study Tm
4	Shrimp	0%	0%	0%	50%	75%	100%	100%	Study Tm
7	Forest (Melaleuca)	0%	0%	0%	0%	0%	25%	50%	SIWRP

Source: Institute of Agriculture Science in South Vietnam(IAS-SV), SIWRP, and the Project Team

With regard to estimating damage loss for paddy yield, there are two critical periods for growth against inundation; one is tillering stage and the other is maturing stage. Le Sam (2006)[18] had examined relationship between flood inundation depth and relevant paddy production loss in 1988 and 1989. Inundation with different depths was applied to experimental plots of paddy at tillering stage, flowering stage, and maturing stage, and the results are summarized in the following figure. Based on the liner approximation established for those data experimented by Le Sam, damage indexes in Table 2.3.2 were estimated.

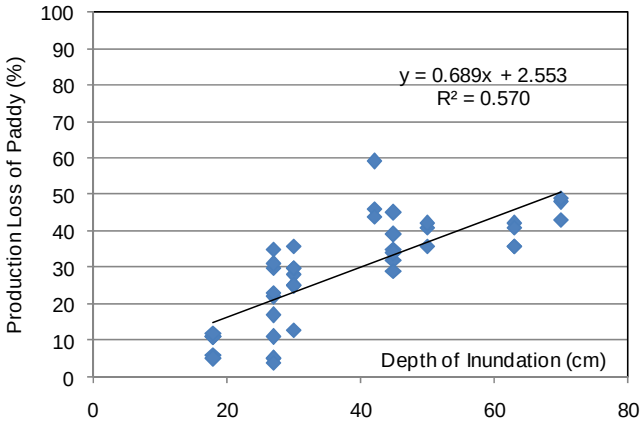


Figure 2.3.13 Inundation Depth and Yield Loss of Paddy

Source; Le Sam (2006), data processed and graphed by the Project Team

2) Yield Loss and Damages under Flood Inundation

Figure 2.3.14 shows the isoline of flood inundation in August (a beginning month of flood inundation) and October (the peak month of flood inundation) under the case of flood year (FY) 2000 Mekong River discharge with the sea level rise of 30 cm, equivalent to year 2050's expected rise under climate change (CC) scenario B2. These figure indicates;

1) As expected, severe flood takes place upper most reach of the Mekong Delta such as Dong Thap and An Giang provinces. Along the coastal areas, the flooding level is not as severe as those in the upper reach of the Delta. However, since Kien Giang province is located upstream of the Delta bordering An Giang province, the province tends to be affected more as compared to other coastal provinces. In addition, upper reach of Tien Giang province is also affected by flood since this area receives not only Mekong River's flood discharge but also runoff coming from

[18] Le Sam (2006), Irrigation in the Mekong Delta, Agricultural Publishing house, Ho Chi Minh

Dong Thap province.

2) In Ca Mau, Bac Lieu and Soc Trang provinces, there are lower areas which are more affected by flood inundation. In these areas, paddy is planted during rainy season. To avoid flood inundation becoming severe towards the end of the rainy season, farmers in these areas usually try to plant and harvest paddy as early season as possible.

3) October is the peak flood inundation month for coastal area of the Mekong delta, which the peak inundation comes a bit later than upstream side such as Dong Thap. This trend corresponds to the flooding from the Mekong River spreading almost all over the Delta starting from the upstream to the tail end (coastal areas) of Delta.

Figure 2.3.15 shows the change in production/area in terms of percentage and monetary value by province. As shown in the figure, in terms of percentage change, Kien Giang province comes first except for the 'Present' case, followed by Tien Giang. Other 5 provinces show more or less same damage percentage. In terms of monetary change (damage), Kien Giang province again shows the biggest loss till year 2080, which is due to the loss of vast areas of paddy production, and followed by Tien Giang till year 2050. At year 2100, Ca Mau, Soc Trang and also Bac Lieu provinces show bigger value loss as in these provinces loss of shrimp takes place to a large extent given 100 cm sea level rise.

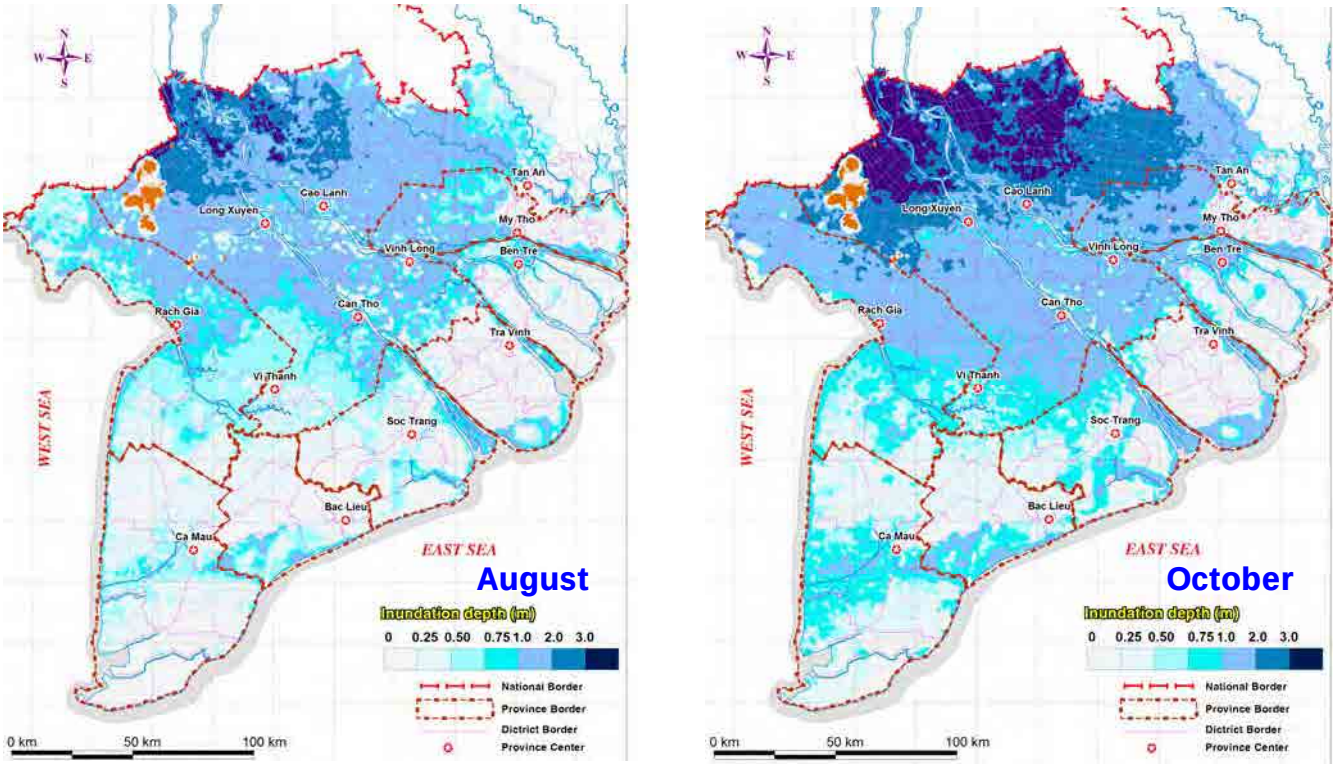


Figure 2.3.14 Flood Inundation Isoline of August (left) and October (right) for FY 2000 Discharge with 30cm SLR (2050; B2 Scenario)

Source; the Project Team

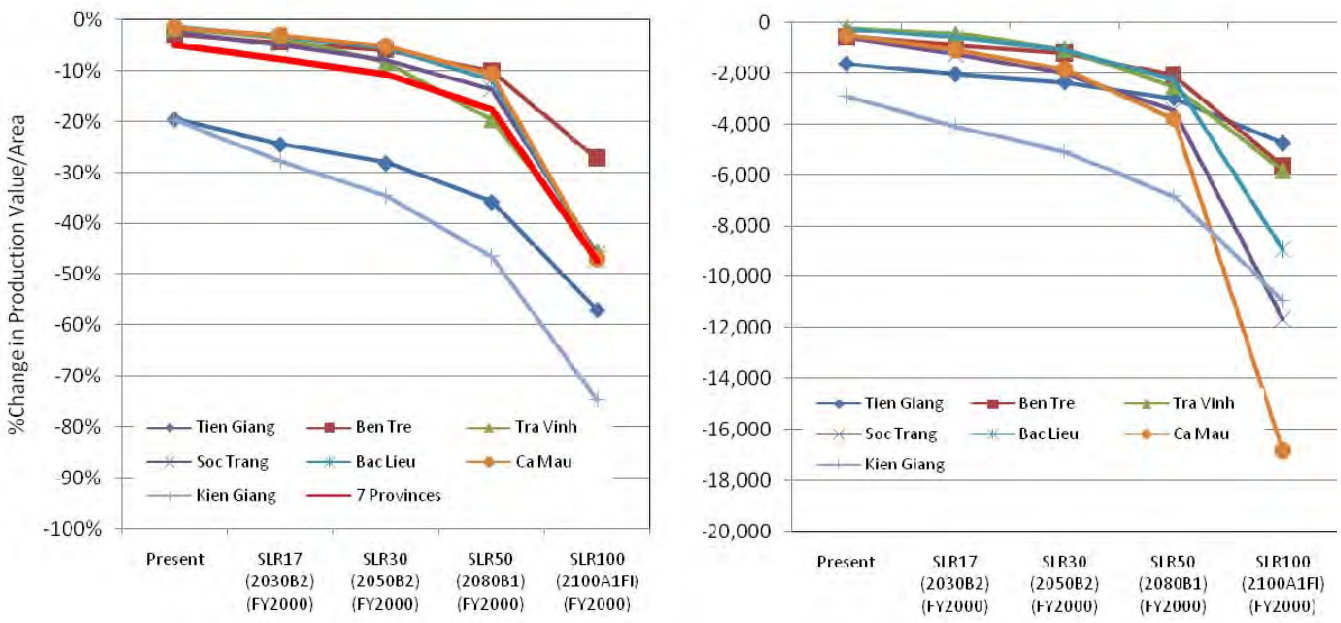


Figure 2.3.15 Production Loss by Flood Inundation of August (left) & October (right) for FY 2000 Discharge

Source; the Project Team

2.3.4 Areas to Focus in the Context of Climate Change: Saline Intrusion Prevention

The Government has been constructing sluice gates in order mainly to prevent saline water from intruding into irrigation canals. In fact, sluice gates had been ranked at 2nd position after sea dyke construction project during a government officers workshop held on October 27, 2011 in terms of number of priority projects. Also, the Master Plan (2011) prepared by SIWRP has identified a lot number of projects, of which sluice gate project shares 2nd largest part after canal rehabilitation/ dredging and canal embankment.

Being so, there is a lot of need to establish sluice gate, and in cases to rehabilitate existing sluice gates. In fact, saline intrusion along the Mekong River becomes severer over years coupled with sea level rise under climate change as aforementioned. The sluice gate shall therefore be installed one by one towards upstream of the River in keeping with the magnitude of the saline intrusion into inland areas, otherwise saline intrusion will destroy the paddy field, fresh water aquaculture and fruits. Therefore, by bringing together all those sluice gates and by prioritizing among them, a sub-sector project which undertakes sluice gate construction/ rehabilitation is proposed.

From a sense of upcoming risks mentioned above in the context of climate change, coastal area of Mekong delta shall be a targeted area for this sub-sector project because saline water intrusion has already affected some areas in the coastal provinces. The prioritization will be conducted according to not only saline water intrusion simulation coupled with predicted sea level rise but also site survey for candidate canals. Through these activities, diversified agriculture as well as environment can be maintained to the future generation.

CHAPTER 3 DESIGN OF THE PROJECT

Priority on the climate change issues was identified by series of workshops for villagers and government officers; and saline water intrusion and drought (shortage of fresh water) were the top priority issues. Sluice gates construction is considered as one of infrastructural interventions to protect coastal area from saline water intrusion and to secure fresh water intake from the Mekong River. This chapter describes proposed infrastructural intervention, sluice gate construction project, as follows.

3.1 Overall Program Planning for the Saline Water Prevention Sluice Gates

Vietnamese government plans to establish hundreds of sluice gates in the Mekong delta with different sizes; some of them are planned to have only one gate in a sluice system, the others are to be equipped with plural numbers of gates in the sluice system. This project deals with medium - large scale sluice systems which shall have about 20m or more in total width. Implementation cost of large scale sluice system becomes huge. This is why construction of sluice shall be done effectively to cope with saline intrusion associated with climate change.

3.1.1 Newly Required Sluice Gates under Saline Intrusion

1) Project Outline

Total 68 numbers of large scale sluices have been identified in the project area (coastal 7 provinces). Selection of these sluices were based on “Master Plan for irrigation projects in the Mekong Delta in the context of climate change and sea level rise (2011)” prepared by SIWRP and approved by the government on September 25, 2012. Outline of the required sluices by province is summarized as follows:

Table 3.1.1 Summary of proposed sluices with major functions in the program area by Provinces

No	Province	Site	Width (m) *	Required Functions	Estimate Cost (bill. VND)
1	Tien Giang	10	240	Flood control, Drainage, Irrigation	1,817
2	Ben Tre	16	830	Salinity control, Irrigation, Drainage	6,323
3	Tra Vinh**	12	550	Salinity control, Irrigation, Drainage	4,087
4	Soc Trang	5	100	Salinity control, Irrigation, Drainage	763
5	Bac Lieu	4	78	Salinity control, Irrigation, Drainage	559
6	Ca Mau	12	360	Salinity control, Irrigation, Drainage	2,568
7	Kien Giang	9	804	Flood control, Drainage, Irrigation	6,571
Total		68	2,962		22.688

*; Width shows total width of all sluices listed in this project.
**; Out of 12 sluices, 3 sluices (Vung Liem, Nam Mang Thit 1,2) are located in Vinh Long Province. The water from these sluices will affect the area in Tra Vinh Province, so that the 3 sluices are included in here Tra Vinh.

Total construction cost under the project arrives at 22.7 trillion VND, about USD 1.1 billion. The average width of sluice comes to about 44m per sluice and the average construction cost is about 334 billion VND. It is therefore approximately equal to 16 million USD/sluice. Required functions are salinity control, irrigation, drainage and flood control. A major function of proposed sluice is salinity control, irrigation, and drainage in five provinces (Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, and Ca Mau) while flood control, drainage, and irrigation are the main purposes for sluices in Tien Giang and Kien Giang.

It is known that flood water level also fluctuates according to tidal regime. The flood water level in Tien Giang and Kien Giang increases when spring tide or high tide occurs. Thus, sluice can protect areas not only from saline intrusion but also from flood inundation. When it is low tide, flood water from inner lands can be drained and released to river. Contrarily, the area can be protected from flood inundation when flood water level in river rises due to high tide. This project is primarily formulated to protect the coastal areas against saline intrusion, while such sluice can also function as flood

protection at the coastal flood plain areas.

2) Integration with Relevant Plans

Directorate of Navigation Management (DNM) under Ministry of Transport (MOT) is responsible for road traffics and navigations; construction of sluice may disturb navigation network controlled by DNM. As a common procedure, information exchange is carried out between SIWRP under MARD and DNM before planning of sluice gate construction. DNM shows national rivers and canals in a region to SIWRP which are considered and identified as important logistics routes for Mekong delta region. According to the information of national canals and rivers, SIWRP starts planning of Master Plan for sluice and embankment construction; SIWRP tries to avoid locations in national canals and rivers as construction sites.

After formulation of aforementioned sluice and embankment master plan, SIWRP consults to DNM to examine their master plan; if DNM rejects the plan of sluice or embankment construction, SIWRP has to revise their master plan and to prepare a revised version of master plan. In some areas, there will be the place where saline intrusion is quite severe. Then, PPC will have an important role of decision for sluice construction; PPC decides whether construction of sluice is to be implemented or not; both SIWRP and DNM usually follow the decision made by PPC.

At the design stage, a design organization has to consult to DNM for necessity of navigation lock in a sluice; according to information and recommendation from DNM, designer will revise designs and exchange their opinions with DNM until both side agree on it. Thus, adjustment of this project has already been carried out with DNM. National canals are shown in the figure 3.1.1.

3) Implementation Schedule

The project requires quite huge investment, total USD 1.06 billion and it is quite difficult to implement within a short period of time. Sea level rise is expected in future but it does not increase immediately. This project therefore divides implementation period into four stages covering up to 2050; the first term is from the present to 2020, the second term from 2021 to 2030, the third one from 2031 to 2040, and the last one is from 2041 to 2050.

Table 3.1.2 Summary of Proposed Sluices by Implementation Stage by Province

Province	2013- 2020	2021-2030	2031-2040	2041-2050	Total
Tien Giang	1	2	2	5	10
Ben Tre	10	0	6	0	16
Tra Vinh	4	6	2	0	12
Soc Trang	3	2	0	0	5
Bac Liue	0	0	4	0	4
Ca Mau	0	12	0	0	12
Kien Giang	0	4	3	2	9
Total	18	26	17	7	68
Share (%)	27%	38%	25%	10%	100%

Source: JICA Project Team

Priority is given to the area where saline water intrusion is already observed. Total number of sluices in the first term is 18 sharing 27% of total sluices. During the following second period from 2021 to 2030, the targeted sluices are located at the areas where saline intrusion is expected till 2030. The total number of sluices is 26 (38%). High tide prevention sluices along coastal line are planned to implement in the following term from 2031 to 2040 with 25% share (17 sluices). Sluices in flood inundation are selected to implement from 2041 to 2050; number of sluice being 7 (10%). Number of sluices changes by term, whereby the required budget shows difference with the sluice numbers by terms:

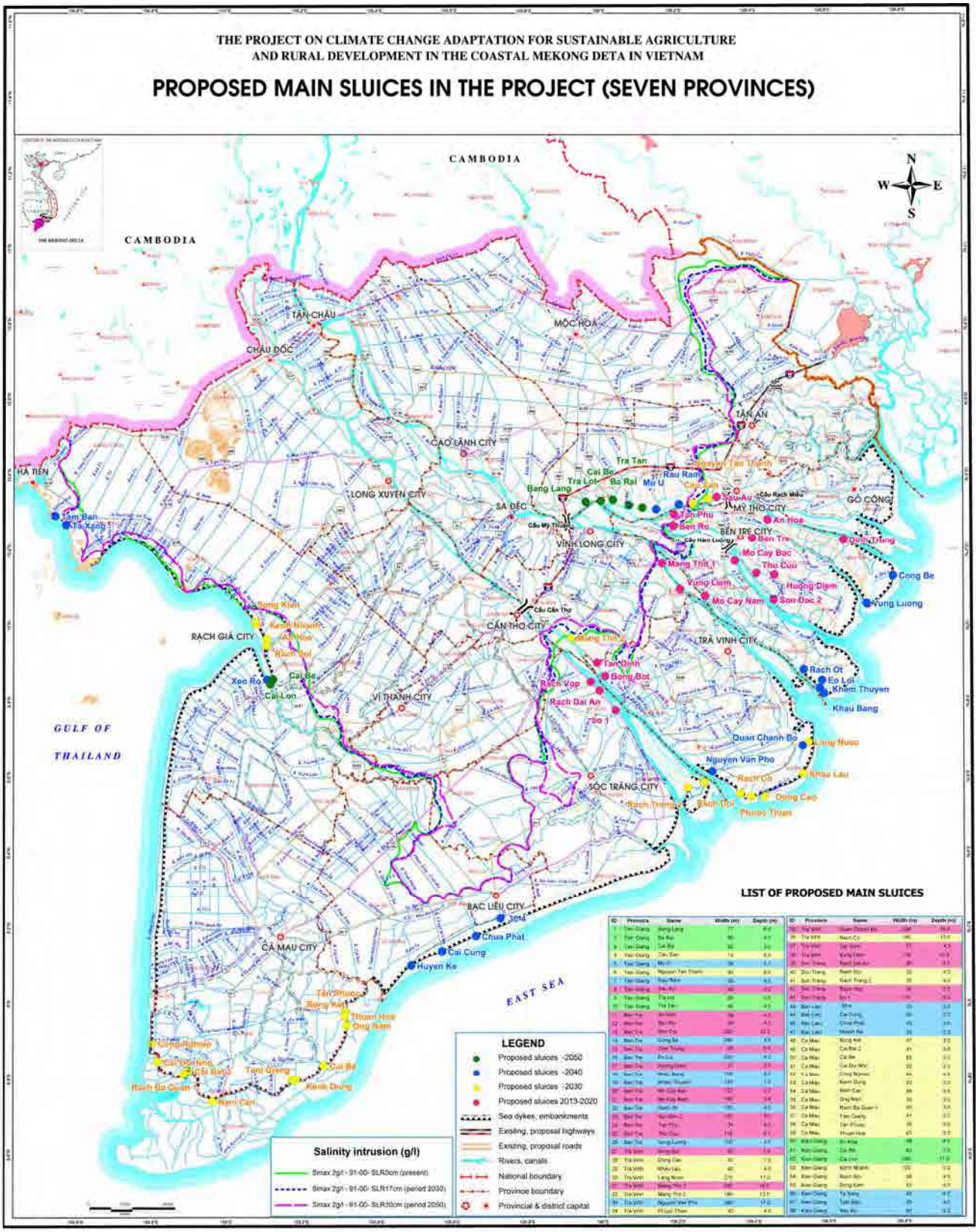
Table 3.1.3 Summary of Sluices Construction Cost by Project Implementation Term by Province

Province	2013- 2020	2021-2030	2031-2040	2041-2050	Total (Bil. VND)	Total (Mil. US$)
Tien Giang	146	381.30	298.37	991.37	1,817	87.35
Ben Tre	3,776	-	2,547.03	0	6,323	303.98
Tra Vinh	1,411	1,950.37	726.38	0	4,087	196.51
Soc Trang	458	305.06	0	0	763	36.67
Bac Liue	0	0	558.78	0	559	26.86
Ca Mau	0	2,568.45	0	0	2,568	123.48
Kien Giang	0	1,306.40	1,087.64	4,176.98	6,571	315.91
Total	5,790	6,512	5,218	5,168	22,688	1,090.77
Share (%)	25%	29%	23%	23%	100%	

Source: JICA Project Team

As is shown in the above table, the first and second terms require about 25% and 29% of total project cost respectively and following two terms share 22% each of the project cost. Saline intrusion is observed in many places of Mekong delta but construction of sluices has not yet implemented fully. This is why the disbursement plan of the project requires relatively higher cost in the first two terms.

It is noted that Tha Phu sluice in Ben Tre province is located at a bit upstream of 2g/l saline intrusion isoline in 2030 (17cm SLR); however, it must be listed as the one of first term projects. Topographically, north Ben Tre shapes a polder and most of canals around the polder have already been affected by saline intrusion. There is however no suitable fresh water resource intake in north Ben Tre except for the Tan Phu sluice. This is why Tan Phu sluice has to be listed in the first term project for early implementation. Simulated saline intrusion isoline and proposed sluice locations are indicated in the following figure:



Reference 1: Proposed sluice contructed in period 2012 up to 2020 by the decision of the Prime Minister No.1397/QĐ-TTg date 25-09-2012' Approved Master plan in the Mekong Delta for impact of climate change - sea level rise - SIWRP
Reference 2: The Project on Climate Change Adaptation for sustainable Agriculture and rural development in the coastal Mekong Deta in Vietnam - JICA

Figure 3.1.1 Newly Required Sluice Gate and Construction Implementation Plan till 2050

Source: JICA Project Team

Table 3.1.4 List of Proposed Sluices in the Project (1/2)

No	Sluice Name	Location	Schedule	Canal		Width (m)	Bottom (EL. m)	Purpose *note
				Width (m)	Depth (m)			
I	**Tien Giang**							
1	Bang Lang	Cai Be	2041-2050	77	8.40	30	-3.50	F/C, IR, DR
2	Ba Rai	Cai Lay	2041-2050	80	4.60	30	-3.50	F/C, IR, DR
3	Cai Be	Cai Be	2041-2050	98	11.70	20	-3.50	F/C, IR, DR
4	Cau Sao	Chau Thanh	2021-2030	74	4.00	20	-3.50	S/P, IR, DR
5	Mu U	Cai Lay	2031-2040	36	3.10	20	-3.00	S/P, IR, DR
6	Nguyen Tan Thanh	Chau Thanh	2021-2030	90	6.00	30	-3.50	S/P, IR, DR
7	Rau Ram	Chau Thanh	2031-2040	50	4.00	20	-3.50	S/P, IR, DR
8	Sau Au	Chau Thanh	2013-2020	40	3.00	20	-3.00	S/P, IR, DR
9	Tra Lot	Cai Be	2041-2050	65	5.00	30	-3.50	F/C, IR, DR
10	Tra Tan	Cai Lay	2041-2050	46	4.00	20	-3.50	F/C, IR, DR
II	**Bến Tre**							
11	An Hoa	Binh Dai	2013-2020	190	11.50	130	-5.00	S/P, I/R, DR
12	Ben Ro	Chau Thanh	2013-2020	30	4.00	20	-4.00	S/P, I/R, DR
13	Ben Tre	Ben Tre city	2013-2020	200	12.20	70	-5.00	S/P, I/R, DR
14	Cong Be	Binh Dai	2031-2040	295	4.00	30	-4.00	S/P, IR, DR
15	Dinh Trung	Binh Dai	2013-2020	65	5.50	40	-4.00	S/P, I/R, DR
16	Eo Loi	Thanh Phu	2031-2040	292	4.00	100	-4.00	S/P, IR, DR
17	Huong Diem	Giong Trom	2013-2020	37	3.50	20	-3.50	S/P, I/R, DR
18	Khau Bang	Thanh Phu	2031-2040	108	4.00	40	-4.00	S/P, IR, DR
19	Khem Thuyen	Thanh Phu	2031-2040	130	1.00	40	-4.00	S/P, IR, DR
20	Mo Cay Bac	Mo Cay Bac	2013-2020	152	5.00	50	-5.00	S/P, I/R, DR
21	Mo Cay Nam	Mo Cay Nam	2013-2020	100	5.00	40	-4.00	S/P, I/R, DR
22	Rach Ot	Thanh Phu	2031-2040	100	4.00	80	-4.00	S/P, IR, DR
23	Son Doc 2	Giong Trom	2013-2020	132	8.00	60	-4.50	S/P, I/R, DR
24	Tan Phu	Chau Thanh	2013-2020	34	4.00	20	-4.00	Irri, S/P
25	Thu Cuu	Giong Trom	2013-2020	116	8.10	60	-5.00	S/P, I/R, DR
26	Vung Luong	Binh Dai	2031-2040	100	4.00	30	-4.00	S/P, IR, DR
III	**Tra Vinh**							
27	Bong Bot	Cau Ke	2013-2020	87	7.00	60	-4.50	S/P, I/R, DR
28	Dong Cao	Duyen Hai	2021-2030	80	7.00	30	-3.50	S/P, IR, DR
29	Khau Lau	Duyen Hai	2021-2030	40	4.00	30	-3.50	S/P, IR, DR
30	Lang Nuoc	Duyen Hai	2021-2030	390	17.00	60	-4.50	S/P, IR, DR
31	Mang Thit 1	Mang Thit	2013-2020	186	13.50	80	-4.50	S/P, I/R, DR
32	Mang Thit 2	Tra On	2021-2030	236	16.50	80	-5.00	S/P, IR, DR
33	Nguyen Van Pho	Tra Cu	2031-2040	276	17.00	30	-3.50	S/P, IR, DR
34	Phuoc Thien	Duyen Hai	2021-2030	40	4.00	20	-3.50	S/P, IR, DR
35	Quan Chanh Bo	Duyen Hai	2031-2040	238	16.50	60	-4.50	S/P, IR, DR
36	Rach Co	Duyen Hai	2021-2030	140	13.00	20	-3.50	S/P, IR, DR
37	Tân Dinh	Cau Ke	2013-2020	57	4.50	20	-3.50	S/P, IR, DR
38	Vung Liem	Vung Liem	2013-2020	118	10.00	60	-4.50	S/P, IR, DR
IV	**Soc Trang**							
39	Rach Đai An	Ke Sach	2013-2020	46	4.50	20	-3.50	S/P, IR, DR
40	Rach Doi	Cu Lao Dung	2021-2030	30	4.00	20	-3.50	S/P, IR, DR
41	Rach Trang 2	Cu Lao Dung	2021-2030	35	4.00	20	-3.50	S/P, IR, DR
42	Rach Vop	Ke Sach	2013-2020	90	5.50	20	-3.50	S/P, IR, DR
43	So 1	Ke Sach	2013-2020	110	8.5	20	-3.50	S/P, IR, DR
V	**Bac Lieu**							
44	30/4	Bac Lieu	2031-2040	70	3.00	24	-3.00	S/P, IR, DR
45	Cai Cung	Dong Hai	2031-2040	60	2.50	15	-2.50	S/P, IR, DR
46	Chua Phat	Dong Hai	2031-2040	40	3.50	24	-3.00	S/P, IR, DR
47	Huyen Ke	Dong Hai	2031-2040	30	2.50	15	-2.50	S/P, IR, DR
VI	**Ca Mau**							
48	Bong ket	Dam Doi	2021-2030	47	3.00	30	-2.50	S/P, IR, DR
49	Cai Bat 2	Phu Tan	2021-2030	41	3.00	20	-2.50	S/P, IR, DR
50	Cai Be	Nam Can	2021-2030	82	3.50	60	-3.00	S/P, IR, DR
51	Cai Doi Nho	Phu Tan	2021-2030	92	3.50	30	-3.00	S/P, IR, DR
52	Cong Nghiep	Phu Tan	2021-2030	65	3.50	40	-3.00	S/P, IR, DR
53	Kenh Dung	Nam Can	2021-2030	93	3.50	60	-3.00	S/P, IR, DR
54	Nam Can	Nam Can	2021-2030	88	3.50	20	-2.50	S/P, IR, DR

No	Sluice Name	Location	Schedule	Canal		Width (m)	Bottom (EL. m)	Purpose *note
				Width (m)	Depth (m)			
55	Ong Nam	Dam Doi	2021-2030	30	3.00	20	-2.50	S/P, IR, DR
56	Rach Ba Quan 1	Phu Tan	2021-2030	40	3.00	20	-2.50	S/P, IR, DR
57	Tam Giang	Nam Can	2021-2030	41	3.00	20	-2.50	S/P, IR, DR
58	Tan Phuoc	Dam Doi	2021-2030	50	3.00	20	-2.50	S/P, IR, DR
59	Thuan Hoa	Dam Doi	2021-2030	63	3.50	20	-2.50	S/P, IR, DR
VII	**Kien Giang**							
60	An Hoa	Rach Gia	2021-2030	58	4.50	30	-3.00	W/S, F/C
61	Cai Be	Chau Thanh	2041-2050	162	5.50	64	-5.00	S/P, F/C
62	Cai Lon	Chau Thanh	2041-2050	580	11.60	390	-6.00	S/P, F/C
63	Kenh Nhanh	Rach Gia	2021-2030	100	5.00	40	-3.50	S/P, F/C
64	Rach Soi	Rach Gia	2021-2030	58	4.50	60	-4.00	S/P, F/C
65	Song Kien	Rach Gia	2021-2030	55	4.50	40	-3.50	S/P, F/C
66	Ta Xang	Kien Luong	2031-2040	45	4.50	40	-3.50	S/P, F/C
67	Tam Ban	Kien Luong	2031-2040	45	4.50	40	-3.50	S/P, F/C
68	Xeo Ro	An Bien	2031-2040	80	5.50	60	-4.00	S/P, F/C

*Note: Purpose: S/P; Saline Intrusion Prevention, F/C; Flood Control, IR; Irrigation, DR; Drainage

Source: JICA Project Team

3.1.2 Rehabilitation for Existing Sluice Gates by Year

1) Project Outline

'Department of Water Resource' (DWR) under DARD of each province is an organization under People's Committee of each province. DWR is responsible for management and operation of hydraulic structures in a province. Sluice gates are the structures which DWR usually deals with. Then, Much of the management responsibility for water resource infrastructure has been transferred to Water Resources Management Company [1] (WRMC) in Mekong delta. Actual sluice operation and management are carried out by WRMC. This company runs as autonomous self-financing enterprise in accordance with recent government decrees. However, they are still under the supervision of the DWR, DARD, and PPC and financial status is actually not self-financing.

As for maintenance, WRMC carries out surveys for necessary maintenance works and these are reported to DWR and DWR summarizes these data in statistics every year. According to the statistics of coastal seven provinces summarized by DWR, the project area has a total of 69 sluices to be rehabilitated. Width of these sluices is equal or more than 10 m. The sluices belong to MARD and they have been constructed until 2011.

Table 3.1.5 Number of Existing Sluices for Rehabilitation by Province

No	Province	Water Resource Management Company	Quantity	Total width (m)	Construction Cost (Mil.VND)
1	Tien Giang	Tien Giang LLC. for Hydraulic Structure Exploitation	6	117	39,500
2	Ben Tre	Ben Tre LLC. for Hydraulic Structure Exploitation	6	144	104,110
3	Tra Vinh	Tra Vinh LLC. for Hydraulic Structure Exploitation	14	494	535,702
4	Soc Trang	Soc Trang LLC. for Hydraulic Structure Exploitation	12	157	148,100
5	Bac Lieu	Bac Lieu Centre of Hydraulic structure Management	5	97	69,192
6	Ca Mau	Ca Mau Water Resources Department	8	132	194,500
7	Kien Giang	Kien Giang Water Resources Department	18	337	466,100
Total			69	1,467	1,557,204

Source: summarized by JICA Project Team based on DWR statistics.

Main purpose of the sluices is to prevent saline water intrusion into the project area. However, corrosion occurs at the surface of iron materials since most of the sluices are located at near sea side especially in Tra Vinh, Soc Trang, and Kien Giang. For these provinces, number of sluices requiring rehabilitation is much more than those of other provinces. Average width of all sluices shown in Table 3.1.4 is 21m per sluice. Invested cost by the Vietnamese government comes to approximately 22

[1] In northern Vietnam, the company is called "Irrigation and Drainage Management Company" (IMC), and that of Mekong delta is called "Water Resource Management Company (WRMC)"

billion VND (about USD 1.1 million) per sluice. The oldest sluice was constructed in 1984 at Tien Giang province.

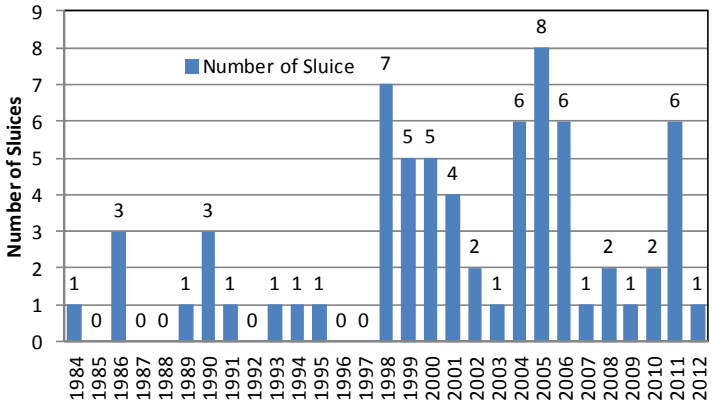


Figure 3.1.2 Number of Existing Sluices by Construction Year in Coastal Provinces

Figure 3.1.2 shows number of existing sluices classified by their construction year. In the period from 1984 to 1997, sluice construction in the coastal provinces was not so many while construction started increasing from year 1998. Due to the increase of sluices, maintenance cost has also increased and it is said that about 2.5% of average construction cost of sluice is required for maintenance at the moment (average rehabilitation cost by 69 sluices is 0.4million USD: average construction cost of proposed 68 sluices is 16 million USD).

2) Implementation Schedule

Some of the existing sluices have been rehabilitated every certain years by DARD. Interval between rehabilitations differs by province but it is in many cases every 5years. Since sluices are usually constructed in saline intrusion areas, corrosion of iron parts of sluice causes a problem. This is why some sluices are required to replace gates and/or other parts by stainless type. Here, priority is given to such sluices which are close to rehabilitation period or heavily rusted. Rehabilitation period is divided into three terms, the first term is from 2013 to 2015, the second term starts from 2016 and continue until 2020, the final term begins in 2021 and it ends in 2025, total 13 years period. Following table shows number of sluices to be rehabilitated by province

Program period of the first term is only 3 years, so that number of rehabilitation sluices is limited. According to strong requirement from provinces of Ben Tre, Soc Trang, and Bac Lieu, total 11 sluices are listed in this term. Total 26 sluices are planned for the rehabilitation in the second term; most of the sluices in Tra Vinh are targeted to be repaired in this period. Most of the Gates in Kien Giang will be rehabilitated in the last period from 2021 to 2025. Finally, rehabilitation for total 69 sluices will be carried out under this project:

Table 3.1.6 Summary of Existing Sluices with Rehabilitation Period by Provinces

Province	2013- 2015	2016-2020	2021-2025	Total
Tien Giang	0	0	6	6
Ben Tre	0	0	6	6
Tra Vinh	2	12	0	14
Soc Trang	7	2	3	12
Bac Lieu	2	3	0	5
Ca Mau	0	6	2	8
Kien Giang	0	3	15	18
Total	11	26	32	69
Share (%)	16%	38%	46%	100%

Source: JICA Project Team

Following table shows rehabilitation cost with project implementation period by provinces. The first

term requires about 25% of whole project cost within 3 years. The second term shares a bit more than half of total project cost, and then, the last term requires 23% of the project cost. It is noted that rehabilitation cost in Tra Vinh is quite high in comparison with those of other provinces. Average cost for one sluice rehabilitation reaches at USD 1 million in Tra Vinh province, which is 6.3% of average construction cost for new sluice. There are 5 large scale sluices in Tra Vinh and these large scale sluices increase the rehabilitation cost.

Table 3.1.7 Summary of sluices rehabilitation cost with project implementation period by Provinces

Province	2013-2015	2016-2020	2021-2025	total (million VND)	total (US$)	Qty	Avg(USD)
Tien Giang	-	-	23,710	23,710	1,140,000	6	190,000
Ben Tre	-	-	28,176	28,176	1,355,000	6	225,833
Tra Vinh	94,000	224,400	-	318,400	15,308,000	14	1,093,429
Soc Trang	14,400	3,400	8,698	26,498	1,274,000	12	106,167
Bac Lieu	40,000	900	-	40,900	1,966,000	5	393,200
Ca Mau	-	52,140	8,237	60,377	2,903,000	8	362,875
Kien Giang	-	20,900	65,961	86,861	4,176,000	18	232,000
Total	148,400	301,740	134,782	584,922	28,121,000	69	407,551
Share (%)	25%	52%	23%	100%			

Source: JICA Project Team

Simulated saline intrusion isoline and existing sluice locations are summarized in the following figure.

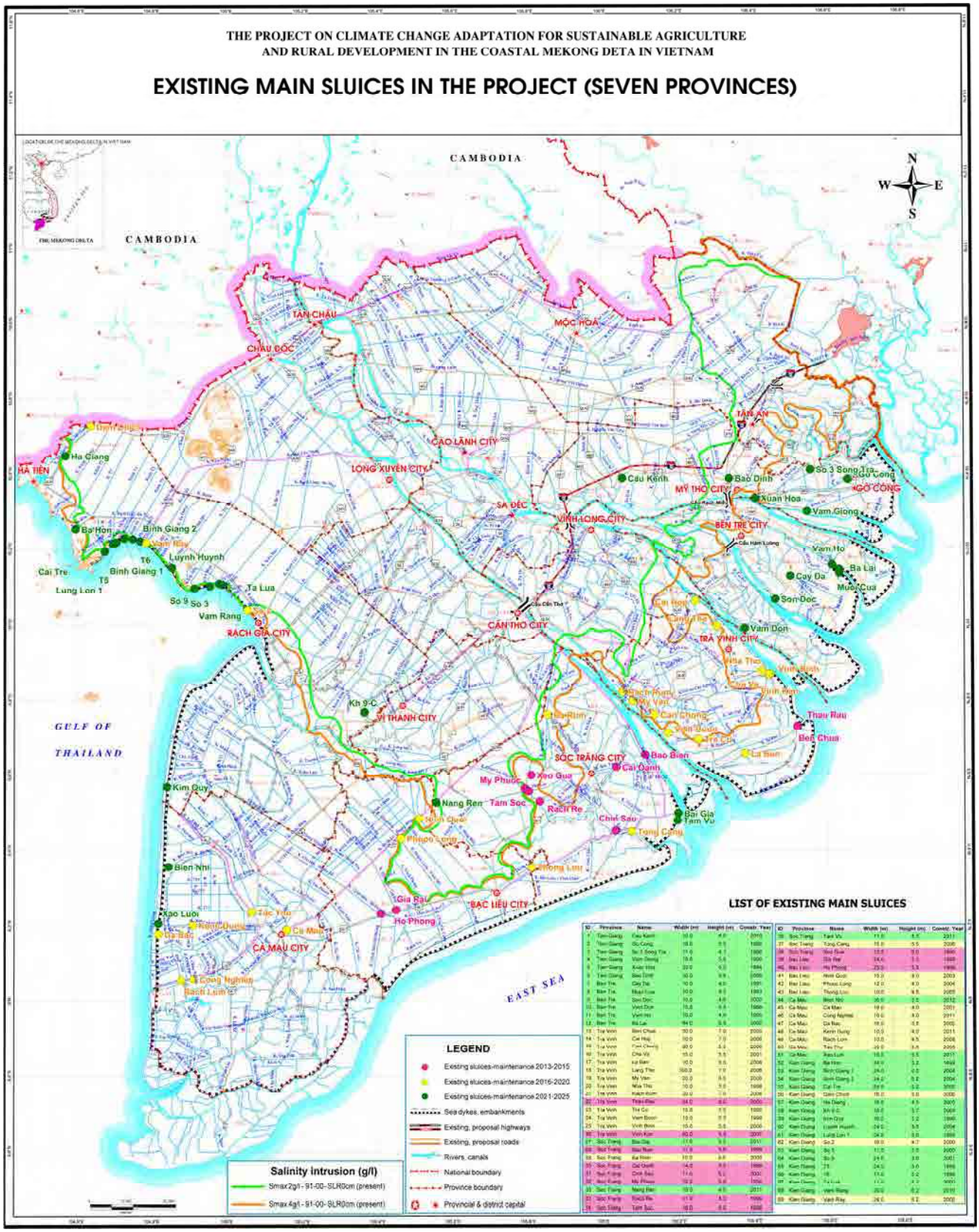


Figure 3.1.3 Rehabilitation Plan of Existing Sluices in Coastal 7 Provinces of Mekong Delta

Source: JICA Project Team

Table 3.1.8 List of Existing Sluices for Rehabilitation in the Project (1/2)

No	Name	Location	Rehabili. Term	Const. Year	Width (m)	*note Purpose	Rehabilitation
I	**Tien Giang**						
1	Bao Dinh	My Tho	2021-2025	2005	3 x 10	IR, DR, S/P	Overhaul maintenance
2	Cau Kenh	Cai Lay	2021-2025	2010	1 x 10	IR, DR, S/P	Overhaul maintenance
3	Go Cong	Go Cong	2021-2025	1989	2 x 8	IR, DR, S/P	Overhaul maintenance
4	So 3 Song Tra	Go Cong	2021-2025	1986	5 x 2.5	IR, DR, S/P	Overhaul maintenance
5	Vam Giong	Go Cong	2021-2025	1990	2 x 8	IR, DR, S/P	Overhaul maintenance
6	Xuan Hoa	Cho Gao	2021-2025	1984	4 x 8	IR, DR, S/P	Overhaul maintenance
II	**Ben Tre**						
7	Ba Lai	Ba Tri	2021-2025	2002	84	IR, DR, S/P	Overhaul maintenance
8	Cay Da	Giong Trom	2021-2025	1991	2 x 5	IR, DR, S/P	Overhaul maintenance
9	Muoi Cua	Ba Tri	2021-2025	1993	10	IR, DR, S/P	Overhaul maintenance
10	Son Doc	Giong Trom	2021-2025	2002	2 x 7,5	IR, DR, S/P	Overhaul maintenance
11	Vam Don	Mo Cay nam	2021-2025	1986	15	IR, DR, S/P	Overhaul maintenance
12	Vam Ho	Ba Tri	2021-2025	1990	2 x 5	IR, DR, S/P	Overhaul maintenance
III	**Tra Vinh**						
13	Ben Chua	Cau Ngang	2013-2015	2005	3 x 10	S/P, IR, DR	- Replace by stainless gate - Reinforce the upstream and downstream slope
14	Cai Hop	Cang Long	2016-2020	2006	7 x 10	S/P, IR, DR	- Replace by stainless gate, renew 2 controlled gate
15	Can Chong	Tieu Can	2016-2020	2006	8 x 10	S/P, IR, DR	-Replace 06 stainless gate, - Renew 2 dynamic gate, repair the d/stream slope.
16	Cha Va	Cau Ngang	2016-2020	2001	2 x 7,5	S/P, IR, DR	- Replace by stainless gate
17	La Ban	Tieu Can	2016-2020	2004	2 x 5	S/P, IR, DR	- Replace by stainless gate
18	Lang The	Cang Long	2016-2020	2006	10 x 10	S/P, IR, DR	- Replace by stainless gate, renew 2 controlled gate
19	My Van	Cau Ke	2016-2020	2005	2 x 10	S/P, IR, DR	- Replace by stainless gate
20	Nha Tho	Chau Thanh	2016-2020	1998	2 x 5	S/P, IR, DR	- Replace by stainless gate
21	Rach Rum	Cau Ke	2016-2020	2004	3 x 10	S/P, IR, DR	- Replace by stainless gate
22	Thau Rau	Cau Ngang	2013-2015	2000	3 x 8	S/P, IR, DR	- Replace by stainless gate - Reinforce the upstream and downstream slope
23	Tra Cu	Tra Cu	2016-2020	1995	2 x 7,5	S/P, IR, DR	- Replace by stainless gate
24	Vam Buon	Tra Cu	2016-2020	1999	2 x 7,5	S/P, IR, DR	- Replace by stainless gate
25	Vinh Binh	Cau Ngang	2016-2020	2006	2 x 7,5	S/P, IR, DR	- Replace by stainless gate
26	Vinh Kim	Cau Ngang	2016-2020	2007	6 x 10	S/P, IR, DR	- Replace by stainless gate
IV	**Soc Trang**						
27	Bai Gia	Tran De	2021-2025	2011	2 x 5,5	S/P, IR, DR	Overhaul maintenance
28	Bao Bien	Long Phu	2013-2015	1998	2 x 5,5	S/P, IR, DR	-Renew gate system
29	Ba Rinh	My Tu	2016-2020	2005	2 x 5,0	S/P, IR, DR	-Painting the controlled system, operating bridge, transport bridge, fence of the management house - Repair the surface of navigation bridge
30	Cai Oanh	Long Phu	2013-2015	1986	2 x 7	S/P, IR, DR	-Repair the upstream slope, renew all stoplog, renew the stop gate, box of the controlled systems
31	Chin Sau	My Xuyen	2013-2015	2001	2 x 5,5	S/P, IR, DR	-Repair the gates, operating bridge, upstream slope, management house.
32	My Phuoc	My Tu	2013-2015	1994	2 x 7,5	S/P, IR, DR	Repair the sluice's plan
33	Nang Ren	Nga Nam	2021-2025	2011	1 x 15	S/P, IR, DR	Overhaul maintenance
34	Rach Re	My Tu	2013-2015	1999	2 x 5,5	S/P, IR, DR	- Repair the plan of sluice; - Renew the operating stair; - Replace 2 gates
35	Tam Soc	My Tu	2013-2015	1998	2 x 8	S/P, IR, DR	- Renew fences, operating bridge; - Repair the management house
36	Tam Vu	Tran De	2021-2025	2011	2 x 5,5	S/P, IR, DR	Overhaul maintenance
37	Tong Cang	My Tu	2016-2020	2006	2 x 7,5	S/P, IR, DR	- Renew gates, - Repair valves, operating bridge, upstream slope, - Repair the management house.
38	Xeo Gua	My Tu	2013-2015	1990	1 x 12	S/P, IR, DR	-Repair the operating bridge, controlled system, renew the stoplog recesses
V	**Bac Lieu**						
39	Gia Rai	Gia Rai	2013-2015	1999	3 x 8	S/P, IR, DR	- Replace by stainless gates; - Reinforce the eroded slope - Extension of Retaining wall, - Paint & repair operating beam, - repairing the stoplog recesses; - Renew fences of the operating bridge
40	Ho Phong	Gia Rai	2013-2015	1998	3 x 8,5	S/P, IR, DR	-Replace by stainless gate. - Increase the elevation of valve beams, stoplog recesses up to 60cm; - Increase crest of bench wall more 60cm; - Reinforce upstream and downstream slope which were subsidence and erosion; - Retaining wall extension, - Repair the operating beam - Repair the stoplog recess
41	Ninh Quoi	Hong Dan	2016-2020	2003	1 x15	S/P, IR, DR	- Painting gates; - Repair up/down stream slope
42	Phuoc Long	Phuoc Long	2016-2020	2004	1 x 12	S/P, IR, DR	- Painting gates;
43	Thong Luu	Vinh Loi	2016-2020	2005	1 x 10	S/P, IR, DR	-Painting gates; -Repair up/down stream slope
VI	**Ca Mau**						

46	Cong Nghiep	Tran Van Thoi	2016-2020	2011	1 x 10	S/P, IR, DR	Overhaul maintenance
47	Đa Bac	Tran Van Thoi	2016-2020	2005	2 x 8	S/P, IR, DR	- Repair column of transport bridge
48	Kenh Dung	Tran Van Thoi	2016-2020	2011	1x 10	S/P, IR, DR	- Paint gates, -Renew controlled cable and repair operation bridge
49	Rach Lum	Tran Van Thoi	2016-2020	2008	1 x 10	S/P, IR, DR	Overhaul maintenance
50	Tac Thu	Thoi Binh	2016-2020	2005	Gate:3x10; Lock:28 m	S/P, IR, DR	- Renew 3 gates and 2 locks
51	Xao Luoi	Tran Van Thoi	2021-2025	2011	1 x 10,5	S/P, IR, DR	Overhaul maintenance
VII	**Kien Giang**						
52	Ba Hon	Kien Luong	2021-2025	1999	3 x 8	S/P, F/C	Overhaul maintenance
53	Binh Giang 1	Hon Đat	2021-2025	2004	3 x 8	S/P, F/C	- Regular maintenance
54	Binh Giang 2	Hon Đat	2021-2025	2004	3 x 8	S/P, F/C	Overhaul maintenance
55	Cai Tre	Hon Đat	2021-2025	2005	3 x8	S/P, F/C	Replace by stainless gate
56	Dam Chich	Giang Thanh	2016-2020	2006	2 x 8	S/P, F/C	Painting and repair gates
57	Ha Giang	Giang Thanh	2021-2025	2009	1 x 15	S/P, F/C	Overhaul maintenance
58	KH9 -C	Go Quao	2021-2025	2008	2 x 8	S/P, F/C	Overhaul maintenance
59	Kim Quy	An Minh	2021-2025	1999	2 x 8	S/P, IR, F/C	Overhaul maintenance
60	Linh Huynh	Hon Đat	2021-2025	2004	3 x 8	F/C, S/P, DR	Overhaul maintenance
61	Lung Lon 1	Kien Luong	2021-2025	1998	3 x 8	S/P, F/C	Overhaul maintenance
62	T5	Hon Đat	2021-2025	1998	3 x 8	S/P, F/C	Overhaul maintenance
63	T6	Hon Đat	2021-2025	1998	2 x 8.5	S/P, F/C	Overhaul maintenance
64	Ta Lua	Hon Đat	2021-2025	2000	2 x 5,5	F/C, S/P, DR	Overhaul maintenance
65	So 2	Hon Đat	2016-2020	2000	2 x 8	F/C, S/P, DR	Replace by stainless gate
66	So 3	Hon Đat	2021-2025	2000	2 x 5,5	F/C, S/P, DR	Overhaul maintenance
67	So 9	Hon Đat	2021-2025	2001	3 x 8	F/C, S/P, DR	Overhaul maintenance
68	Vam Rang	Hon Đat	2021-2025	2010	3 x 10	F/C, S/P, DR	Overhaul maintenance
69	Vam Ray	Hon Đat	2016-2020	2000	3 x 8	F/C, S/P, DR	Replace by stainless gate

*Note: Purpose: S/P; Saline Intrusion Prevention, F/C; Flood Control, IR; Irrigation, DR; Drainage
Source: JICA Project Team

3.2 Standard Design of Sluice Gate

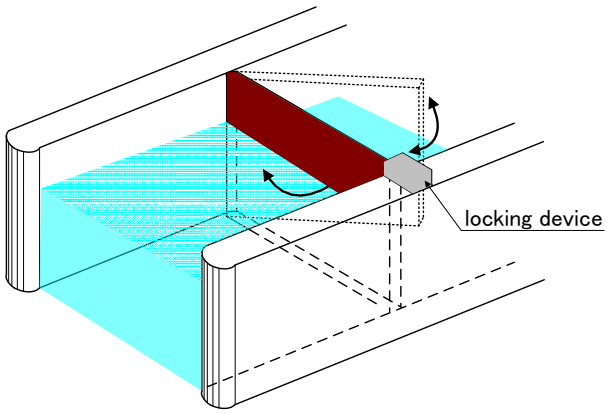
Functions required for the sluice gate in this Project are as follows; 1) to intercept river water above predetermined salinity concentration; namely preventing saline water intrusion, 2) to take river water below predetermined salinity concentration into canal, 3) to drain water of the canal out to the river, 4) to prevent intrusion of high tide or flood, and 5) not to impede the passing of ships. This section discusses different types of gates and proposes most suitable gate(s) in Mekong delta:

3.2.1 Characteristics of Swing Gate

Swing gate with non power type is spread widely in Mekong Delta area as the type of tide gate, and this project also applies this type of swing gate in most cases with stainless material gate. This type of gate has a same mechanism as a single swinging door. The gate leaf rotates horizontally and the one side of it is attached with pier by hinge. Since it is suitable for navigation pass as there is no structure above gate crest, this gate is used not only as a tide barrier with about 10-15m span at canals near the estuary but also as navigation sluice.

At the time of fully closed, the gate leaf serves as a simple beam of the both-ends support which receives water pressure. A swing gate installed symmetrically with the canal right-and-left side, for which both sides of gate leafs contact in the center of a canal to stop water leakage at the time of fully closed, is called miter gate, and this type is adopted in case canal is wide.

An electric rack gear type or the axial drive type by a hydraulic cylinder of opening and closing the gate is commonly employed in Japan. However, swing gate adopted in the Mekong Delta area is a non-power type. It rotates 180 degrees automatically by differences in the hydraulic heads at the gates created by each side. When the flow of water needs to be artificially stopped in the dry season etc., locking device which is installed at the opposite side of the hinge is operated by human power.



When swing gate is necessary to be closed, operation staff handles the locking device and fixes it.

Figure 3.2.1 Perspective Image of Typical Swing Gate (left) and Photo (right) in Mekong Delta

Main advantages for the swing gate are; 1) construction cost including sluice body is usually cheaper and maintenance cost such as fuel is almost free, and 2) since gate is movable both sides of canal, intake and drainage can be done even by rough management, and 3) as clearance under the maintenance bridge of the sluice is secured, navigation of ships is possible ever during maintenance work.

On the other hand, there are some disadvantages associated with the swing type gate. These are; 1) since the gate is opened or closed by the difference of water level; namely, by flow direction, optional operation according to the salinity concentration or emergency operation can not be done, 2) since quick and artificial control is not possible, some amount of saline intrusion is inevitable, 3) incomplete closing can easily take place even by a slight amount of garbage, 4) frequent maintenance is difficult since the gate is installed under the water, 5) spare gate and hoisting equipments are usually necessary for the gate repairing.

In addition, long span gate is difficult for this swing type gate to apply by structural reason. In most cases, less than 10 m width gate is common in Mekong delta area. Since this gate is superior in terms of cost as well as entailing relatively easy operation and maintenance, this swing type gate shall basically be adopted as the tide gate in Mekong Delta area except for 4 gates in North Ben Tre area (see later discussion). Although so far steel gate has been applied in Mekong Delta, this project propose stainless gate since they are to be installed in saline area.

(Regarding fish-pass attached to the gate, refer to Appendix VI-4)

3.2.2 Specific Design of Sluice Gate (Vertical Gate Type)

Though the sluice gate to be constructed under the project is basically to be swing type, there should be some cases when frequent and urgent operation is required in which vertical gate is superior. Vertical gate is classified in fixed wheel type gate, double leaf gate and slide gate. For a fixed wheel type gate, the hydraulic load is transmitted to a horizontal main girder through the skin plate and its supporting girder. The load is finally transmitted to the guide frame by vertical end girders at each side of the gate leaf and wheel. Since this gate type is mechanically and structurally simple, hoisting load is lighter than slide gate and is more dependable. This type of gate is most frequently used as barrage gate. The applicable range is also wide from small gates to long span gates.

Three types, namely girder type, shell type and truss type, are classified by leaf structure of vertical gate and generally defined by height of leaf (H), width (L) and their ratio (H/L). Stiffness must be considered for long span gate. H/L should be kept large to maintain the safety of gate body against leakage to be caused by bending under direct sunshine. The shape of rubber seal should also be carefully considered.

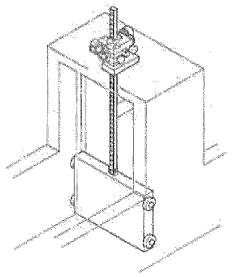
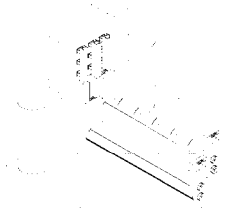
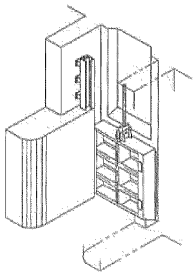
		
Fixed wheel type gate (Girder type)	Double leaf gate (Shell type)	Slide gate (Girder type)

Figure 3.2.2 Main Types of Vertical Gate

On the double leaf gate, control of discharge and reduced height of piers are the significant features. If control of discharge is the main purpose, the range of intake discharge must be decided in considering the intake method, operation method and the river condition. Since double leaf gate has a complex mechanism for sealing, guide frame and operation, the H/L ratio has to be smaller than the other types. Stability of the mechanisms should be checked carefully. A spoiler (that separates vein of water and supplies air behind the leaf) or other reasonable treatment is required to minimize vibration. Double leaf gates are divided into three types from the view points of structural differences:

- ✓ Double leaf gate; Two shell type or girder type gates are combined. Track rail and hoist are installed to operate each leaf.
- ✓ Hook shape type gate; Hook type gate leaf is installed for upper leaf and combined with lower wheel gate. Bottom wheel of upper leaf transmits load by rolling on the skin plate of the lower leaf. A hoist is usually used.
- ✓ Shell type with flap; This is a combination type of a flap gate for the upper gate and a shell type gate for the lower gate. Since the sealing mechanism and hoisting mechanism are comparatively simple, this type has been adapted as regulating gate for diversion weirs. The hoist part consists of both upper and lower operative winches and has a mechanism that makes it possible for the two hoists to work together.

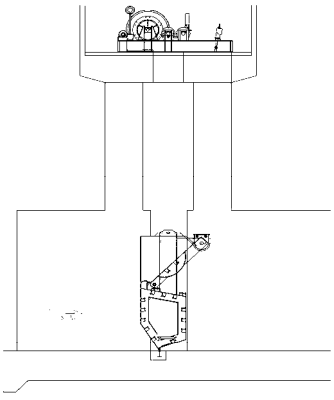


Figure 3.2.3 Schematic Figure of Shell Type with Flap

Slide gate is suitable for a relatively small span and water level gap. The mechanism is simple as a metal plate can be used for guide frame. Operation under hydraulic load causes a large load for hoisting since the gate leaf has to slide on the guide frame. Thus this type is not suitable for large gate leaves unless operated under balanced water pressure. The spindle of an oil-pressure - operated cylinder is generally used as the servomotor system.

Advantages of fixed wheel gate, representative vertical gate, are; 1) it is reliable as a structure which closes certainly in the time of flood, etc., 2) it can descend by self weight at the time of mechanical failure with hoist, 3) control of water level and/or the amount of discharge is possible by adjustment of optional openings, and when it is an electromotive type, opening-and-closing time is short, 4) if the gate is wound up, maintenance check and repairing of the gate is possible, and 5) application of the long span gate is possible structurally.

On the other hand, disadvantages associated with vertical type gate are; 1) since it is necessary to lift up the gate at the time of vessel passing, the structure should have a gatepost with necessary height, and, generally investment become high compared with a swing type, 2) in an electromotive type, operation and maintenance costs including electricity is required.

As above-mentioned, the vertical lift gate is supposed to be far superior to swing gate in terms of functionality. However selecting gate type should be determined in consideration of the importance of the sluice, the necessity for operation in accordance with saline concentration or water level since the cost of vertical lift gates is higher than that of swing gate in the respects of construction cost, operation and also maintenance cost.

1) Application for Intake Gate (Tan Phu sluice and Ben Ro sluice in North Ben Tre)

Tan Phu sluice and Ben Ro sluice in North Ben Tre province are to be constructed in the uppermost stream part of the area. These two sluices should work as fresh water intake during the time all the downstream sluices are closed in order to prevent saline intrusion from coming into the North Ben Tre area. In order to secure a flow demand as much as possible for a long time, it is necessary to operate the gate according to the water level situation by the side of the river and also the canal side continuously.

Therefore, accurate adjustments of openings, high water tightness, steady and smooth operational workability are required for its function of the Tan Phu sluice and Ben Ro sluice. From such a viewpoint, a vertical lift gate with electric motor is the most appropriate gate type for these sluices. In this gate, the introduction of advanced managerial systems, such as automation of operation linked to water level observed, monitoring and operation from a remote place can also be put into a view.

2) Application for Navigation Gate (An Hoa sluice and Ben Tre sluice in North Ben Tre)

On An Hoa sluice and Ben Tre sluice in North Ben Tre province, a large gate for ship passing must be installed, and its size are 30m in width and 8.5m in height. If flap gate, which was originally proposed in the preliminary design, is applied to these sluices, steady and smooth operation will possibly be prevented due to sedimentation, and moreover, maintenance is difficult since almost all the part of this gate is submerged. For this reason, a fixed wheel gate should be applied and especially the double leaf type is recommended in order to lower the gate pier height.

Shell type is applied for gate leaf structure in a view point of strength. Four (4) motor 4 drum type is suitable for its hoisting equipment which drives two leafs independently or simultaneously from both sides. Electric synchronizer should be equipped in hoisting device on either side, forming a system that can operate a certain speed in a range of a fixed error. In order for a vessel to pass even in high tide, it is necessary to ensure clearance below the gate leaf when it is full-opened. In this context, the elevation of lower end of gate leaf when lifted up should be same as the beam seat height of operation and maintenance bridge.

3.2.3 Gate Crest Elevation

Gate crest elevation must ensure the height against design outside water level and design wave height. Design outside water level means the maximum tide level which is intended for protection by tidal

sluice gate. Taking North Ben Tre area as an example, 1.97m which is the tidal level with 1% frequency at My Thuan Station, probability once in 100 years, according to the Vietnamese criteria of 14TCN130-2002 Design Guide is selected as the design outside water level. In this case, the required gate crest elevation is calculated as follows.

$H=TL+d$

$d=h_{s1}+a$

$h_{s1}=3.2K\times\tan\alpha\times hs$

$hs=0.0208V^{5/4}D^{1/3}$

where,

H : Design gate crest elevation (m)

TL : Design tidal level ; 1.97m (at My Thuan Station corresponding with frequency 1%)

d : Safety height (m)

h_{s1} : Design Wave height (m)

K : Coefficient depending on the ragged characteristics of dike roof; 1.0

α : Inclination angle of dike(°)

when the slope gradient =1:2, $\tan\alpha=0.5$

hs : Wave height by AndoreIanop's formula (m)

V : Wind velocity; 15m/s (the maximum wind velocity at Ba Tri Station)

D : Wave propagation length ; $D=0.5\times B$

B : Average river width; 2.0 km

a : Freeboard ; 0.3-0.5m depending on work grade (here 0.5 m is applied taking into account the importance of the facilities as well as the sea level rise effect under climate change)

$hs=0.0208\times15^{5/4}\times(0.5\times2.0)^{1/3}=0.61m$

$h_{s1}=3.2\times1.0\times0.5\times0.614=0.98m$

$d=0.98+(0.3\text{-}0.5)=1.28\text{-}1.48m$

$H=1.97+(1.28\text{-}1.48)=3.25\text{-}3.45m$, rounded at 3.50 m

Although freeboard is defined within the rage of 0.3-0.5 m according to the scale of project or an importance of the facility by the Vietnamese criteria (14TCN130-2002 Design Guide), maximum value of 0.5m is employed for safety in this project. As a result, it is decided that gate crest elevation shall be H= 3.50 m. Even if a change of water level by climate change takes place in future, it can be said that the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard). These views are applicable also in other areas in Mekong Delta, though, numerical values, such as design outside water level need to be based on the latest data.

3.2.4 Gate Sill Elevation

The tide gate must have sufficient cross-sectional area of flow to meet the design discharge. Therefore, the cross-sectional area of flow of a tide gate is obtained basically based on the plan for drainage of inner basin by means of hydraulic calculation. The sill level of movable portion of a sluice must be decided in strict conformity with the canal bed, so that it would not cause any sediment on the sill to block the gate operation. Sedimentation of sand or scouring is hard to take place when the gate sill elevation coincides with current canal bed elevation.

3.2.5 Span Length of Movable Portion

Span length of movable portion of sluice must be of such a length as not to have a serious effect on the flow taking into consideration the design maximum discharge, condition of the water flow and technical and economical factors for manufacturing the gates. It is said that about 40-60% of present canal width is suitable as a cross-sectional area of a flow from the several results of design in Vietnam

although it should basically be obtained by hydraulic study as above-mentioned.

The number of spans of gates is obtained by dividing the whole flow width by the single gate width. This basic unit of width per gate is 10m in the example of North Ben Tre project. Since there are advantages such as sharing of component parts and diversion of stop-logs during repairing period, the width of one gate is set to be 10m in this project as a basic rule.

3.2.6 Gate Material

In Vietnam, steel gate has been widely used for sluice gates. Most of the gates had been installed in fresh water areas for the purpose of controlling water distribution in irrigation and drainage system. However, under this project, the gates are to confront high content of saline water since they are constructed in saline water intrusion areas. Therefore, stainless material gate is recommended rather than steel material gate. Though the stainless material gate is higher in cost than the steel gate, the cost difference is not so much nowadays, and there are several advantages pertinent to the stainless material gate.

As summarized in the following table, stainless gate is in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Further, when comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting. Therefore, this project proposes to adopt stainless material gate for the sluices.

Table 3.2.1 Comparison between Carbon Steel Gate and Stainless Gate

Item	Carbon Steel	Stainless Steel
Strength	Both strength and stiffness are excellent.	Both strength and stiffness are excellent.
Corrosion resistance	Inferior in corrosion resistance, hence painting is required.	Excellent in corrosion residence is.
Appearance	Various colors available by painting.	Gloss is kept for long.
Productivity	Easy to weld and fabricate.	Easy to weld and fabricate.
Maintenance	Repeated painting is required.	Painting is not necessary.
Total Cost for 30 years (M. VND)	13,574 (refer to Table 3.2.2)	13,150 (refer to Table 3.2.2)
Conclusion	Not apply	To be applied

Source: JICA Project Team

Table 3.2.2 Cost Estimation of the Gates over 30 years

Particulars			Carbon Steel	Stainless Steel
Representative Dimensions			B=10.5m, H=7.5m (common size in MD)	
Weight of gate leaf(ton):A			49.5	50.0
Unit cost for fabrication(1,000VND/ton):B			202,000	263,000
Area for painting(m^2):C			200	-
Unit painting cost(1,000VND/m^2):D			8,000	-
Painting cost per one time(1,000VND):E=CxD			1,600,000	-
Initial Cost(1,000VND):F=AxB+E			11,599,000	13,150,000
Running cost for painting (1,000VND)	Passed years	Discount Rate (12%)	Running cost	
	5	0.567	907,883	-
	10	0.322	515,157	-
	15	0.183	292,314	-
	20	0.104	165,867	-
	25	0.059	94,117	-
Total painting cost for 30 years(1,000VND):G			1,975,338	0
Initial cost +running cost(1,000VND):F+G			13,574,338	13,150,000

Source: JICA Project Team

3.3 Specific Construction Works Required

3.3.1 Specific Foundation Works

The foundations of a sluice must transmit the loads of pier, sluice body, etc. safely to the bedrock below or in subsoil stratum having sufficient bearing capacity. In addition it serves to cut-off the ground water flow below the sluice body, which may be caused by difference in water level between upstream and downstream. The foundation shall also work as a cut-off wall to secure required creep length preventing the piping of the gravel layer, and as a partition wall to prevent scour occurring on the riverbed at the upstream and downstream ends of the sluice body.

The appropriate construction method must be selected in consideration of the situation of the foundation ground at the point where the sluice is to be erected and also the functions of the superstructure. Therefore, in the design of the foundation of the sluice, care must be taken to understand the objective mentioned above thoroughly, and to adopt the construction method that is suitable for the site.

Foundation work includes; 1) spread foundations constructed directly on bedrock or gravel; 2) pile foundations which are bearing piles with piles resting on a foundation layer or by friction piles; and 3) well foundations and caisson foundations as special foundations. As for the spread foundation, there is usually no problem when sluices are erected on bedrock. However, footings are required when the sluice is erected directly on gravel whereby the base of a sluice body, abutment and piers are enlarged.

Pile foundations are used where the top layer of the ground is weak and the safe bearing layer lies deep. Also, when dewatering is difficult and it is impossible to construct a spread foundation by excavation without timbering, this pile foundation is employed. Compaction of the ground is expected by driving the piles. In selecting a pile foundation, attention should be given to workability and reliable strength of the ground.

When designing a pile foundation, the condition of the ground stratum must be investigated by boring to examine the bearing capacity. Examination for possible settlement must also be conducted. In considering the allowable bearing capacity of a pile foundation, the bearing capacity of the pile alone is usually considered without adding the bearing capacity of the ground. It is considered safer not to assume the bearing capacity of the ground since the base of the pier and sluice body supported by piles may be floating on the piles as a result of ground settlement and the flow of the sediment beneath the foundations.

The types of pile foundation and their length applied generally are as follows.

Table 3.3.1 Typical Pile Characteristics

Type	Advantage	Disadvantage
Timber pile	◦Easy to transport and handle. ◦Easy to adjust length of piling ◦Short construction period	◦Limited to use in submerged part and poor durability where no ground water exists. ◦Unsuitable for large load ◦Uniform less material owing to bending , knots, etc. ◦Difficult to obtain
Pre-cast concrete pile	◦As material is uniform and dense, it has large compression strength and impact resistance ◦Reliable when splice is not used ◦Possible to use without examination of normal water level ◦Possible to negotiate slightly hard intermediate layer	◦Heavy weight and poor treatment causes cracks ◦Unreliable when splice is not suitable ◦Difficult to obtain long one (up to 15m)

Steel pile	◦Possible to use long pile (up to70m) ◦Reliable (splice should be made by electric welding and material should be uniform) ◦Bearing capacity is high because impact bending resistance is large. ◦Possible to negotiate intermediate layer (N value:50-70) ◦Easy to transport and handle (Unit weight of steel pile is approximately 1/3 of that of concrete pile. Rough handling is permitted and it is possible to transport steel piles on the water if necessary) ◦Easy to adjust length of pile by cutting and welding if necessary	◦High cost ◦Treatment of prevention against corrosion is needed depending on site conditions ◦Much preparation work in load testing, etc. is required because of high bearing capacity

Table 3.3.2 Types of pile foundation and its applicable length

		Length of pile (m)					
		10	20	30	40	50	60
Driven pile	Reinforced concrete pile	▬	▬				
	PHC pile		▬	▬	▬		
	Steel pipe pile		▬	▬	▬	▬	▬
Cast-in-place pile	Overall casing method		▬	▬	▬		
	Reverse circulation drill method			▬	▬	▬	▬
	Earth drill method		▬	▬	▬	▬	
Inner excav'n pile	PHC pile		▬	▬	▬	▬	
	Steel pipe pile		▬	▬	▬	▬	▬

PHC Pile: Prestressed High- Strength Concrete Pile

3.3.2 Specific Temporary Works

1) Construction Site

About the construction method of a sluice, two measures can be considered; one is to construct on the present channel, the other one is to construct in a land and change the waterway after the construction. In the former case, the construction is usually carried out with a temporary cofferdam. In the latter case, though the construction of sluice is easy since cofferdam is not necessary, a large amount of earthwork, resettlement of household and compensation expense may become inevitable. In this project, construction site is in an existing canal in principal from the point that no serious influence on surrounding circumstances is expected.

2) Coffer dam

There are various types of cofferdam structures to be constructed in a waterway, and it is necessary to determine in consideration of economical efficiency, the importance of the structure, constraints of construction nature, etc. In the river works, earth embankment or single row or double-row sheet-piles cofferdam are usually used. In particular case of large-scale river works, a double row steel sheet piles method is suitable considering the high water stop performance capability and its stability.

Generally, where the subject river or canal is broad in width and small in water volume at normal times, earth cofferdam is often employed with gabion or cages to resist erosion by the running water. This method is inexpensive; however, it is susceptible to overflowing as well as it permits much seepage flow. However, the addition of a cut-off curtain cofferdam composed of steel sheet piles driven in a single row inside of this cofferdam will be effective in reducing the seepage of water.

Steel sheet-piles are used frequently as they are watertight and relatively safe against floods. In this case, they are often used in single row. However, since they must be driven, sometimes to great depth, it may be applied to fill the earth one side (putting soil at one side) or on the both sides of the steel sheet-piles if space permits in order to reduce the driving depth.

If a double row of sheet-piles is used, the two sides of the cofferdam are tied together with tie rods or round steel bars, and the inside is filled with earth. With this arrangement, it can stand by itself even with short embedded lengths of steel sheet-piles. The double row cofferdam is resistant against floods and is specially suitable when it is located at the place with its outside high water level, or in a river of narrow width or when it has to be left in place even in the flood season. In this case, attention must be paid to the danger of piping under the cofferdam foundation, and the top of the earth fill must be covered with concrete or other suitable material.

An example of double row steel sheet pile method: Steel sheet pile and filling sand can secure high water-stop ability.

Sectional view of double row sheet piles cofferdam. Sheet piles on both sides are connected with steel tie-rod and the space between the sheet piles are filled by sand

The height of cofferdam is determined in consideration of a freeboard adding to the water level which occurs during the construction stage. Generally, design discharge is defined based on past observation data, and water level will be obtained by hydraulic calculation in consideration of the cross-sectional area of flow to be obstructed by the cofferdam. If the water level caused by tide or waves is higher than the above-mentioned level, this water level is applied.

3) Material and Equipment Transportation Facilities

A plan must be established to transport construction materials, gates, construction equipment, etc. It is necessary to select, modify, repair or construct roads capable of transporting these materials and equipment. Installation of cables, etc. may be required. Generally, vehicular transportation is the easiest and most economical, and therefore access roads must be provided. The need for intermediate repair or maintenance during the construction period must also be taken into account. The desirable width of the road may be such that two-way traffic of major vehicles for the work can pass safely, although this is dependent on the frequency of road use.

4) Electric Power Facilities

A monthly power consumption schedule must be established based on the construction equipment use schedule and lighting installations. Based on this consumption schedule, negotiation with the electric power company must be made in advance. Where power distribution is very costly or a large amount of electricity will be consumed temporarily, it is necessary to consider the provision of a non-utility power generator or other type of power installation. A countermeasure for power failure must be taken into account.

5) Temporary Storage Yards

Temporary storage yards include a temporary site buildings area (accommodating guardhouse, workshops and warehouses), temporary road area, material storage yard, material and equipment storage yard, substation area, etc. Though these yards and areas differ in required area depending on

the scale of the work, they must be suitably allocated so as not to interfere with the scheduled progress of work.

6) Access Roads

Access roads have to be constructed as required before or during the work and maintained thereafter. Construction equipment today is mostly large, and ready-mixed concrete is often transported from off-site plants. Therefore access and approach roads must be thoroughly resistant to heavy loads and large vehicles. When construction continues 2 to 4 years, the pavement of the road has to be studied in consideration of maintenance, noise and dust. To facilitate the haulage of materials and appliances, access roads should preferably be provided up to the inside of the cofferdam.

7) Concrete Placing Facilities

Concrete placing facilities of the required capacities to suit the construction schedule have to be mutually balanced with regard to concrete mixing, transportation and placing. When ready-mixed concrete is used, the ready-mixed concrete plant must be located near the construction site as well as capable of performing sufficient quality control. Depending on the site where off-site ready-mixed concrete plants are situated, the use of either site mixing or ready-mixed concrete should be determined.

3.4 Operation and Maintenance of the Sluice Gates

3.4.1 Operation of the Sluice Gates

The objectives of operation are to meet demands for preventing saline intrusion, storing fresh water, removing acidity and sedimentation and keeping water traffic effectively. Operation rules should be established in accordance with the rules of neighboring existing sluices and in consideration of present condition of water use or water traffic in the beneficiary area and so on. Basic operation manner of the gates are as follows.

During dry season, in order to prevent saline intrusion into the project area and to store fresh water in the canals, all the gates of sluices must be closed. However, they are usually opened artificially a few times per month even in this period to drain water or to allow boats passing through the sluices.

During rainy season period, all the gates, which are powerless swing type gate, are open and move freely depending on the water difference between the river side and the canal side. Basically water traffic is not obstructed by the gates. But in case the water level is expected to rise higher unusually because of, e.g., storm or some other causes, gates should be closed in order to prevent flood damage in the area.

3.4.2 Maintenance of the Sluice Gates

Since a hydraulic gate is one of a public infrastructure for the purpose of water utilization or flood management, the damage which affects community life is serious when the gate loses proper functions due to a failure. Therefore, maintenance, inspection and control for a gate shall be conducted properly to well-maintain each function.

The hydraulic gate should be inspected regularly or as appropriate in order to maintain the functions and to prevent accidents beforehand. The historical records, specifications, design drawings, test records, and operation manuals for the gate should be maintained. In addition, the inspection record, operating record, and repair record, etc., should also be well-maintained.

The interval of regular inspections should be set in the control standards established separately taking into account the use conditions, functions, and importance of gate. After flooding, it is desirable that

the gate leaf, gate guide, and auxiliary facilities should be inspected immediately.

The support for a gate leaf is a point where the hydraulic pressure working on the leaf concentrates, and therefore all the supports should be in a completely maintained condition so that they operate smoothly under hydraulic pressure. In other words, main wheel pins of a fixed wheel gate are always required to be covered with appropriate lubricants. In particular, the wheel pins of a fixed wheel gate are numerous and the foothold for maintenance is generally poor, thus leading to insufficient maintenance.

The hinged supports of swing gate are generally subject to large pressure and revolve at a low speed, and therefore extreme care should be taken so that the lubricant is always applied throughout the entire surface of the support. With insufficient lubrication, bearings are likely to be seized, and the wheel pin tends to rotate with the wheels, thus leading to trouble in operating the gate leaf. For this reason, lubrication is one of the essential maintenance items for smooth operation.

A gate hoist of vertical lift gate should be perfectly maintained, so that the gate leaf is operable at any time. Attention should be paid during the inspection to lubrication, occurrence of rust and slackness of tightening bolts at each part of the gate hoist, temperature increases in the bearings, electric parts and the rope wires, and limit switches and brakes, as well as greasing of the wire-ropes. Cleaning up is also required for the rubber seals and roller to rid them of tree leaves or wood chips before operation.

Repair or replacement of a gate should be made based on the followings: 1) when there is a fear that the stress of each member exceed the allowable stress for each material used, thus leading to a breakdown, 2) when the gate is estimated to be in danger because of structure instability due to vibrations, and 3) when there is some trouble in operating the gate because of an excessive drop in performance.

Although the gate leaf itself is supposed to be maintenance-free when it is made by stainless steel, some parts such as rubber seals should generally be repaired or replaced. In addition stop-log or temporary gate shall be provided for the purpose of repairing the hydraulic gate. When repairing the gate, these ones are temporarily used as a substitute for the gate so that the repair work can be done without lowering the water level in a canal.

Crane equipped for hoisting and carrying the gate leaf. Crane is usually driven by electric motor.

Hoisting device for repairing the swing gate: If the height of swing gate leaf is large, high gate pier is also needed.

3.5 Monitoring of Saline Intrusion

3.5.1 Monitoring Organization

Ministry of Natural Resources and Environment is responsible for meteorological observation and data

collection at national and regional level with several weather measurement stations; water level and saline content of major rivers are measured at the meteorological stations. In each province, there is an or a water resource management company (WRMC); which is responsible for monitoring of saline content of river/canal water near sluices. Much of the management responsibility for irrigation infrastructure has been transferred WRMC from DWR of DARD.

WRMC receives technical assistance from DWR and DARD but it is so called an autonomous self-financing enterprise while WRMC is a monopoly enterprise on provincial water management works in a province. Each coastal province has a such company and the management system is the same as this way. In addition to technical assistance, administrational instruction is also made by DWR and MARD. The WRMC operates and maintains water distribution systems in Mekong delta until canals reach the point at which water is delivered to a “district” level.

3.5.2 Measurement of Saline Content

Saline content of water is measured near a sluice location; whether the saline content excess 2g/L or not. This regulation comes from irrigation standard of Vietnamese government, which saline content of water equal or more than 2g/L is not suitable for irrigation purpose. If saline content of water arrives 2g/L, WRMC have to close gates of sluice in order to prevent saline intrusion into farm area. this is why the measurement is usually once a month (=28days cycle) at the beginning of dry season. Water level of Mekong River descends and becomes lowest in April and May.

In April and May, interval of measurement on saline content becomes short such as once a two-weeks, or once a week. There is early saline intrusion sometimes in comparison with ordinary years, then, it is reported that unexpected saline intrusion occurs in some areas; a delay of confirmation for saline content of water caused a delay of closing operation of gates for saline intrusion. Consequently, there was serious damage to the crops and loss of crops was over 70% in 8,000 ha in 2011 in Tra Vinh province. IMC/WRMC will undertake monitoring of saline content for each sluices to be constructed; appropriate monitoring system establishment is necessary together with this project in the context of climate change. “Capacity Building on Water Flow Management” will be one of intervention for this purpose and detail of it is described in Part IV in this report.

3.6 Agriculture Extension

3.6.1 Change of Water Resource Circumstances

Sluice enables to prevent saline water intrusion into beneficiary areas; irrigation water condition in such places will improve in comparison with the days without sluice. It will be new circumstances for farmers, saline content of water does not increase in dry season. In some cases, there will be necessity for farmers to revise or change cropping pattern in accordance with availability of fresh water in dry season. Thus, cropping pattern shall be examined according to progress of sluice construction, and suitable agriculture extension shall be conducted coupled with the revise of cropping pattern. This is why attention shall be given to keep agricultural and/or aquacultural farm lands to be suitable for stable production in response to circumstances newly created by investment.

Aforementioned activity will save the livelihood of farmer household through a sustainable manner. Construction of sluice gates alone cannot achieve the above purpose, it should be combined with other effective measures, which may include improvement of water management and/or shifting cropping patterns to be more suitable to newly obtained water resource circumstances. Among all, an agriculture extension program is proposed as a supportive component of sluice gate construction project. Note that agricultural extension program should not be implemented without strategic conduct of sluice gate construction as sluice gate should be operated based on the introduced farming systems and farming systems should be planned based on an availability of saline water control enabled by a series of sluice

gates and their operation.

3.6.2 Extension System

As for the agricultural and aquacultural extension, there are two major channels; one led by government and the other by private institutes. The government extension system, or national agricultural promotion system, is administrated through a cascading system from top to down: 1) MARD at national level represented by National Center for Agricultural Extension, 2) provincial agricultural extension centers, 3) agricultural extension stations at district level, 4) commune extension clubs for agricultural extension, which is composed of advanced farmers, and 5) common farmers on the ground (see Figure 3.6.1).

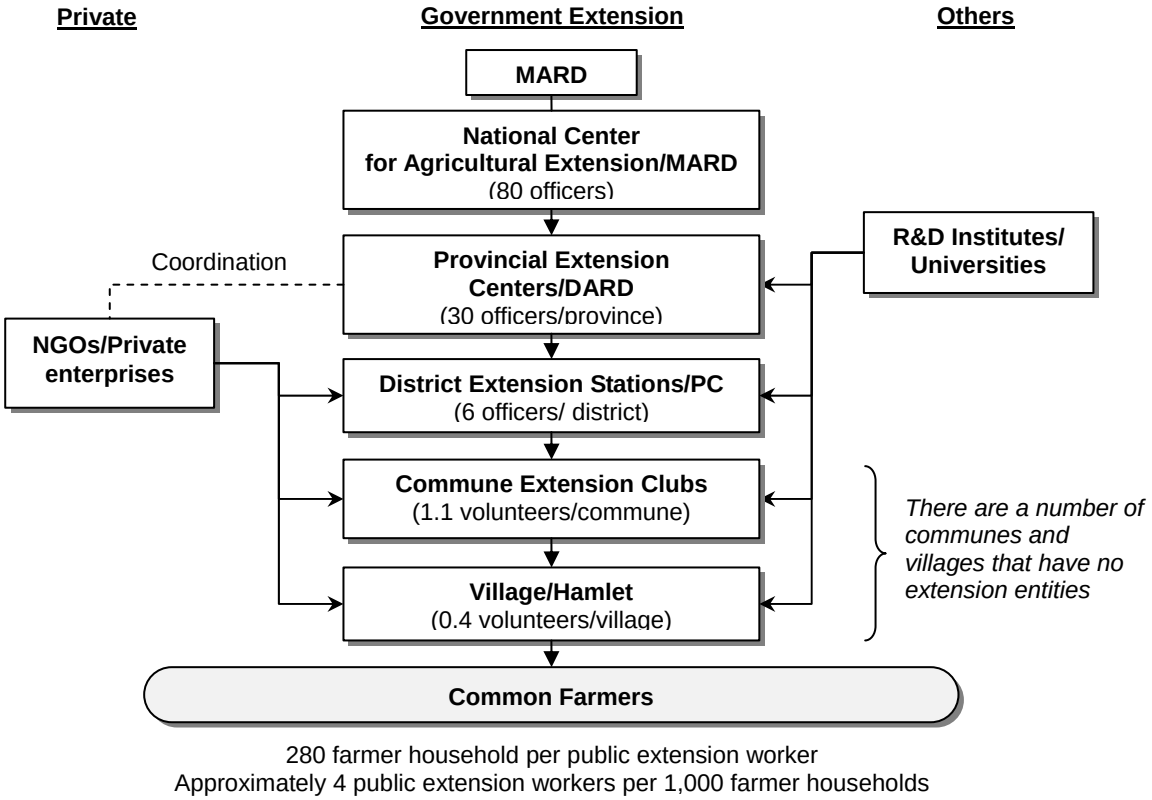


Figure 3.6.1 Agricultural Extension System

Source: "Agricultural Extension Systems of Vietnam, Vietnam Academy of Agricultural Sciences (VAAS) (year not known)
Modified based on interviews to Southern Horticultural Research Institute and Sub-NIAPP (2012)

The role of MARD in the system is to comprehend entire national agricultural extension system. Given necessary budget from MARD, the national extension center takes a leading role on technology aspect, under which several research and development institutes cooperate. In the national center, there are approximately 80 officers. At provincial level, provincial extension centers are attached to DARD in each province, in which on average 30 officers are stationed. In addition to administrative functions, those provincial officers take a role of giving technical assistance to officers at district level.

Officers at district level usually take charge of 3-5 communes, that is, those officers are working as generalists not specialists of specific commodities. The governmental system maintains its offices down to district level, at commune level, district officers sometimes stays at peoples' committees' office to work on demonstration, lectures and other technology dissemination activities on the ground. At commune level, there are sometimes groups of advanced farmers called "club." Those advanced farmers are the key personnel who then transmit any information or technologies to other common farmers in villages.

Aside from the government agricultural extension system, a number of independent institutions carry out extension activities at provincial level or below. Those institutes include research and development institutes of specific subjects, universities, private enterprises and NGOs. For example, Southern Horticultural Research Institute (SOFRI) and Cuulong Rice Research Institute promote new technologies or varieties they developed in coordination with the extension centers at province and/or district level. Furthermore, private enterprises, such as fertilizer companies, do promotion of their products with a technical guidance of their products (i.e. effective use of fertilizer along with cropping calendar or type of soil). When doing promotion activities, such enterprises coordinate with provincial extension centers.

3.6.3 Extension in the Context of Sea Level Rise

To advance effects of saline water prevention for beneficially area with suitable and sustainable agricultural and aquacultural manner, there are four major points to be identified; 1) vulnerable areas where saline intrusion has already become apparent is the first one for adjustment of implementation schedule; 2) improved agricultural and aquacultural systems are the second one to be established for advancing effect of sluice construction, which are suited to each level of environmental features caused by sea level rise and its intervention ; 3) new agricultural and aquacultural systems are put in the agricultural and aquacultural land use plan in accordance with the progress of sea level rise for the third one to enhance further development; 4) the forth is that an entire process of the above is systematized as an improved extension system oriented to sea level rise and its intervention for coping with uncertain change of sea level rise in future.

Details of agriculture extension is described in Part V “Capacity Building on Cropping Pattern Improvement and Adjustment” in this report.

CHAPTER 4 IMPLEMENTATION ARRANGEMENT

This chapter describes necessary implementation arrangement for the project. As is mentioned in Chapter 1.3 Implementation Organizations, a responsible office for the project implementation depends on budget source whether it comes from national budget or foreign budget. This project deals mainly with sluices over 20m of width; by which implementation arrangement is discussed hereunder:

4.1 Institutional Arrangement

4.1.1 Implementing Agency

For the project, there are three agencies which can implement for sluice construction under Ministry of Agriculture and Rural Development; one is Central Project Office Unit 10 for Mekong Delta regions (CPO (10)), the second is Permanent Representative Office under Department of Construction Management (PRO), and the third one is Department of Agriculture and Rural Development (DARD) in each Province.

CPO (10) deals with ODA project for large and regional scale. PRO can implement a project with medium and/or regional scale with Vietnamese government budget and also ODA budget. DARD is an implementation organization for a small and/or provincial scale project with Vietnamese government budget and also ODA budget. Implementing agencies for the project are summarized as follows. In fact, however, there is not clear demarcation among the scales of project; then, the minister of agriculture and rural development makes decision on the final section of the implementing agency.

Table 4.1.1 Implementation Agencies for Projects in Mekong Delta with different project scale

Project scale	Vietnamese Government's Budget	ODA Budget
Large and Regional	PRO	CPO (10)
Medium and Regional	PRO	PRO
Small and Provincial	DARD	DARD

4.1.2 Institutional Arrangement for Construction

There are two major procedures for construction works; one is budget disbursement procedure and the other is monitoring procedure. An implementation agency deals with procurement of engineers and contractors for sluice construction such as; tender, contract, construction inspection, budget disbursement. These activities must be reported to PRO, and DCM checks and approves them for the budget disbursement. DCM disburses budget for the project in case of Vietnamese government fund, and budget disbursement of ODA project is done by CPO.

There are some monitoring items for sluice construction in Mekong Delta such as technical aspects and governmental procedures. PRO is responsible to monitor these items to DCM in accordance with relevant laws and regulations of Vietnamese government. During this monitoring, if there is necessity to support and guide to DARD, PRO conducts appropriate and adequate guidance to DARD.

1) CPO (10)

Office of CPO (10) represents CPO for tasks and duties in Mekong Delta region. An office of it is located in Can Tho province and it is one of 10 regional branch offices under CPO. A dominant sector which CPO (10) deals with concerns water resource or drainage such as sluice construction, dike construction, and pump station construction. Since CPO was established for dealing with ODA budget project, CPO (10) represents MARD as a focal point for international donors; therefore, all projects whose budgets come from international donors in Mekong Delta are controlled by CPO (10).

Major tasks of CPO (10) for construction implementation are; to contact and communicate with donors as the representative of MARD in Mekong Delta region, to collaborate with PPCs in order to

implement projects, to procure engineers and contractors, to disburse project payment to the contractors according to project progress, to disburse payment according request from PRO and/or DARD with endorsement of DCM, to manage large and regional projects on their own, and to prepare annual and/or semiannual monitoring and management report to MARD.

In year 2012, CPO (10) deals with total 12 ODA projects under their management and total projects' budget in this year is about US$ 24 million. Cost from donor shares about 30% of it, so that estimated disbursement in this year from ODA account is about US$ 7 million. Total staff in CPO (10) is 60 persons. Organization Chart of CPO with CPO (10) is shown in the following figure.

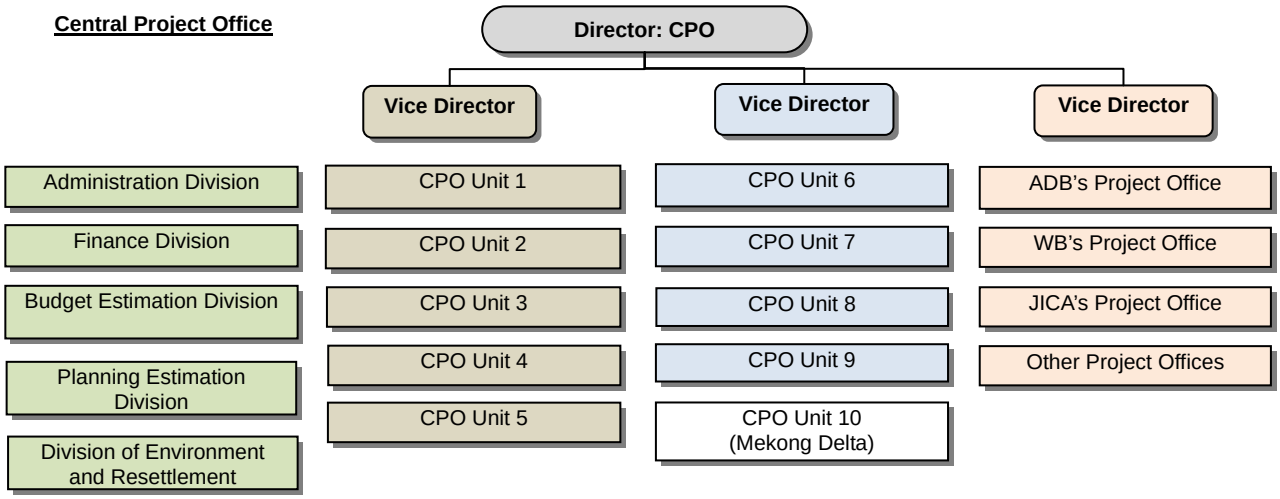


Figure 4.1.1 Organization Chart of Central Project Office with CPO (10)

2) PRO

Permanent Representative Office in Ho Chi Minh (PRO) represents Department of Construction Management and mainly deals with Vietnamese government budget project in Mekong Delta. PRO is basically a monitoring body for the government budget projects; PRO monitors construction implementation procedure whether DARD follows policy, laws, and regulations of the government or not. PRO also takes responsibility for construction implementation and technical assistant projects funded by ODA budget, then, PRO also monitors CPO (10)'s management for construction implementation procedures.

Major tasks of PRO for construction implementation are; to prepare monitoring reports on construction implementation procedures of DARD, to submit the reports to MARD for government approval on budget disbursement, to manage medium and regional scale projects on their own which the source of budget comes from Vietnamese government and/or ODA, to prepare and submit reports on international fund projects to MARD which implementing agencies are DARD, PRO, and CPO (10), to prepare annual evaluation report on the aforementioned projects.

In year 2012, PRO deals with total 25 regional projects with local budget and 3 regional projects with ODA budget; donors of these ODA projects are WB[1], ADB[2], and AFD[3], funded amount by donors are about 160 million US$, 220 million US$, and 110 million US$ respectively. There are total 8 staff in PRO. Organization Chart of DCM with PRO is shown in the following figure.

[1] Mekong Delta Water Resource Management for Rural Development Project, funded by WB, 2011
[2] Phuoc Hoa Water Resource Supplementary Project, funded by ADB
[3] Flood prevention for Lower Saigon River Area

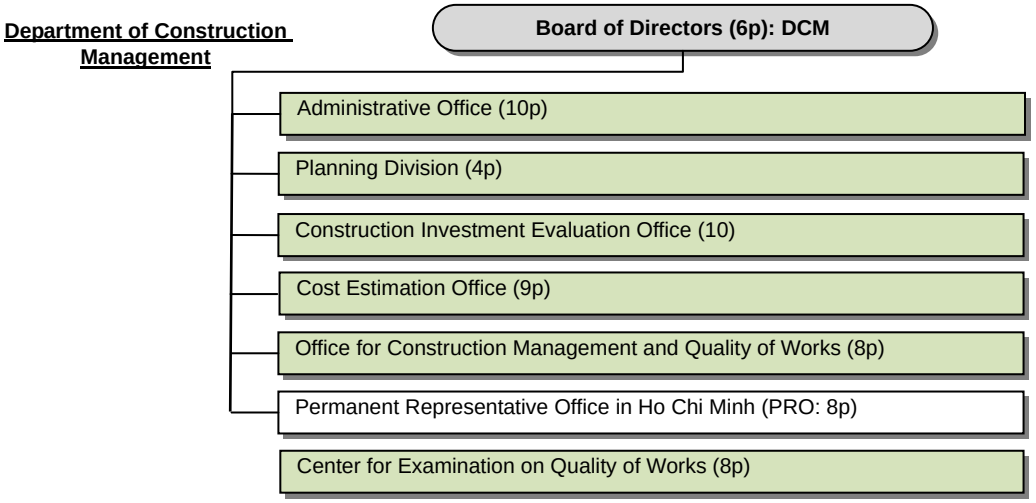


Figure 4.1.2 Organization Chart of Department of Construction Management with PRO

3) DARD

Department of Agriculture and Rural Development (DARD) is a regional branch office of Ministry of Agriculture and Rural Development in a province. DARD is responsible for the project implementation of hydraulic infrastructure construction in each province. Organization structure of DARD differs by province but there are usually several vice directors under the director. Under a vice director, there are usually a water resource department and an investment management department which concerns sluice construction.

The water resource department is a planning section of hydraulic infrastructure and this department assists an investment management department for implementation. The investment management department deals with all related works on hydraulic infrastructure construction implementation such as; land acquisition, resettlement, procurement of contractor and engineers, project management in association with the water resource department.

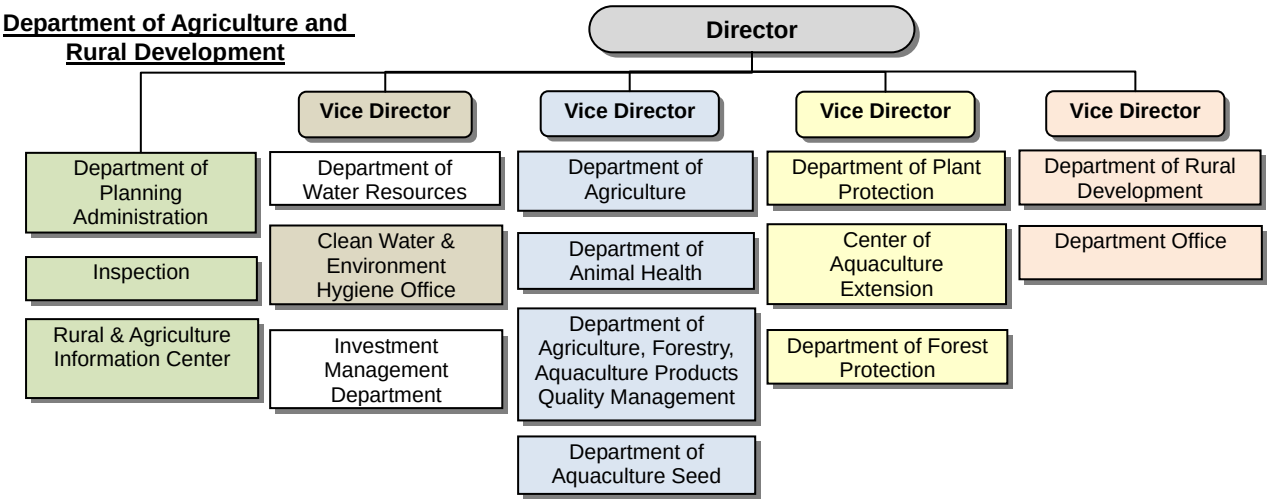


Figure 4.1.3 Example of Organization Chart of Department of Agriculture and Rural Development

DARD obtains project budget for construction implementation from PRO and/or CPO (10) subject to obtaining approval from the Provincial Peoples Committee. Project scale which DARD deals with is normally small and/or provincial scale; implementing organization is decided by the Minister of Agriculture and Rural Development. DARD usually deals the local budget project while it can manage

not only local budget project but also ODA budget project. A project with local budget is normally small and provincial scale but a project of such ODA project has large and regional scale, so that local budget project is dominant for DARD activities.

Number of staff in DARD is about 300 – 400 peoples; staff number of water resource department is 10 or more, and that of investment management department is about 10. In year 2011, DARD of Tra Vinh province deals with total 230 Billion VND, which is composed of 20% for ODA project, and 80% for Vietnamese government project in the water resource sector. The following figure shows an example of DARD organization chart.

4.1.3 Institutional Arrangement for Operation and Maintenance

After completion of sluice construction, Water Resource Management Company (WRMC) is responsible for operation and maintenance of sluices. WRMC is an autonomous self-financing organization from DARD while it receives some works from DARD or PPC. WRMC in case of Tra Vinh province received budget from the central government (78% in share), provincial peoples committee (19% in share), and donation from people in the province (3%), total about 267 billion VND in 2007. Their tasks are; sluice management and operation including saline content monitoring, canal dredging, small scale road construction, and small scale bridge construction. Total 39 staff is involved in these works.

4.2 Cost Sharing Arrangement

4.2.1 Construction Project

Total cost of this project is estimated as US$ 1,090 million which is composed of construction cost, compensation cost (for resettlement), and other cost. Since total cost of the project is quite huge, it is considered very difficult for the Vietnamese government to implement whole project on her own. Therefore, ODA assistance should be sought for the part of the construction cost. Construction cost shares about 54% of total cost, compensation cost is 23%, and other cost is 23%. Other cost is composed of miscellaneous cost and contingency cost.

It is considered that project cost will be changed according to socio-economical situation and environmental condition; procedure of resettlement takes time and it takes more than 10 years in some cases. Therefore the costs including compensation shall be undertaken by Vietnamese government. Negotiation and discussion with peoples for resettlement should be done continuously and steadily, and then, implementation of the project will be commenced smoothly. Recommended cost share is summarized as follows.

Table 4.2.1 Proposed Cost Share for the Sluice Construction Project

Items	Cost (million US$)	Share (%)	Demarcation
Construction	585	54%	ODA
Compensation	255	23%	Vietnamese Government
Others	250	23%	Vietnamese Government
Total	1,090 (585: 505)	100% (54%: 46%)	-

Note: Others includes physical contingency, project management cost, consultation cost, and other miscellaneous cost.

Table 4.2.2 Proposed Cost Share for the Sluice Construction Project (1/2)

No	Sluice Name	District / city	Schedule	Width (m)	Foreign (Bil.VND)	Vietnam (Bil.VND)	Total Cost (Bil.VND)
I	**Tien Giang province**				**936.32**	**880.56**	**1,816.88**
1	Bang Lang	Cai Be	2041-2050	30	117.90	110.87	228.77
2	Ba Rai	Cai Lay	2041-2050	30	117.90	110.87	228.77
3	Cai Be	Cai Be	2041-2050	20	78.60	73.93	152.53
4	Cau Sao	Chau Thanh	2021-2030	20	78.60	73.93	152.53
5	Mu U	Cai Lay	2031-2040	20	75.16	70.68	145.84
6	Nguyen Tan Thanh	Chau Thanh	2021-2030	30	117.90	110.87	228.77
7	Rau Ram	Chau Thanh	2031-2040	20	78.60	73.93	152.53
8	Sau Au	Chau Thanh	2013-2020	20	75.16	70.68	145.84
9	Tra Lot	Cai Be	2041-2050	30	117.90	110.87	228.77
10	Tra Tan	Cai Lay	2041-2050	20	78.60	73.93	152.53
II	**Bến Tre province**				**3,586.43**	**2,736.34**	**6,322.77**
11	An Hoa	Binh Dai	2013-2020	130	599.20	229.77	28.97
12	Ben Ro	Chau Thanh	2013-2020	20	63.58	28.37	91.95
13	Ben Tre	Ben Tre city	2013-2020	70	397.57	136.80	534.37
14	Cong Be	Binh Dai	2031-2040	30	123.06	115.72	238.78
15	Dinh Trung	Binh Dai	2013-2020	40	164.08	154.30	318.38
16	Eo Loi	Thanh Phu	2031-2040	100	410.20	385.75	795.95
17	Huong Diem	Giong Trom	2013-2020	20	78.60	73.93	152.53
18	Khau Bang	Thanh Phu	2031-2040	40	164.08	154.30	318.38
19	Khem Thuyen	Thanh Phu	2031-2040	40	164.08	154.30	318.38
20	Mo Cay Bac	Mo Cay Bac	2013-2020	50	222.30	209.04	431.34
21	Mo Cay Nam	Mo Cay Nam	2013-2020	40	164.08	154.30	318.38
22	Rach Ot	Thanh Phu	2031-2040	80	328.16	308.60	636.76
23	Son Doc 2	Giong Trom	2013-2020	60	256.44	241.17	497.61
24	Tan Phu	Chau Thanh	2013-2020	20	61.18	23.40	4.58
25	Thu Cuu	Giong Trom	2013-2020	60	266.76	250.87	517.63
26	Vung Luong	Binh Dai	2031-2040	30	123.06	115.72	238.78
III	**Tra Vinh province**				**2,263.39**	**1,824.02**	**4,087.41**
27	Bong Bot	Cau Ke	2013-2020	60	141.50	54.46	195.96
28	Dong Cao	Duyen Hai	2021-2030	30	117.90	110.87	228.77
29	Khau Lau	Duyen Hai	2021-2030	30	117.90	110.87	228.77
30	Lang Nuoc	Duyen Hai	2021-2030	60	256.44	241.17	497.61
31	Mang Thit 1	Mang Thit	2013-2020	80	341.92	321.55	663.47
32	Mang Thit 2	Tra On	2021-2030	80	355.68	334.48	690.16
33	Nguyen Van Pho	Tra Cu	2031-2040	30	117.90	110.87	228.77
34	Phuoc Thien	Duyen Hai	2021-2030	20	78.60	73.93	152.53
35	Quan Chanh Bo	Duyen Hai	2031-2040	60	256.44	241.17	497.61
36	Rach Co	Duyen Hai	2021-2030	20	78.60	73.93	152.53
37	Tân Dinh	Cau Ke	2013-2020	20	171.33	66.12	237.45
38	Vung Liem	Vung Liem	2013-2020	60	229.18	84.60	313.78
IV	**Soc Trang province**				**393.00**	**369.65**	**762.65**
39	Rach Đai An	Ke Sach	2013-2020	20	78.60	73.93	152.53
40	Rach Doi	Cu Lao Dung	2021-2030	20	78.60	73.93	152.53
41	Rach Trang 2	Cu Lao Dung	2021-2030	20	78.60	73.93	152.53
42	Rach Vop	Ke Sach	2013-2020	20	78.60	73.93	152.53
43	So 1	Ke Sach	2013-2020	20	78.60	73.93	152.53
V	**Bac Lieu province**				**287.96**	**270.82**	**558.78**
44	30/4	Bac Lieu	2031-2040	24	90.19	84.82	175.01
45	Cai Cung	Dong Hai	2031-2040	15	53.79	50.59	104.38
46	Chua Phat	Dong Hai	2031-2040	24	90.19	84.82	175.01
47	Huyen Ke	Dong Hai	2031-2040	15	53.79	50.59	104.38
VI	**Ca Mau province**				**1,323.64**	**1,244.81**	**2,568.45**
48	Bong ket	Dam Doi	2021-2030	30	107.58	101.17	208.75
49	Cai Bat 2	Phu Tan	2021-2030	20	71.72	67.45	139.17
50	Cai Be	Nam Can	2021-2030	60	225.48	212.05	437.53
51	Cai Doi Nho	Phu Tan	2021-2030	30	112.74	106.02	218.76
52	Cong Nghiep	Phu Tan	2021-2030	40	150.32	141.37	291.69
53	Kenh Dung	Nam Can	2021-2030	60	225.48	212.05	437.53
54	Nam Can	Nam Can	2021-2030	20	71.72	67.45	139.17
55	Ong Nam	Dam Doi	2021-2030	20	71.72	67.45	139.17
56	Rach Ba Quan 1	Phu Tan	2021-2030	20	71.72	67.45	139.17

57	Tam Giang	Nam Can	2021-2030	20	71.72	67.45	139.17
58	Tan Phuoc	Dam Doi	2021-2030	20	71.72	67.45	139.17
59	Thuan Hoa	Dam Doi	2021-2030	20	71.72	67.45	139.17
VII	**Kien Giang province**				**3,386.42**	**3,184.60**	**6,571.02**
60	An Hoa	Rach Gia	2021-2030	30	112.74	106.02	218.76
61	Cai Be	Chau Thanh	2041-2050	64	284.54	267.58	552.12
62	Cai Lon	Chau Thanh	2041-2050	390	1,868.10	1,756.76	3,624.86
63	Kenh Nhanh	Rach Gia	2021-2030	40	157.20	147.83	305.03
64	Rach Soi	Rach Gia	2021-2030	60	246.12	231.46	477.58
65	Song Kien	Rach Gia	2021-2030	40	157.20	147.83	305.03
66	Ta Xang	Kien Luong	2031-2040	40	157.20	147.83	305.03
67	Tam Ban	Kien Luong	2031-2040	40	157.20	147.83	305.03
68	Xeo Ro	An Bien	2031-2040	60	246.12	231.46	477.58
60	An Hoa	Rach Gia	2021-2030	30	101.47	112.74	214.21

4.2.2 Rehabilitation Project

Rehabilitation is routine activity after sluice construction and it shall be continued until sluice finishes its roles of function. Total cost of this rehabilitation project is about US$ 28 million for 69 sluices; all sluices except one are now well functioning and there is no emergent need for urgent rehabilitation. There are enough staff and techniques for sluice rehabilitation in Water Resource Management Company (WRMC) which does operation and maintenance of sluices during years after the commencement of operation. Considering these situations for sluice rehabilitation, cost for this project can be implemented by Vietnamese government

Table 4.2.3 Proposed Cost Share for the Sluice Rehabilitation Project

Number of Sluices for Rehabilitation	Cost (million US$)	Share (%)	Demarcation
69	28	100%	Vietnamese Government

Table 4.2.4 Detail of Sluice Rehabilitation Plan

No	Name	Location	Rehabili. Term	Purpose	Rehabilitation	Cost (Mil. VND)
I	**Tien Giang**					**23,710**
1	Bao Dinh	My Tho	2021-2025	IR, DR, S/P	Overhaul maintenance	5,620
2	Cau Kenh	Cai Lay	2021-2025	IR, DR, S/P	Overhaul maintenance	2,540
3	Go Cong	Go Cong	2021-2025	IR, DR, S/P	Overhaul maintenance	3,464
4	So 3 Song Tra	Go Cong	2021-2025	IR, DR, S/P	Overhaul maintenance	2,694
5	Vam Giong	Go Cong	2021-2025	IR, DR, S/P	Overhaul maintenance	3,464
6	Xuan Hoa	Cho Gao	2021-2025	IR, DR, S/P	Overhaul maintenance	5,928
II	**Ben Tre**					**28,176**
7	Ba Lai	Ba Tri	2021-2025	IR, DR, S/P	Overhaul maintenance	13,936
8	Cay Da	Giong Trom	2021-2025	IR, DR, S/P	Overhaul maintenance	2,540
9	Muoi Cua	Ba Tri	2021-2025	IR, DR, S/P	Overhaul maintenance	2,540
10	Son Doc	Giong Trom	2021-2025	IR, DR, S/P	Overhaul maintenance	3,310
11	Vam Don	Mo Cay nam	2021-2025	IR, DR, S/P	Overhaul maintenance	3,310
12	Vam Ho	Ba Tri	2021-2025	IR, DR, S/P	Overhaul maintenance	2,540
III	**Tra Vinh**					**318,400**
13	Ben Chua	Cau Ngang	2013-2015	S/P, IR, DR	- Replace by stainless gate - Reinforce the upstream and downstream slope	52,000
14	Cai Hop	Cang Long	2016-2020	S/P, IR, DR	- Replace by stainless gate, renew 2 controlled gate	35,700
15	Can Chong	Tieu Can	2016-2020	S/P, IR, DR	-Replace 06 stainless gate, - Renew 2 dynamic gate, repair downstream slope.	40,800
16	Cha Va	Cau Ngang	2016-2020	S/P, IR, DR	- Replace by stainless gate	7,650
17	La Ban	Tieu Can	2016-2020	S/P, IR, DR	- Replace by stainless gate	5,100
18	Lang The	Cang Long	2016-2020	S/P, IR, DR	- Replace by stainless gate, renew 2 controlled gate	51,000
19	My Van	Cau Ke	2016-2020	S/P, IR, DR	- Replace by stainless gate	10,200
20	Nha Tho	Chau Thanh	2016-2020	S/P, IR, DR	- Replace by stainless gate	5,100
21	Rach Rum	Cau Ke	2016-2020	S/P, IR, DR	- Replace by stainless gate	15,300
22	Thau Rau	Cau Ngang	2013-2015	S/P, IR, DR	- Replace by stainless gate - Reinforce the upstream and	42,000

					downstream slope	
23	Tra Cu	Tra Cu	2016-2020	S/P, IR, DR	- Replace by stainless gate	7,650
24	Vam Buon	Tra Cu	2016-2020	S/P, IR, DR	- Replace by stainless gate	7,650
25	Vinh Binh	Cau Ngang	2016-2020	S/P, IR, DR	- Replace by stainless gate	7,650
26	Vinh Kim	Cau Ngang	2016-2020	S/P, IR, DR	- Replace by stainless gate	30,600
IV	**Soc Trang**					**26,498**
27	Bai Gia	Tran De	2021-2025	S/P, IR, DR	Overhaul maintenance	2,694
28	Bao Bien	Long Phu	2013-2015	S/P, IR, DR	-Renew gate system	5,100
29	Ba Rinh	My Tu	2016-2020	S/P, IR, DR	-Painting the controlled system, operating bridge, transport bridge, fence of the management house - Repair the surface of navigation bridge	1,000
30	Cai Oanh	Long Phu	2013-2015	S/P, IR, DR	-Repair the upstream slope, renew all stoplog, renew the stop gate, box of the controlled systems	1,200
31	Chin Sau	My Xuyen	2013-2015	S/P, IR, DR	-Repair the gates, operating bridge, upstream slope, management house.	400
32	My Phuoc	My Tu	2013-2015	S/P, IR, DR	Repair the sluice's plan	600
33	Nang Ren	Nga Nam	2021-2025	S/P, IR, DR	Overhaul maintenance	3,310
34	Rach Re	My Tu	2013-2015	S/P, IR, DR	- Repair the plan of sluice; - Renew the operating stair; - Replace 2 gates	5,500
35	Tam Soc	My Tu	2013-2015	S/P, IR, DR	- Renew fences, operating bridge; - Repair the management house	600
36	Tam Vu	Tran De	2021-2025	S/P, IR, DR	Overhaul maintenance	2,694
37	Tong Cang	My Tu	2016-2020	S/P, IR, DR	- Renew gates, - Repair valves, operating bridge, upstream slope, - Repair the management house.	2,400
38	Xeo Gua	My Tu	2013-2015	S/P, IR, DR	-Repair the operating bridge, controlled system, renew the stoplog recesses	1,000
V	**Bac Lieu**					**40,900**
39	Gia Rai	Gia Rai	2013-2015	S/P, IR, DR	- Replace by stainless gates; - Reinforce the eroded slope - Extension of Retaining wall, - Paint & repair operating beam, - repairing the stoplog recesses; - Renew fences of the operating bridge	20,000
40	Ho Phong	Gia Rai	2013-2015	S/P, IR, DR	-Replace by stainless gate. - Increase the elevation of valve beams, stoplog recesses up to 60cm; - Increase crest of bench wall more 60cm; - Reinforce upstream and downstream slope which were subsidence and erosion; - Retaining wall extension, - Repair the operating beam - Repair the stoplog recess	20,000
41	Ninh Quoi	Hong Dan	2016-2020	S/P, IR, DR	- Painting gates; - Repair up/down stream slope	300
42	Phuoc Long	Phuoc Long	2016-2020	S/P, IR, DR	- Painting gates;	300
43	Thong Luu	Vinh Loi	2016-2020	S/P, IR, DR	-Painting gates; -Repair up/down stream slope	300
VI	**Ca Mau**					**60,377**
44	Bien Nhi	U Minh	2021-2025	S/P, IR, DR	Overhaul maintenance	5,620
45	Ca Mau	Ca Mau city	2016-2020	S/P, IR, DR	- Repair transport bridge, control system of operation bridge	1,000
46	Cong Nghiep	Tran Van Thoi	2016-2020	S/P, IR, DR	Overhaul maintenance	2,540
47	Đa Bac	Tran Van Thoi	2016-2020	S/P, IR, DR	- Repair column of transport bridge	1,200
48	Kenh Dung	Tran Van Thoi	2016-2020	S/P, IR, DR	- Paint gates, -Renew controlled cable, repair operation bridge	1,000
49	Rach Lum	Tran Van Thoi	2016-2020	S/P, IR, DR	Overhaul maintenance	2,540
50	Tac Thu	Thoi Binh	2016-2020	S/P, IR, DR	- Renew 3 gates and 2 locks	43,860
51	Xao Luoi	Tran Van Thoi	2021-2025	S/P, IR, DR	Overhaul maintenance	2,617
VII	**Kien Giang**					**74,621**
52	Ba Hon	Kien Luong	2021-2025	S/P, F/C	Overhaul maintenance	4,696

53	Binh Giang 1	Hon Đat	2021-2025	S/P, F/C	- Regular maintenance	681
54	Binh Giang 2	Hon Đat	2021-2025	S/P, F/C	Overhaul maintenance	4,696
55	Cai Tre	Hon Đat	2021-2025	S/P, F/C	Replace by stainless gate	12,240
56	Dam Chich	Giang Thanh	2016-2020	S/P, F/C	Painting and repair gates	500
57	Ha Giang	Giang Thanh	2021-2025	S/P, F/C	Overhaul maintenance	3,310
58	KH9 -C	Go Quao	2021-2025	S/P, F/C	Overhaul maintenance	3,464
59	Kim Quy	An Minh	2021-2025	S/P,IR, F/C	Overhaul maintenance	3,464
60	Linh Huynh	Hon Đat	2021-2025	F/C,S/P, DR	Overhaul maintenance	4,696
61	Lung Lon 1	Kien Luong	2021-2025	S/P, F/C	Overhaul maintenance	4,696
62	T5	Hon Đat	2021-2025	S/P, F/C	Overhaul maintenance	4,696
63	T6	Hon Đat	2021-2025	S/P, F/C	Overhaul maintenance	3,618
64	Ta Lua	Hon Đat	2021-2025	F/C,S/P, DR	Overhaul maintenance	2,694
65	So 2	Hon Đat	2016-2020	F/C, S/P, DR	Replace by stainless gate	8,160
66	So 3	Hon Đat	2021-2025	F/C,S/P, DR	Overhaul maintenance	2,694
67	So 9	Hon Đat	2021-2025	F/C,S/P, DR	Overhaul maintenance	4,696
68	Vam Rang	Hon Đat	2021-2025	F/C,S/P, DR	Overhaul maintenance	5,620
69	Vam Ray	Hon Đat	2016-2020	F/C,S/P, DR	Replace by stainless gate	12,240

4.3 Implementation Schedule in line with the Magnitude of Saline Intrusion

4.3.1 Construction Project

Implementation schedule of proposed sluice construction project is formulated based upon a series of saline water intrusion simulation and site survey. The simulations have indicated that saline intrusion will further increase an affected area coupled with going-up of saline intrusion front line along Mekong River; saline contents in such areas will become more serious. The site survey has identified tangible saline intrusion phenomenon at several places for sluice gate construction in this project. Based on the conditions and present situations aforementioned, priority is given to the area whereby the saline intrusion is identified such as; Ben Tre, Tra Vinh, and Soc Trang provinces.

The following priority is given to the areas along sea-shore line that sea level rise will seriously affect such areas in terms of saline intrusion, coast erosion, and inundation by sea-water. Number of locations for this category counts 33 locations, so that it is divided into two terms; about 48% of sluices of this project. The forth priority is flood area in the project area; sluice will function for not only flood prevention purpose but also saline intrusion prevention purpose. The overall schedule aforementioned is summarized as follows (for the locations of sluices for each term, see Chapter 3 of this report)..

Table 4.3.1 Implementation Schedule of Sluice Construction Project

Terms	Period	Remarks
Term I	2013-2020	Priority areas; locations have already affected by saline intrusion in dry season at present
Term II	2021-2030	Locations are mostly along shoreline whereby the areas are seriously affected by high tide
Term III	2031-2040	Along shorelines affected by high tide, remained places after term II implementation
Term IV	2041-2050	Major purposes are for flood prevention, saline intrusion prevention, and irrigation

4.3.2 Rehabilitation Project

According to results of site investigation conducted by the JICA project team, all sluices are now functioning but corrosion on iron materials is identified; then, such condition requires replacement of gates and other related iron devices of sluices. Since sluice rehabilitation is a routine work of maintenance, each Water Resource Management Company has been carrying out regular maintenance until now.

Some provinces have proposed early rehabilitation of existing sluices because the sluices are heavily rusted; the name of provinces are Tra Vinh, Soc Trang, and Bac Lieu. Existing sluices in these provinces are selected as the first priority rehabilitation projects and the total number of this group is

11. These first priority rehabilitation projects are to be implemented from 2013 to 2015 within 3 years.

As shown in the Figure 3.1.3, there is a certain distance between the salinity content isolines of 4g/L and 2g/L in Tra Vinh province. If sluices are effectively utilized and functioning, saline intrusion is prevented and the isoline shows a similar pattern in Kien Giang province; there is not so much gap between salinity content isolines of 4g/L and 2g/L, and it runs along coastal line where sluices are constructed. This is why rehabilitation of sluices in Tra Vinh province shall be conducted with priority. Thus, sluices are selected for rehabilitation as the second priority in Tra Vinh, Soc Trang, Bac Lieu, and Ca Mau provinces. Implementation period of the second priority project is planned from 2016 to 2020 total 5 years.

The remaining sluices are given the third priority and implementation period is planned from 2021 to 2025 total 5years. Rehabilitation period of each sluice is demarcated into aforementioned three periods and it is summarized in the Figure 3.1.3.

CHAPTER 5 PROJECT COST

This chapter describes project cost for the proposed sluice construction project. Cost for the new construction of sluices referred to the cost estimation made in a master plan formulated by SIWRP in 2011, and that of rehabilitation project was based on information obtained from Water Resource Management Company (WRMC) in each province.

5.1 Standard Project Cost

The proposed sluices have total width 20m or more, and standard cost for construction is based on those cost referred to in "Master Plan for Irrigation Project in the Mekong Delta in the context of Climate Change and Sea Level Rise" prepared by SIWRP in June 2011.

Table 5.1.1 Standard Project Cost for Proposed Major Sluices (Unit: Billion VND)

Items	W=20m	W=30m	W=40m	W=60m	W=70m	W=80m	W=100m
Construction	78.6	117.9	150.32	256.44	311.22	328.16	410.2
Compensation, Resettlement	39.3	58.95	75.16	128.22	155.61	164.08	205.1
Project management	0.79	1.18	1.5	2.56	3.11	3.28	4.1
Consultation (Engineering)	6.29	9.43	12.03	20.52	24.9	26.25	32.82
Other Cost	4.72	7.07	9.02	15.39	18.67	19.69	24.61
Tax	8.41	12.62	16.08	27.44	33.3	35.11	43.89
Physical contingency	13.59	20.39	25.97	44.29	53.77	56.69	70.88
Total	151.7	227.54	290.08	494.86	600.58	633.26	791.6

Source: SIWRP and Project Team

Aside from the construction cost, compensation and/or resettlement cost is set at 50% of the construction cost, which is based on information from actually implemented projects in Mekong delta. One (1) % of construction cost is applied for project management; consultancy services' cost is set at 8% of the construction cost, and also physical contingency is applied to all items of costs.

5.2 Disbursement Schedule by Size of the Sluice Gate

There are several sizes of sluices; width of sluice is 20m, 30m, 40m, 60m, and over 100m. According to past construction implementation information, construction schedule is formulated by the width of sluices; if the sluice equal or less than 60m in width, construction period is set at 2 years; if it is more than 60m in width, construction period is now set at 3 years as follows;

Table 5.2.1 Disbursement Schedule based on Size of Sluices

		Implementation Period			
		1st year	2nd year	3rd year	4th Year
W<=60m	Construction		━━	━━	
	Compensation, Resettlement	━━			
	Project management		━━	━━	
	Consultation (Engineering)	- - -	- - -	- - -	
	Other Cost	- - -	- - -	- - -	
	Physical contingency	- - -	- - -	- - -	
W>60m	Construction		━━	━━	━━
	Compensation, Resettlement	━━			
	Project management		━━	━━	━━
	Consultation (Engineering)	- - -	- - -	- - -	- - -
	Other Cost	- - -	- - -	- - -	- - -
	Physical contingency	- - -	- - -	- - -	- - -

CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATION

Saline intrusion resulting from the climate change in the Mekong Delta is regarded as a critical threat, especially, along the coastal areas, whereby it is an urgent matter to cope with the issue. Therefore, construction of saline intrusion prevention sluice gates was proposed as one of priority projects. On the other hand, there is a possibility that the construction can cause some negative environmental impacts on surrounding environment. This chapter discusses expected impacts taking consideration into current natural and social conditions in the area and how to mitigate anticipated negative impacts.

6.1 Legislative and Institutional Framework of Environmental Consideration in Vietnam

In Vietnam, based on the Environment Protection Law enforced in January 1994, the government ordinance for the law practice (Government Decree No.175/CP) was enacted on October in the same year. Furthermore, many regulations regarding the penalty to violaption, an environmental impact assessment, etc. were enacted. After 2008, QCVN which have a role of regulation accompanied by a penalty.and become a new standard was applied instead of TCVN. Some parts of TCVN were replaced for QCVN, and TCVN itself became invalid. The environmental standards of Vietnam have cleared the international level as a standard, and even if they compare with environmental standards of Japan, they are in an appropriate level (see Appendix VIII Chapter 1 for detail).

Current Environment Protection Law stipulates projects which need EIA and SEA, however, it does not mention neccecity of pubication of scoping and exmination of alternatives of proposed projects, while they are stiplulated in the JICA Environemtnal and Social Consideration Guideline. Following table illustlates differences between the JICA Guideline and Vietnamese law.

Table 6.1.1 Gap between JICA Guideline and Vietnamese Legal Frame

JICA Guideline	Vietnamese regulation	Remarks
▪ Alternatives of project shall be included in EIA report (JICA Guideline)	▪ No mention about examination of alternatives in EIA report contents preparation	
▪ After the disclosure of the scoping drafts, project proponents etc. conduct consultations with local stakeholders*. JICA incorporates the results of such consultations into its TOR. The consultations cover the needs of projects and the analysis of alternatives. (JICA Guideline)	▪ no mention	▪ There are description about consultation, however, the agenda does not cover scoping nor alternatives (Decree No.29-2011, Article 15).
▪ The socio-economic studies should be implemented in the early stages of project preparation and with the involvement of potentially displaced people (WB OP4.12, Para 6)	▪ no mention	
▪ Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets--provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan are eligible for benefit (WB OP4.12, Para 15)	▪ Those who have a certificate of land use right or satisfying all of the conditions for issuance of a certificate of land use right are qualified as targets of compensation by the State	
▪ Compensation based on the full replacement cost must be provided as much as possible (JICA Guideline).	▪ The land prices stipulated by people's committees of provinces and cities under central authority shall be used as the basis for calculating compensation when the State recovers land. They must be close to actual market prices for assignment of land use right in normal conditions and, when there is a big difference compared with actual market prices, they must be adjusted for conformity. (Law on Land Article 56)	▪ Since compensation is based on the land price specified by Provincial People's Committee, there are some cases that there are differences between actual land price and compensated ones, they are not significant ones, though (interview result by the JICA Team, 2012).
▪ In preparing a resettlement action plan, consultations must be held with the affected	▪ Agencies (organizations) that are assigned by the provincial-level People's	▪ Draft resettlement arrangement plan is informed

JICA Guideline	Vietnamese regulation	Remarks
people and their communities based on sufficient information made available to them in advance. (JICA Guideline) ▪ Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood (JICA Guideline)	Committees to arrange resettlement must inform every household that has land recovered and must be relocated of the tentative resettlement arrangement plans and publicly post up these plans at their headquarters, at the offices of the commune-level People's Committees of the localities where exists the recovered land and in the resettlement areas 20 days before such resettlement plans are approved by competent State bodies (Decree 197-2004, Article 34)	to the affected people, however, people's participation in planning is limited.

6.2 Alternative Plans and Those Environmental Impacts

Taking consideration into geographic conditions, convenience/easiness of construction, necessity of resettlement, local people's request, budgetary issue and so on, proper location of each sluice gate should be examined. For the sluice gate construction, two options, namely, 1) construction on the shore and 2) construction across the river, are examined. In general, construction in water way is more difficult than that on the shore in terms of technical aspect, while adverse environmental impacts e.g. resettlement and land recovery or damage to transportation is smaller. In terms of minimization of resettlement, it is judged that Option 2 can be recommendable.

Table 6.2.1 Examination of Proposed Construction Sites

Environmental items	Option 0 (no project)	Option 1	Option 2
Construction site	-	Sluice construction on the shore	Sluice construction in water
Resettlement and land acquisition (land recovery)	-	XX	X
Transportation	-	XX	-
Protection of farmland from high tide	XX	+++	+++
Possibility to be regrettable project	None	None	None
Technical difficulty	-	Not very difficult	Relatively difficult
Project cost	Zero	High	Medium
Selection	-	-	○

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact
+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

6.3 Scoping of Environmental Impacts

Prior to IEE, examination of degree of environmental impacts by those constructions, so called "Scoping" is done, and some environmental parameters, on which negative impacts are likely to be caused, are to be identified. For those parameters, terms of reference (TOR) to identify study method of IEE is prepared. Scoping of environmental impacts and TOR are presented as follows:

Table 6.3.1 Scoping

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operational phase	
1. Air Pollution	B^-	D	Due to the construction works, air quality deterioration such as dust generation and gas emission from construction vehicles is expected, however it will be temporally. After the completion of works, no air pollution is anticipated.
2. Water Pollution	B^-	D	Drainage from construction sites, heavy industrial machines, vehicles and so on is expected. However, the period water is polluted is limited.
3. Waste	B^-	D	Construction waste will be dumped during construction phase.

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operational phase	
4. Soil Contamination/ salinization	B^-	D	Oil leakage from construction vehicles can be caused, however, its scale is limited to construction phase.
5. Noise and Vibration	B^-	D	Noise due to construction works and transportation of construction vehicles is anticipated. However, it is tentative.
6. Ground Subsidence	D	D	Ground subsidence is not expected both during and after works.
7. Offensive Odor	D	D	Offensive odor is not expected both during and after works.
8. Bottom sediment	D	D	Bottom sediment is not expected both during and after works.
9. Protected area/rare species	D	B^-	There is a possibility that closure of water way by sluice will give negative impacts on the aquatic eco-system such as fish.
10. Ground water	D	D	The works does not give any impacts on ground water.
11. Hydrological Situation	D	B^+	Due to construction works to prevent from saline water intrusion, hydrological situations will be changed, however, it will be positive. In addition, the project will not prevent flow of main Mekong subsidiaries.
12. Topography and Geographical features	D	D	No topographical and geographical impacts by the works will be caused.
13. Involuntary Resettlement	A^-	D	There are many households to resettle due to the works.
14. Land Acquisition	B^-	D	Some lands are recovered for construction works.
15. Cultural heritage	D	D	There is no cultural heritage in and around sites.
16. Landscape	D	D	No adverse effect on landscape is anticipated.
17. The indigenous and ethnic people	D	D	There is no ethnic minority in and around construction sites.
18. Livelihood	D	B^+/B^-	Since some households are requested to resettle have to restart their livelihood in new area, others will not be affected negatively. On the other hand, due to increase of fresh irrigation water, the project will be beneficial fro the livelihood.
19. Local economy	B^-	B^+/B^-	Resettlement and land recovery can cause negative impact, on the other hand, prevention of saline water intrusion will give positive impacts on local economy in general.
20. Existing social infrastructures and services	B^-	B^-	During construction works, traffic jam can be caused by the increase of traffic volume. Shipping will be disturbed in and after construction.
21. Misdistribution of benefit and damage	B^+	B^+	Except those who to be resettled, the people can enjoy decrease of damage by saline water intrusion.
22. Social institutions	D	B^-	Since the number of resettlement is big, negative impact on social institution is expected.
23. Water Usage or Water Rights and Rights of Common	D	B^+	Due to the prevention of saline water intrusion, the local people can access to fresh water more than present.
24. Gender	D	D	No negative impact in terms of gender is expected.
25. Children rights	D	D	Damage to children rights is not anticipated.
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	D	D	No hazard or infectious disease is expected both during and after works.
27. Accidents	B^-	D	During construction, there is a possibility that number of accident will be increased due to increase of traffic increase for construction

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operational phase	
			works. But it is temporally.
28. Global Warming	D	D	No global warming by the works is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 6.3.2 Terms of Reference

Environmental Parameters	Study Contents	Study Method
Air Pollution	• General situations in the adjacent area of construction sites	• Confirmation of construction period, construction sites
Water Pollution	• Information collection of other similar cases	• Data collection in other similar projects
Waste	• Waste disposal method	• Data collection in other similar projects
Soil Contamination/ salinization	• Oil leakage from construction vehicles	• Confirmation of situations in other similar projects
Noise and Vibration	• General situations in the adjacent area of construction sites	• Confirmation of location of hospital, school, residential areas and so on
Involuntary Resettlement/ Livelihood	• Number of households to be relocated • Main income source • Annual income	• Interview to local people (in Ben Tre, Tra Vinh and Vinh Long provinces) • Collection of statistic data in the seven provinces • Cost estimation for resettlement
Local economy/ Social institutions	• Main income source • Necessary support in case of resettlement	• Interview to local people (in Ben Tre, Tra Vinh and Vinh Long provinces) • Collection of statistic data in the seven provinces
Existing social infrastructures and services	• Traffic jam due to the project • Impacts on shipment	• Confirmation of shipment • Confirmation of situations in other similar projects
Protected area/Rare species	• Habitat of endangered fish species and migratory fish	• Data collection of fish species in the rivers which surrounding
Accidents	• Possibility of accident	• Confirmation of situations in other similar plans

Source: JICA Project Team
* Since scale of land recovery is large, identification of affected area in detail has yet to be done. Cost of compensation for land loss is estimated altogether with involuntary resettlement (see Chapter 6.6).

6.4 Initial Environmental Examination

Following the TOR mentioned above, IEE based on the existing data and households survey to parts of the affected households were organized.

- Air pollution: Considering construction period is relatively limited and population density around the construction sites is relative low, significant negative impact is not expected. Any large scale air pollution by other similar project haves not been reported
- Noise/Vibration: Locations of hospital or schools have yet to be identified, however, the area around construction sites are located on rural area and it is common that such structures are not constructed along the water canal. Therefore, the scale of impact on surrounding environment is limited.
- Water pollution: It is stipulated that waste water from the construction sites shall be treated before drainage into the surrounding environment based on the national regulations/standards in

Vietnam, therefore, water pollution can be negligible. Any big impacts on water around construction sites by other similar project have not been reported

- Soil contamination: Oil leakage from construction vehicles, however, it will be negligible.
- Waste: Garbage from construction lodging houses and construction works will be produced, the impact will be avoidable, as far as waste is disposed properly. Excavated soil can be reused for embankment. As a whole, severe impact will not be expected.
- Accident: Construction site will be surrounded by the fence not to allow the residents and accident by the construction works will not give damage to the people. Still, there is a possibility that traffic accident can be caused due to increase of transportation.
- Transportation by water: Half-and-half construction method in the water canals is to be applied to minimize impacts on shipment. If the sluices are equipped with lock gate, shipment will not be affected after the construction works very much.
- Impacts on eco-system: There is no natural reserve around the construction sites. There are some migratory fish between sea and Mekong River and it is though that Hau River is one of path for the migratory fish. However, considering that the fish are rarely observed in the Mekong Delta and proposed sluice gates will constructed in the water canal instead of subsidiary of Mekong River, the possibility that the project give damage to the fish. It is needed to collect data of eco-system continuously.
- Resettlement: It is expected that resettlement of 958 household and land recovery are needed due to the construction works (refer to Figure 6.4.1), still, the location and area of land recovery have yet to be identified. Since the target area is located on the rural area, seemingly the residents make a living by farming. Their livelihood can be changed by the resettlement and land recovery. This stage is feasibility study level and censes survey or socio-economic survey have not be implemented. On the other hand, improvement of agricultural productivity due to prevention from high tide is expected.
- Impacts on local economy: As mentioned before, change to livelihood is expected and some impacts on the local economy can be caused. On the other hand, due to prevention from high tide, local agriculture can be improved and activated.
- Impacts on social institutions: In general, Vietnamese people like to stay their familiar areas continuously instead of going to strange area, even though they have to relocate for the project. They prefer compensation by cash to new land provision by the government and they like to purchase other lands within their familiar areas. Therefore, the possibility that existing social institutions will be disrupted significantly even if there would be some change to the institutions is low.

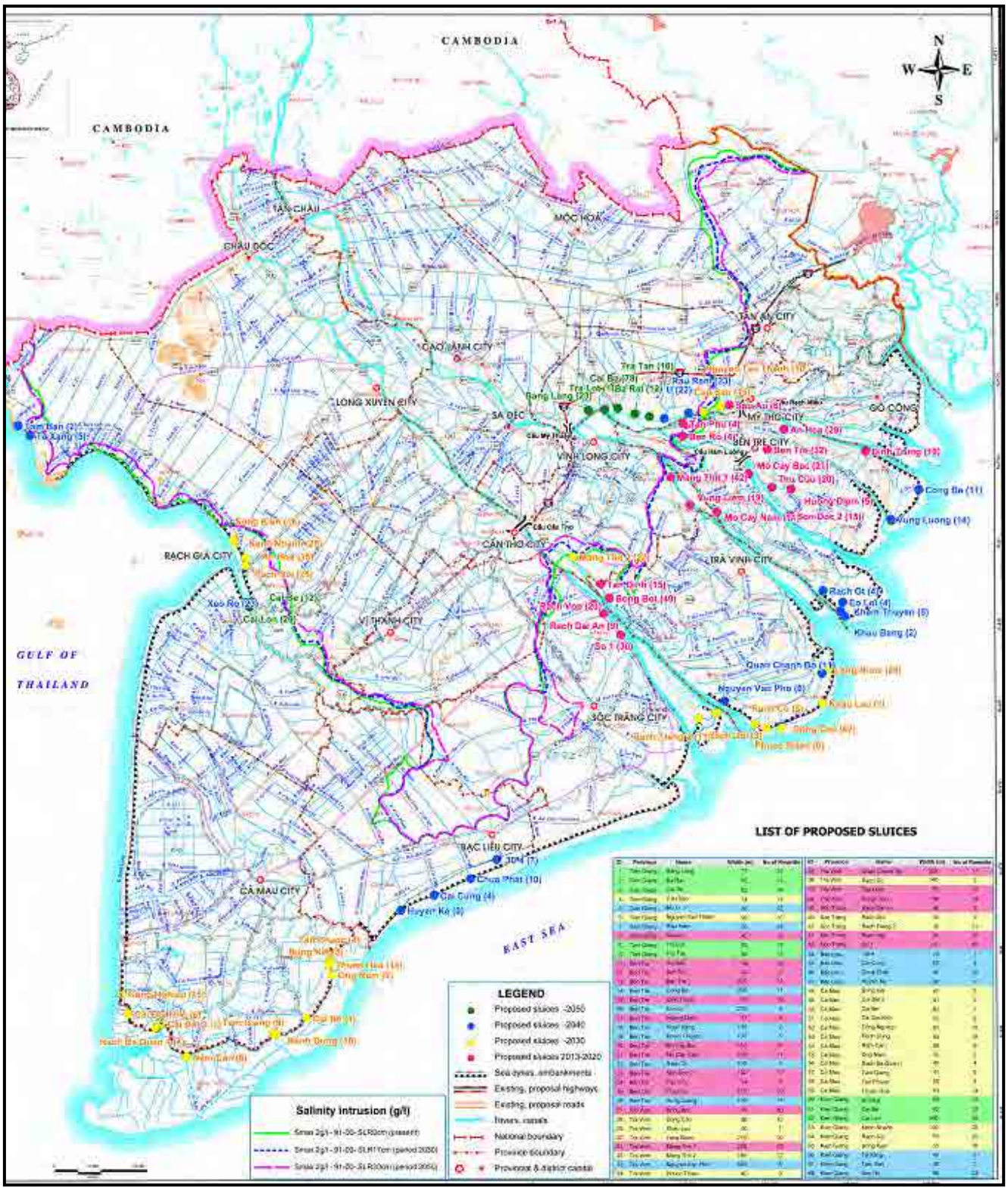


Figure 6.4.1 Locations of Resettlement and Number of Affected Households

*The numbers in the parenthesis show number of households to be relocated

In the Study Area, there are five protected area as shown in Table 6.4.1 and Figure 6.4.2. Some proposed sluices are located on around the Thanh Phu Nature Reserve in Ben Tre Province and the Ca Mau Cape National Park. It is prohibited to construct any structures within such protected area by the government; therefore it is needed to determine the construction sites taking consideration into the situations.

Table 6.4.1 Basic Information of Natural Reserve in the Target Area

Ca Mau Cape National Park	
Ca Mau province 41,862 ha	To conserve the saline-ecosystem forest in Ca Mau, a typical wetland area in the coastal zone of Mekong River
U Minh Thuong National Park	
Kien Giang rovince 8,038 ha	To conserve the ecosystem of malaleuca forest and the alkaline wetland on peat base, rare wild animals and historical place of U Minh
Thach Phu Nature Reserve	
Ben Tre Province 4,510 ha	To conserve the saline wetland ecosystem of Mekong Delta and National historical place of Ho Chi Minh Rail at Sea.
Bac Lieu Bird Sanctuary	
Bac Lieu province 127 ha	To conserve saline wetland ecosystem and water bird species
U Minh Ha National Park	
Ca Mau Province 8,286 ha	To conserve ecosystem of ancient alkaline inundated malaleuca forest and water bird species.

Source: Ministry of Agriculture and Rural Development (2004) Forestry Handbook
Institute for Environment and Natural Resources National University at HCM City (2010), Inventory of Peat lands in U Minh Ha Region, Ca Mau Province, Viet Nam

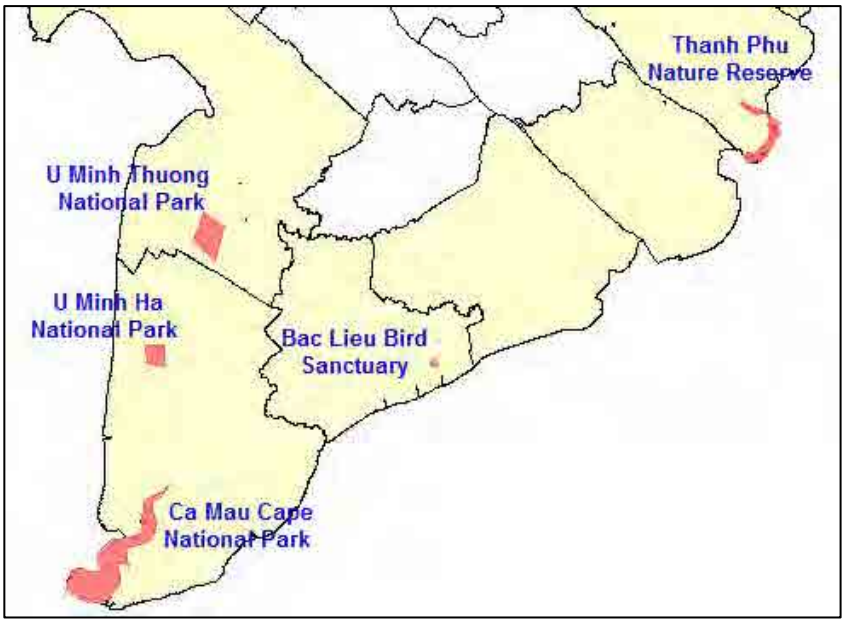


Figure 6.4.2 Location Map of National Parks and Natural Conservation Areas in the Project Area

(Modified based on the map of "Forestry Planning in the Mekong Delta", SIWRP 2011)

There are some migratory fish within Mekong River or sea and freshwater in the Mekong Delta, and the Hau River and Tien River are also regarded as migration paths. Tfhe Mekong River within the Mekong Delta has rich and unique fish diversity, namely, 481 fish species in total, including 28 endemic species, and the number of species in the Delta is bigger than those of other Mekong River basins (MRC, 2010a)[1].

Some of them are migratory between marine/estuarine and freshwater for spawning, and their migration paths are thought to be various dependent on the species. The migratory species are as follows (MRC, 2010b)[2], and as of now no species below are listed as Globally Threatened -Critical (GT-CR) nor as Globally Threatened-Endangered (GT-EN). However, *Pangasius krempfi* is specified

[1] MRC (March 2010), SEA for Hydropower on the Mekong Mainstream, Aquatic Systems Baseline Assessment, Working paper 8
[2] MRC (June 2010), Impacts on Wetland and Biodiversity (Draft), Technical Note 9

as Vulnerable (VU), which is presumed to faces a high risk of extinction in the wild.

1) Krempf's catfish (*Pangasius krempfi)*, which is believed to spend its life in the coastal waters of the South China Sea, but returns to the Mekong River to spawn (designed as a Vulnerable species in 2011 by IUCN).
2) Engraved Catfish *(Arius caelatus)* is reported to undertake diadromous migrations;
3) Giant mottled eel (*Anguilla marmorata)* is known to migrate from the ocean to upland tributaries for spawning;
4) Threadfins: *Eleutheronema tetradactylum* and *Polynemus borneensis;*
5) Perch: *Lates calcarifer*; and
6) Herrings: *Coila* sp., *Setipinna* sp.

The rapid development of the Mekong River Basin in those several decades, such as dam constructions, has caused big-scale environmental changes, consequently, the unique ecosystem has been affected adversely. Many fish species, especially, migratory fish (within the river) may have been damaged, and some of them are threatened as GT-CR or GT-EN. The Lower Mekong River basin has the richest biodiversity in the whole Mekong River basins. However, it faces to the same issue now. Globally threatened fish species in Vietnam (the Mekong Delta) are as shown below;

Table 6.4.2 Globally Threatened Fish Species in Vietnam (Mekong Delta)[3]

Scientific name	Common name	Status (IUCN) [4]	Remarks
Chela caeruleostigmata	Leaping Barb	GT-CR	
Pangasius sanitwongsei	Giant Catfish	GT-CR	Highly migratory
Pristis microdon	Freshwater Sawfish	GT-CR	
Pristis zijsron	Green Sawfish	GT-CR	
Scleropages formosus	Golden Arowana	GT-EN	Heavily traded
Tenualosa thibaudeaui	Laotian Shad, Freshwater Herring	GT-EN	Highly migratory, Endemic
Probarbus jullieni	Jullien's Barb	GT-EN	Highly migratory In 2003, it was observed in Tan Phu District, Ben Tre Province.
Himantura chaophraya	Giant Freshwater Stingray	GT-EN	
Himantura oxyrhynchus	Marbled Mekong Stingray	GT-EN	
Balantiocheilos melanopterus	Silver Shark	GT-EN	
Pangasius krempfI	Krempf's catfish	VU	Highly migratory between sea and river In 1994, it was observed in Tan Phu District, Ben Tre Province.
Carcharhinus leucas	Bull Shark	LC	
Mekongina erythrospila	Striped River Barb		Endemic
Puntioplites falcifer	Silver Barb		Endemic

GT-CR: Globally Threatened-Critical, GT-EN: Globally Threatened-Endangered, LC: Least Concern

Following table summarizes behaviors of migratory and spawning of endangered fish species which range in the Mekong Delta mentioned above. As illustrated below, information on spawning habitats for migratory fish species of Mekong River in Vietnam is not sufficient, especially very rare for spawning. It is because most of migratory fish spawn in deep pools, which makes it very difficult to observe directly. Moreover, available data of migratory paths in the Mekong Delta is limited to only main Mekong tributaries e.g. Hau River and Tien River, and there is no data for other small tributaries and canals. In other spots within Mekong River such as Khone fall far upstream of Mekong Delta, those species are observed more frequently than in the Mekong Delta.

[3] This table is prepared based on the data of MRC (2010b) http://fish.mongabay.com/data/VietNam.htm and http://www.iucnredlist.org/apps/redlist/details/181328/0

[4] IUCN Red List Categories: EX: Extinct, EW - Extinct in the Wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened and LC: Least Concern. Out of those categories, CR, EN and VU are classified as "Threatened". The categorization contributes to setting priorities to conserve threatened species.

Table 6.4.3 Migratory and Endangered Fish Species in Vietnam (Mekong Delta)

Species	Movement in Mekong Delta in dry season (March to May)	Spawning situations	Trigger of movement	Level of endanger
Pangasius Kremfi	Going downward to the sea	There were no reports from the Mekong delta on spawning or the occurrence of eggs.	Water level, rainfall	VU
Pangasius sanitwongsei	It is rarely observed in these days.	Spawn in the upper sections of stretches during May to July.	Water level	GT-CR
Tenualosa thibaudeaui	No information on migration was reported from the Mekong Delta.	Unknown	First rainfall, water level and increased tributaries (above of Khone wall)	GT-EN
Probarbus jullieni	Going downward to the sea	There were no reports on actual spawning sites below the Khone Falls.	Water level	GT-EN

Source:MRC, http://ns1.mrcmekong.org/programmes/fisheries/mig_probarbus_j.htm
MRC, 2006, Fish migration triggers in the Lower Mekong Basin and other freshwater tropical systems, MRC Technical Paper No. 14

Mekong river migration system is categorized into three systems in terms of migratory, Lower Mekong Migration System (LMS), Middle Mekong Migration System (MMS) and Upper Mekong Migration System. The LMS covers the stretch from the Khone Falls to southern Cambodia and the Mekong Delta. Major migration route are illustrated in Figure 6.4.3[5].

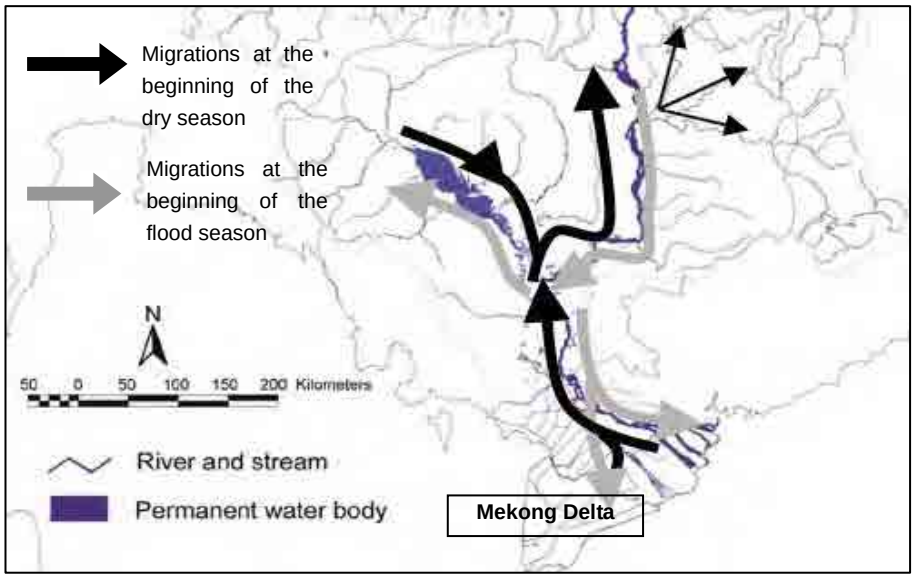


Figure 6.4.3 Simplified Migration System in the Lower Mekong River Basin

The Khone Fall, which has many deep pools, is the branch point of LMS and MMS, and the Mekong Delta is located on the downstrems of LMS. There are plural migration paths, and one of them passes through along Ben Tre Province and Tra Voing Province. There is a possibiity that some of the fish gain entry to the samll tributaries within those provinces. However, given that the proposed constructions will not close main tributaries but small ones, and the endangered species are rarely observed in the main and small tributaries in the Mekong Delta, significant nagative impacts on such fish are not anticiapted.

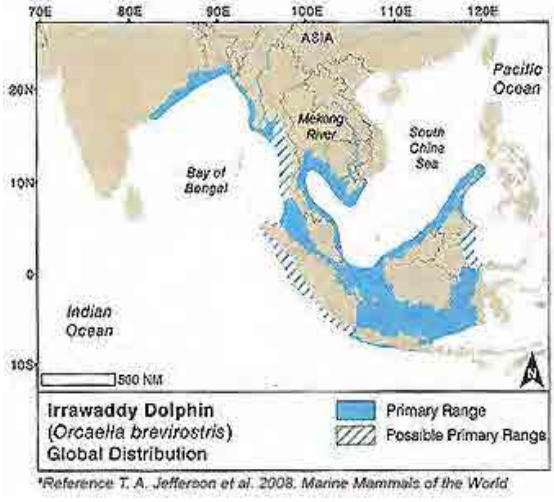


Figure 6.4.4 Distribution of Irrawaddy Dolphin

Aside from the threatened fish species listed in the above table, the Riverine Irrawaddy Dolphin (*Orcaella brevirostris*) is very famous as a flagship endangered

[5] Based on "Fish migrations of the Lower Mekong River Basin: implications for development, planning and environmental management" (MRC Technical Paper No. 8, 2002), the figure is modified partly.

wildlife in the Mekong River (see Figure 6.4.4). The freshwater sub-population ranges in the Mekong River, while the dolphins are distributed in the coastal, shallow, blackish, or fresh waters in Southeastern Asia, from India to Indonesia. It is said that oil from boats, blast fishing, gillnet entanglement and so on have damaged the species[6] and recently the sighting of dolphin within Vietnam is very rare. The sub-population in the Mekong River is designated as critically endangered by IUCN in 2004 and the population numbers is estimated at 127 minimally (WCS, 2007)[7]. The project which constructs gates in the tributaries only, and not on the Mekong River itself, will not give negate impact to the flagship.

It is estimated that 958 households in the seven provinces have to be relocated due to the proposed project. Transportation by water during construction phase will be affected to some extent. However, it is possible to mitigate the impact by application of modified construction method, which closes water way half-and-half for the construction. In operation phase, if the sluices are equipped with navigation lock gate, the adverse effect on shipping will not be significant.

Based on the examination discussed above, anticipated environmental impacts are presented in the following table.

Table 6.4.4 Environmental Evaluation

Environmental parameters	Evaluation at Scoping		Evaluation based on IEE		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
1. Air Pollution	B-	D	B-	D	Due to the construction works, air quality deterioration such as dust generation and gas emission from construction vehicles is expected, however it will be temporally. After the completion of works, no air pollution is anticipated.
2. Water Pollution	B-	D	B-	D	Drainage from construction sites, heavy industrial machines, vehicles and so on is expected. However, the period of water pollution is limited to construction phase.
3. Waste	B-	D	B-	D	Construction waste will be dumped during only construction phase.
4. Soil Contamination/ salinization	B-	D	B-	D	Oil leakage from construction vehicles can be caused, however, its scale is small and limited to construction phase.
5. Noise and Vibration	B-	D	B-	D	Noise due to construction works and transportation of construction vehicles is anticipated. However, it is temporary during only construction.
6. Ground Subsidence	D	D	N/A	N/A	No negative impact is expected.
7. Offensive Odor	D	D	N/A	N/A	No negative impact is expected.
8. Bottom sediment	D	D	N/A	N/A	No negative impact is expected.
9. Protected area/ Rare species	D	B-	D	B-	There are some protected areas within the target 7 provinces, therefore, it is needed to avoid such area as construction sites. Furthermore, there is a possibility

[6] IUCN, 2011, The IUCN Red List of Threatened Species, http://www.iucnredlist.org/apps/redlist/details/44555/0

[7] Wildlife Conservation Society (WCS), 2007, Status and Conservation of Freshwater Populations of Irrawaddy Dolphins, Working Paper No. 31

Environmental parameters	Evaluation at Scoping		Evaluation based on IEE		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
					that migratory fish can be affected, but the scale will not be significant, since they are rarely observed in the Mekong Delta.
10. Ground water	D	D	N/A	N/A	No negative impact is expected.
11. Hydrological Situation	D	B^+	N/A	N/A	No negative impact is expected.
12. Topography and Geographical features	D	D	N/A	N/A	No negative impact is expected.
13. Involuntary Resettlement	A^-	D	A^-	D	958 households are requested to resettle due to the construction works.
14. Land Acquisition	B^-	D	B^-	D	Some lands will be recovered for construction works, at this moment the areas and locations to be recovered have yet to be identified.
15. Cultural heritage	D	D	N/A	N/A	No negative impact is expected.
16. Landscape	D	D	N/A	N/A	No negative impact is expected.
17. The indigenous and ethnic people	D	D	N/A	N/A	No negative impact is expected.
18. Livelihood	D	$B+/B^-$	D	$B+/B^-$	While some households are requested to resettle have to restart their livelihood in new area, others will not be affected negatively and can enjoy increase of available fresh water.
19. Local economy	D	$B+/B^-$	D	$B+/B^-$	The scale of resettlement and land recovery is big、which can cause negative impacts, while prevention of saline water intrusion will give positive impacts on local economy.
20. Existing social infrastructures and services	B^-	B^-	B^-	B^-	During construction works, traffic jam can be caused by the increase of traffic volume and transportation by water can be affected. Half-and-half construction method is to be applied to minimize impacts on shipment. If the sluices are equipped with lock gate, shipment will not be affected after the construction works very much.
21. Misdistribution of benefit and damage	D	D	N/A	N/A	No negative impact is expected.
22. Social institutions	B^-	B^-	B^-	B^-	Since some impacts on local economy are expected, change of social institutions can be caused.
23. Water Usage or Water Rights and Rights of Common	B^+	B^+	N/A	N/A	No negative impact is expected.
24. Gender	D	D	N/A	N/A	No negative impact is expected.
25. Children rights	D	D	N/A	N/A	No negative impact is expected.
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	D	D	N/A	N/A	No negative impact is expected.

Environmental parameters	Evaluation at Scoping		Evaluation based on IEE		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
27. Accidents	B-	D	B-	D	During construction, there is a possibility that number of accident will be increased due to increase of traffic increase for construction works.
28. Global Warming	D	D	N/A	N/A	No negative impact is expected.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.
Source: JICA Project Team

6.5 Mitigation Measures

Some adverse effects by the project are anticipated, and in general most of them are limited to construction phase only, e.g. air pollution, water pollution and noise. Those mitigation measures are to be covered by construction companies. It is possible to minimize such impacts by some mitigation measures as shown in the following table. DARD and DONRE are to monitor whether those mitigation measures are taken as planned. For operation phase, internal and external monitoring will be implemented to check the resettled households and their living conditions, and the monitoring cost is included in the management cost for resettlement.

Table 6.5.1 Mitigation Measures

Environmental Parameters	Proposed Environment Management Plan		Implementing Organization	Monitoring /responsible organization
	Construction phase	Operation phase		
Air Pollution	• Setting of temporary enclosure • Utilization of construction machines equipped with reduction of gas emission reduction system • Regular check and full maintenance of construction vehicles • Water spray in and around entrances of construction sites	-	Construction contractor	DARD and DONRE
Water Pollution	Waste water treatment before discharge into rivers	-	Construction contractor	DARD and DONRE
Waste	Classification waste dumping, recycle, reduction of waste • Entrustment of Proper disposal of waste which can not be reused to dismantling operator	-	Construction contractor	DARD and DONRE
Soil Contamination/ salinization	• Proper management of construction vehicles	-	Construction contractor	DARD and DONRE
Noise and Vibration	• Setting of temporary enclosure • Utilization of construction machines with less noise and vibration • Not to work during nighttime and to use detour in the residential area	-	Construction contractor	DARD and DONRE
Existing social infrastructures and services	• Half-and-half construction method is to be applied to minimize impacts on shipment for construction phase. • To set lock gate for no disturb of shipment after construction works • To ensure enough width of road and to prepare turnout according to necessity • Decentralization of construction vehicles by disperse traveling route	-	Construction contractor	DARD and DONRE
Involuntary Resettlement	• To keep residential area from construction roads and material storage sites	Monitoring	DARD and Board for Compensation, Support and	PMU

Environmental Parameters	Proposed Environment Management Plan		Implementing Organization	Monitoring /responsible organization
	Construction phase	Operation phase		
			Resettlement	
Land Recovery	Ditto	Monitoring	DARD and Board for Compensation, Support and Resettlement	PMU
Protected area/endangered species	To ensure enough distance from the construction sites to the protected area	Monitoring	Construction contractor	Natural Resources Conservation Department* and DARD
Safety	• Working environment	-	Construction contractor	DARD and DONRE
Accidents	• Proper management of construction vehicle operation to minimize centralization • Instruction on compliance with prescribed routes, speed, to drivers of construction vehicles	-	Construction contractor	DARD and DONRE

*1: The Department is under the Vietnam Administrative of Forestry, MARD

Source: JICA Project Team under the Vietnam Administrative of Forestry, MARD

6.6 Monitoring Plan

Main environmental impacts are expected to be caused in construction phase, and monitoring will be implemented during the period. Since the environmental items which can be affected by the construction works are air pollution and so on , those items shall be monitored. Although there is no standard of water quality of effluent from sites of construction for water resource in Vietnam, according to MONRE, it is possible to apply QCVN 08/2008 National Technical Regulation on Surface Water Quality, Class 2B[8] for water quality monitoring. DARD and DONRE are to monitor whether those mitigation measures are taken as planned. Regarding monitoring of resettlement, details are discussed in another sub-chapter. The proposed monitoring plan is shown below:

Table 6.6.1 Proposed Monitoring Plan

Environmental Parameter	Phase	Monitoring Item	Survey point	Standard	Frequency	Responsible
Air pollution	Construction	NOx SOx Ozone CO TSP	Construction site	200μg/m^3/hour 350μg/m^3/hour 180μg/m^3/hour 30,000μg/m^3/hour 300μg/m^3/hour	Once per month	DARD and DONRE
Water pollution	Construction	pH TSS Total oil and grease	Drainage outlet	6.5-8.5 <100mg/l <0.3mg/l (QCVN-38/2011)	Once per month	DARD and DONRE
Noise and vibration	Construction	Noise (dB)	Construction site	70 dB	Once per month	DARD and DONRE
Protected area	Construction	Impacts on the eco-system in the protected area and	Specified national parks, natural reserve and bird sanctuary in the seven provinces.	-	Once per month	Natural Resources Conservation Department and Management Unit*
Endangered fish	operation	Impacts on fish	In Tien River Hau River, and Ham Luong	-	Once in Rainy and dry season	Sub-Department of Capture Fishery and Resources Protection under DARD
Waste	Construction	Volume of	Construction	-	Once per	DARD and

[8] Class 2B: water quality limitation for traffic by water and other purposes with requirements of low water quality

Environmental Parameter	Phase	Monitoring Item	Survey point	Standard	Frequency	Responsible
		waste	site		month	DONRE
Safety	Construction	Working environment	-	-	Once per month	DARD and DONRE

Source: JICA Project Team * This unit is under DARD

Monitoring formats for construction period and operation period, respectively, are to be prepared. Comments obtained from the people through the monitoring and response by the government also are needed to be recorded.

Table 6.6.2 Proposed Monitoring Form (Construction Period)

(1)Response and actions by the government

Comments and response	Monitoring results
Number and contents of comments from the people	
Number and response to the comments from the people	

(2) Pollution

Environmental Parameter	Monitoring Item	Measured value (min)	Measured value (max)	Standard	Survey point	Frequency
Air pollution	NOx SOx Ozone CO TSP			200μg/m^3/hour 350μg/m^3/hour 180μg/m^3/hour 30,000μg/m^3/hour 300μg/m^3/hour		Once per month
Water pollution	pH TSS Total oil and grease			6.5-8.5 <100mg/l <0.3mg/l (QCVN-38/2011)		Once per month
Noise and vibration	Noise (dB)			70 dB		Once per month

(3) Natural Environment

Environmental Parameter	Monitoring results	Measures taken
Waste		
Soil contamination		
Protected area		

(4)Social Environment

Environmental Parameter	Monitoring results	Measures taken
Existing social infrastructures and services		
Accident	Incidence per 1000 residents	

Table 6.6.3 Proposed Monitoring Form (Operation Period)

(1)Response and actions by the government

Comments and response	Monitoring results	Measures taken	Frequency
Number and contents of comments from the people			
Number and response to the comments from the people			

(2) Natural Environment

Environmental Parameter	Monitoring results	Measures taken	Frequency
Endangered fish			

6.7 Resettlement

6.7.1 Resettlement Policy of the Project

The Government of Vietnam will use the Resettlement Policy for a series of projects to cope with the climate change. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Those are summarized as follows:

1) Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

2) Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.

3) Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which are on account of project implementation would have his, her or their:

   - ✓ Standard of living adversely affected;
   - ✓ Right, title or interest in any house, interest in, or right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
   - ✓ Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
   - ✓ Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

4) Compensation will be paid to current users of land recovered by the State who fully satisfy the conditions specified in Clauses 1, 2, 3, 4, 5, 7, 9, 10 and 11, Article 8 of the Government's Decree No. 197/2004/ND-CP. For land users who are ineligible for compensation, PPC shall consider these cases in order to provide support. Support for life and production stabilization, and support for job-change training and job creation in case of recovery of agricultural land.

5) PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.

6) People temporarily affected are to be considered PAPs and resettlement plans address the issue of temporary acquisition.

7) Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

8) The resettlement plans will be designed in accordance with the Land Law (2003), Decrees No.84/2007,/ND-CP, Decree No. 69/2009/ND-CP and other decrees or circulars concerned.

9) The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups such as communes.

10) Payment for land and/or non-land assets will be based equal to the value of land use rights and non-land assets as at the time when the decision on recovery is made by PPC where no land is

available for compensation or PAPs prefer the monetary compensation to land-based compensation.

11) Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training and skill development.

12) Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and new land for the same purpose as the type of land which was recovered. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

13) Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support includes implementation of vocational training and payment of cash equivalent to 30 kg of rice to each affected person per month.

14) The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement such as without legal title to land.

15) Representatives of PAPs will be involved in the process of developing and implementing resettlement plans

16) PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

17) Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

18) Displacement does not occur before provision of compensation and of other assistance required for relocation. Sufficient civic infrastructure must be provided in resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities).

19) Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

20) Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

In terms of principle of replacement cost, a compensation for land and non-land assets owned by households/shop owners will be based on the principle of replacement cost. Replacement cost is the

amount calculated before displacement which is needed to replace an affected asset without depreciation and without deduction for taxes and/or costs of transaction as follows:

- ✓ Existing local government regulations for compensation calculations for building, crops and trees will be used where ever available.
- ✓ For perennial crops, cash compensation at replacement cost that should be in line with local government regulations.
- ✓ For timber trees, cash compensation at replacement cost that should be in line with local government regulations.

Based on the discussion above, following Entitlement Matrix is proposed:

Table 6.7.1 Entitlement Matrix

Type of loss	Definition of entitlement person	Entitlement
Loss of land	Land user who are affected by the project	1) Cash compensation for acquired land, or 2) Land provision Based on JICA Guideline
Loss of house/structure	User of the house/structure	1) Compensation for affected constructions with 100% of replacement price, or 2) Compensation price being calculated on real affected area
Loss of income and business	Aquaculture	There is no regulation of compensation for pond loss, therefore, based on actual conditions (construction cost, maintenance cost, profit and so on), compensation will be estimated.
Loss of standing crops and trees	Lost crop	Compensation for lost crop based on productivity of the biggest crop in the last three years of the major cultivated tree in the locality and the average price at the time of land recovery (Decree 197/2004 ND-CP, Article 24)
Assistance for restoration (1)	Households to be resettled	Support for transportation to the resettled area 3 million VND/household based on Decree No. 22/1998/ND-CP 24/4/1998
Assistance for restoration (2)	Households to be resettled	Support for life and production stabilization, and support for job-change training and job creation in case of recovery of agricultural land (Cash support equal to 1.5-5 times the agricultural land, Decree No.69/2009/ND-CP 12/2/2009)
Assistance for restoration (3)	Households to be resettled	Monetary support to affected person to stabilize their livelihood (12month*30Kg rice *11000 VND per person) based on Article 20, Decree No.69/2009/ND-CP 12/2/2009
Assistance for restoration (4)	Vulnerable persons	Not specified in the laws, People's Committee at commune level will decide depending on the situations of affected persons.

The level of this study is pre-feasibility study, census survey of the affected households have yet to be implemented. Therefore, it is not clear how many households own the official land use rights, it is recommended to apply the JICA Guideline which says that all affected households by the project will be targets of compensation and supports. It is recommended to set "Cut-off-date" on the date that the project will be declared officially.

Concerning the land price for compensation by the project, a study to check market prices and official price set by Provincial People's Committee has yet to be organized. If there is a big difference between both prices, it is needed to minimize the gap based on the Article 56 of Law on Land (2003). Furthermore, it is common that farmers prefer compensation by cash to new land provision in Vietnam, and it is necessary to provide support such as support of job change according to the Article 22 of Decree 69/2009/ND-CP to compensate the gap mentioned above.

6.7.2 Scope of Resettlement

The affected areas are located on seven provinces, namely, all of the province in the Project area. The estimated number of sluice gates and households to be relocated are 68 and 958, respectively at this

moment. In general, compensation cost accounts for less than half of construction cost in Vietnam, and therefore 50% of construction cost is applied (except seven sluice gates[9]) for the compensation on the safer side (see Table 6.7.2). Detailed information such as numbers of legal and illegal land users, electric poles, temples, graves, etc. to be resettled has yet to be confirmed. It is needed to identify the affected areas in detail before the project approval.

Table 6.7.2 Number of Project Affected Units and Compensation Cost

Province	No. of sluices	Resettlement (H/H) (1)	Resettlement (Person) (2)=(1)×4.7*	Estimate construction cost (billion VND) (3)	Compensation cost (billion VND) (4)=(3) ×0.5
Tien Giang	10	223	1,048	936	468
Ben Tre	16	191	900	3,580	1,303
Tra Vinh	12	223	1,048	2,263	873
Soc Trang	5	73	343	393	197
Bac Lieu	4	21	99	288	144
Ca Mau	12	81	381	1,324	662
Kien Giang	9	146	687	3,386	1,693
Total	68	958	4,506	12,171	5,340

Source: JICA Project Team

* Number of persons to be resettled is estimated by means of number of households and average number of family member per households (=4.7/HH).

1) Restoration of Livelihood

The affected households have right to choose either of new land or cash payment as compensation for the land loss. Given that Vietnamese people are reluctant to migrate to unknown lands and they prefer staying within their home town in general, cash payment as compensation in accordance with the governmental regulations and actual conditions is recommended. In the detailed resettlement plan, support for job change such as training provision, transportation for movement, stabilization of life and so on shall be included.

2) Implementation and Resettlement

Due to the large number of proposed sluice gates, it is difficult to construct all of them in a short period of time. Therefore, it is planned that the construction will be implemented gradually and it will take almost four decades to complete all the works in keeping with saline intrusion associated with sea level rise under climate change (see Table 6.7.3):

Table 6.7.3 Estimated Compensation Cost for Resettlement (Unit: Billion VND)

Province/year	2013- 2020	2021-2030	2031-2040	2041-2050	Total
Tien Giang	37.58	98.25	175.13	157.20	468.16
Ben Tre	647.13	123.06	533.26	-	1,303.45
Tra Vinh	242.22	443.61	187.17	-	873.00
Soc Trang	117.90	78.60	-	-	196.50
Bac Lieu	-	-	143.98	-	143.98
Ca Mau	131.53	530.29	-	-	661.82
Kien Giang	-	336.63	280.26	1,076.32	1,693.21
Total	1,176.36	1,610.44	1,319.80	1,233.52	5,340.12
Share (%)	22%	30%	25%	23%	100%

Resettlement by the project also will be implemented gradually. The peak of relocation is expected in 2013. The estimated number of households to be resettled on yearly basis is as follows:

[9] Ben Ro sluice, Ben Tre sluice, An Hoa sluice, Tan Phu sluice, Vung Liem sluice, Bong Bot sluice and Tan Dinh sluice where the site surveys for resettlement have already been implemented.

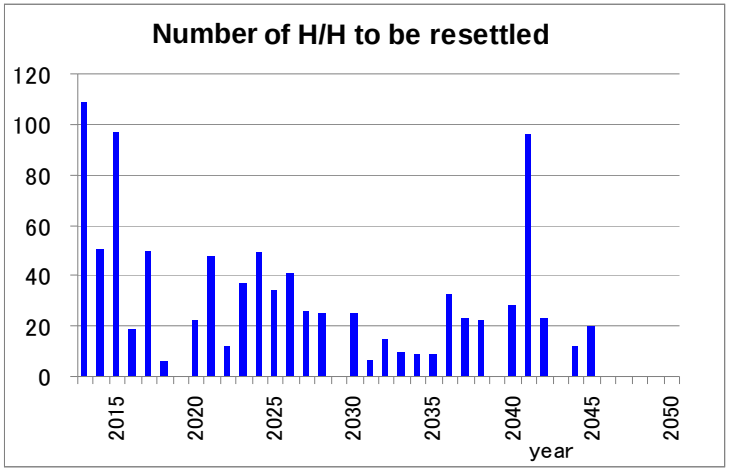


Figure 6.7.1 Annual Number of Households to be Resettled

6.7.3 Handling of Complaints

According to No.181/2004/ND-CP and Decree No.69/2009/ND-CP, "Board of Compensation, Support and Resettlement" is responsible for receiving complaints, denunciations and considers submission to the President of District PC (peoples' committee) for settlement of disputes within thirty (30) working days after receiving the application. If those who are recovered their land do not agree with the decision by DPC, it is possible to initiate lawsuit at people's court or complain to the Provincial PC. Apart from the PCs, there is no organization which handles such disputes in Vietnamese system.

6.7.4 Implementation Structure

In Vietnam, implementation structure for resettlement is stipulated by a governmental regulation. There is no big difference among projects depending on scale or category. At first, Project Management Unit (PMU)[10], which is responsible for overall project management, namely, project design, implementation and monitoring, is to be established, and this PMU plays an important role in resettlement, too. Moreover, "Board of Compensation, Support and Resettlement" shall be established prior to resettlement. It is the directly responsible organization for a series of resettlement activities. In addition to them, various organizations are concerned to the resettlement; namely, PPC, DPC, Provincial Department of Natural Resources and Environment, Department of Finance, Project Management Unit and so on. Those organizations' tasks are summarized in the following table based on the 197/2004/ND-CP:

Table 6.7.4 Major Tasks of Organizations Concerned

No.	Organization	Task
1	Project Management Unit (PMU)	To design the detailed project to determine the exact boundaries of land acquisition To train staffs joined in the resettlement activities To survey and investigate the population in detail To Present the draft plan for compensation and resettlement to the authorities. After approved, this plan will be reported at the public meeting To relocate the affected people To monitor project progress, the performance analysis, synthesis, evaluation and reporting performance results and propose solutions to solve difficult problems during project implementation to ensure project implementation schedule, proper technical requirements, economic.
2	Board of Compensation and	To make, submit for approval and organize the implementation of, the compensation, support and resettlement plan;

[10] PMU is an organization which has responsibilities for management and implementation of projects including resettlement activities. It can be formed from personnel of the investor or as an organization hired by the investors.

No.	Organization	Task
	Resettlement Support	To check accuracy and rationality of inventory statistics, the legality of land and property eligible or ineligible for compensation, supports in the compensation, support and resettlement plans. To receive complaints from affected persons and submit it to DPC
3	PPC	To direct, organize, propagate and mobilize all organizations and individuals concerning compensation, support and resettlement policies and ground clearance according to the land recovery decisions of competent state bodies; To direct the provincial/municipal services, departments, branches and district-level People's Committees: To approve or assign the district-level People's Committees to approve compensation, support and resettlement plans; To approve land prices; promulgate the property price tables for compensation calculation; prescribe support levels and supporting measures according to their competence; resettlement arrangement plans, job change training plans according to their assigned competence; To direct the concerned agencies to settle citizens' complaints, denunciations related to compensation, support and resettlement according to their law-prescribed competence; To guarantee impartiality and equity when considering and deciding on the compensation, support and resettlement when land is recovered by the State according to their competence prescribed in this Decree; To decide or assign the district-level People's Committees to apply coercion to cases of deliberately failing to abide by the State's land recovery decisions according to their competence; To direct the examination and handling of violations in the compensation, support and resettlement domain.
4	DPC	To direct, organize, communicate and mobilize all organizations and individuals on policies of compensation, support, resettlement and site clearance that are done in accordance with the land revoking decision of State competent agencies. To direct board of compensation and resettlement support for setting up and organizing methods for compensation, support and resettlement, implement approved plan of compensation, support and resettlement. To settle complaints and denunciation for compensation To coordinate with provincial Departments, institutions and Investor in implementation of project construction, plans for creating a resettlement area locally as assigned by PPC
5	People's Committees of communes	To coordinate with the compensation, support and resettlement boards in certifying land and property of persons who have land recovered; To join in, and create conditions for, the payment of compensation and support money to, and arrange resettlement for, persons who have land recovered, and create conditions for the ground clearance.
6	Department of Natural Resources and Environment	To guide the determination of land area, soil type, land position, land area and conditions for compensation, land without compensation when the State revokes land. To guide the determination of the size of land that is eligible for compensation or no compensation, the amount of compensation or support for each of revoked land users as the basis for the calculation of compensation and support for each object. To guide for uniform inventory forms, using price for compensation and resettlement, support for Board of Compensation, support and resettlement of districts, cities in the province.
7	Department of Planning and Investment	To guide and supervise the establishment and implementation of resettlement projects.
8	Construction Department	To guide the determination of the size, area, legitimacy, illegality of the construction works associated with the revoked land as the basis for the calculation of compensation and support for each object. To make price list for housing, new construction projects and submit to PPC for issuing decision as a basis for calculating the value of compensation.
9	Department of Finance and Provincial Inspector	To check the payment of compensation, support and costs for works of organizing compensation payment and resettlement support locally.
10	Working group*	To advise and assist PC of Districts to inspect and supervise the implementation of regulation on compensation, support and resettlement

*Working group is established if a project covers plural districts.

The resettlement system in Vietnam is very complicated; however, an organization which plays a central role is the Board of Compensation, Resettlement and Support, which is chaired by official personnel from DPC. Basic implementation structure of resettlement in the country can be illustrated as follows:

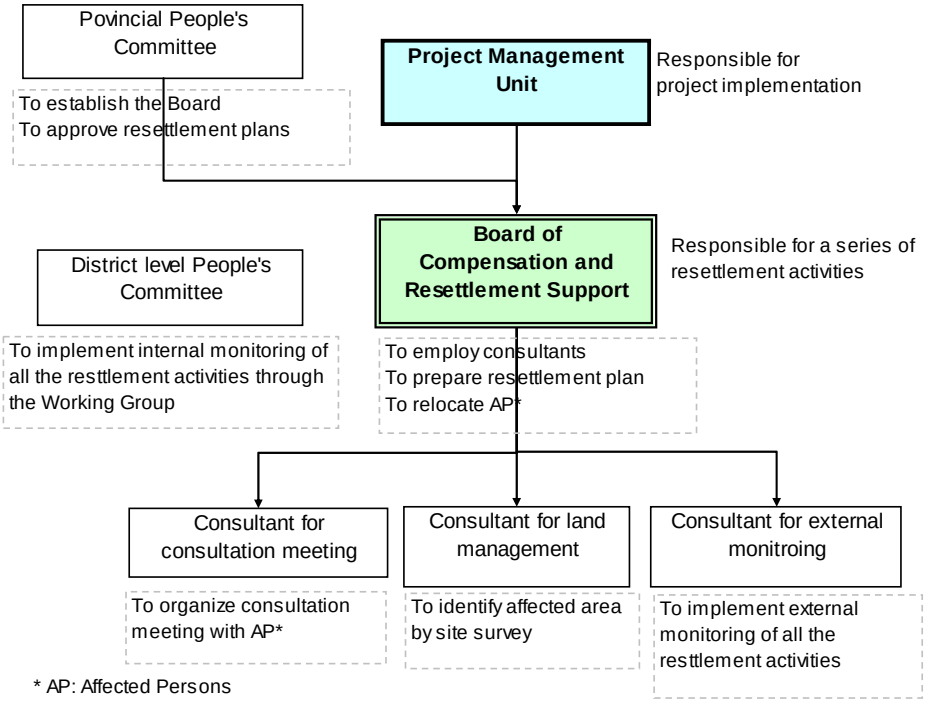


Figure 6.7.2 Basic Implementation Structure

6.7.5 Implementation Schedule

After the approval of project implement, a series of resettlement will be organized based on the following procedure.

1) Establish of Board of Compensation, Support and Resettlement

Board of Compensation, Support and Resettlement will be established by means of initiative of PPC and the board shall include 1) a DPC leader as its chairman; 2) a finance agency's representative as its vice chairman; 3) the investor as a standing member; 4) a natural resources and environment agency's representative as member; 5) a representative of the commune-level People's Committee of the place where land is recovered as member; 6) one or two representatives of households having land recovered. Staff who join in the resettlement planning and implementation will be trained by the PMU.

2) Announcement of Project

The approved plan shall be informed to the public by PMU before detailed design of the projects. A meeting for announcement will be held in affected wards in order to hear opinions from the people: (i) scope of the project, (ii) impacts, (iii) inherited rights for types of losses and damages, (iv) operation schedule staring with study of detailed design, (v) responsibilities of organization, and (vi) mechanism of complaint and grievance.

3) Resettlement Plan Preparation

At this stage, site inspection and socio-economic survey will be implemented to identify the conditions of affected households. Commune level People's Committee and DARD will hold a set of consultation meetings at each construction site, which representative of all affected households can join, and they

will explain the principle of compensation and results of site inspection and socio-economic survey. At the consultation, they will also receive comments on the proposed compensation policy from the participants. Based on the consultation meeting results, Board of Compensation, Support and Resettlement prepares a draft resettlement plan in collaboration with other organization concerned to resettlement. The draft version shall be approved by PPC.

4) Consultation Meeting on Draft Resettlement Plan

A consultation meeting, which the affected persons, the Board, PPC, DPC, PMU and so on participate, is organized. At the meeting, the draft resettlement plan is presented to the attendants, and the affected persons can lodge complaints against the drafted document.

5) Site Investigation and Cost Estimation for Resettlement

The board implements a household survey covering all of displaced persons to identify their houses, farmlands and so on to estimate of resettlement cost with the support of representatives of affected persons. Based on the result and the resettlement policy mentioned above, the unit price for resettlement and land recovery including transportation, vocational support and monitoring will be e determined ed by the board. The revised resettlement plan and cost estimation will be approved by the PPC.

6) Publication of the Revised Resettlement Plan

Revised resettlement plan will be publicized at headquarter of Commune People's Committee for twenty (20) days and the affected persons have a chance to complain the revised one.

7) Finalization of the Resettlement Plan

Based on the opinions acquired through the publication, the draft resettlement plan is finalized. The board sends the final resettlement plan and the decision, which mention level of compensation, support, locations of house/land to be relocated, and timing of compensation and resettlement, to each affected person in collaboration with Commune People's Committee.

8) Compensation

Prior to resettlement and land recovery, compensation shall be paid in accordance with the resettlement plan.

9) Resettlement

Resettlement is implemented, according to need, vocational support or monetary support to stabilize livelihood of affected persons will be organized under the supervision of the PMU and Board.

10) Social Support

Together with resettlement, income restoration and social supports for the affected people is to be completed by the PMU and Board.

11) Monitoring

There are two kinds of monitoring system, namely, internal and external ones. The Board is responsible for internal monitoring in collaboration with Working Group of District while PMU employs consultants for external monitoring. Regarding duration of monitoring, even after the completion of monitoring of resettlement activities, it is recommended to continue motioning quarterly during construction period and annually during operation period for 2 years. The overall implementation schedule regarding resettlement is shown as below:

Table 6.7.5 Implementation Schedule

Work	Work schedule (month)										
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Construction period	Operation period until 2 years later of start
Approval of project implementation	▲										
1. Establish of Board of compensation, support and resettlement	↔										
2. Announcement to the affected people	↔										
3. Draft Resettlement plan preparation (F/S level)	↔	↔	↔								
3.1 Site inspection	↔	↔									
3.2 Socio-economic survey		↔									
3. 3 Consultation meeting		↔	↔								
3.4 Preparation of draft resettlement plan			↔								
4.Detail design level site investigation/ Cost estimation for resettlement			↔	↔							
5 Consultation meeting of detailed design level of resettlement plan and revise				↔							
6. Publication of the resettlement plan at the Commune People's Committee (for 20 days)				↔	↔						
7. Finalization of the resettlement plan					↔						
8. Compensation					↔	↔					
9. Resettlement						↔	↔	↔			
10. Social supports such as job training							↔	↔	↔		
11. Monitoring	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔

Source: JICA Project Team

6.7.6 Cost and Fund

The total estimated cost for resettlement is 5,340.12 billion VND as mentioned above. This cost covers a series of resettlement activities and contingency. The cost shall be covered by the implementation agency, namely, MARD and/or DARD.

6.7.7 Monitoring Structure and Monitoring Form

The monitoring of resettlement is to be organized during and after the construction in order to ensure that resettlement and land recovery shall be conducted in accordance with the rules and specific resettlement plan. These activities will provide feedbacks for the implementation to all the stakeholders. It is expected that likelihood of success and risks could be timely detected and solved during the operational phase of the project. A series of resettlement monitoring is categorized into two systems, namely, internal and external ones.

1) Internal monitoring

The Board and working group are entirely responsible for internal monitoring, as well as for the resettlement plan with the assistance of the project consultants. The monitoring will be based on the monitoring format as shown below. The monitoring indicators include; 1) Information dissemination and community consultation, 2) The complaint procedures, especially the involved problems in management, 3) payment for affected households in accordance with the compensation plan, 4) support for stabilizing their lives; 5) restoration of income, and 6) progress of land recovery. PMU shall get the information by means of the Board. The database collected in the resettlement plan will be kept and updated monthly.

2) External monitoring

External monitoring is an activity of a research organization or consultant to ensure the monitoring. This organization or consultant must have the experience for monitoring the resettlement, and is normally appointed by PMU. The external monitoring should be started when the Board is established. Same monitoring format can be used for both internal and external monitoring for cross-check. The proposed monitoring format is as shown below:

Table 6.7.6 Recommended Monitoring Format

Responsible organization: PMU

Work	Planned in total	Progress in quantity	Progress in percentage	Responsible organization
Announcement to the affected people				
Draft resettlement plan preparation and site investigation (socio-economic survey)				
Cost estimation for resettlement				
Consultation meeting				
Revise of the resettlement plan and signing based on the feedback at the consultation meeting				
Compensation in cash				
Compensation by land				
Resettlement				
Social supports such as job training				

Announcement to the affected people		
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Consultation meeting with the affected people		
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune

6.7.8 Consultation Meeting

Consultation meeting will be organized after the approval of the program; at this moment, it has yet to be done. According to the current law, only two representatives of affected persons in each province can join in the consultation meeting. However, it is proposed to invite all the affected persons to

collect various opinions and to let the affected persons understand the impacts at the F/S level. At the meeting, it is recommended to present compensation policy for land loss, resettlement and livelihood restoration, schedule, basic socio-economic survey results, project location map and so on. In such case, the affected people can understand the resettlement frame more, which makes it easy for them to accept the project. Their opinions presented at the meeting shall be reflected for the revise of the draft resettlement plan and minutes of discussions shall be documented with a name list of all the participants.

6.8 Conclusion and Recommendations

It can be said that the proposed project does not give severe adverse effects on surrounding environment except for resettlement and land recovery. Even though temporary impacts such as air pollution are to be caused, it is temporary and possible to mitigate them by some measures mentioned above. On the resettlement and land recovery, it is needed to pay enough attention to the affected persons.

The legal frame of resettlement is well developed in Vietnam. Especially, the system, where each PPC has its original unit price of compensation considering local conditions and national level regulation, functions very well. It is, however, further recommended to apply WB policy 4.12 more in the resettlement frame. For instance, opportunity for the affected persons to participate in the preparation of resettlement plan is limited at present. Furthermore, minimization of gap between market price and prescribed price of land compensation shall be promoted according to the Law on Land (2003). Therefore, it is recommended to involve the affected persons at earlier stage and to fill the gap mentioned above based on the actual conditions.

As mentioned above, some aquatic species have already been affected by the construction work on the Mekong River so far. Large scale construction will give negative impact on the migratory species, and 6 species and endangered species mentioned above may further be threatened. Though it is rare to see Riverine Irrawaddy Dolphin in the Mekong Delta, the endangered mammal will also be affected. However, information related to their behaviors in small tributaries within the provinces, where the project is to construct sluice gates, is rarely reported. Therefore, it is expected that the scale of negative impacts on aquatic wildlife is not very significant.

6.9 Checklist

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	1) Have EIA reports been officially completed? 2)Have EIA reports been approved by authorities of the host country's government? 3) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? 4) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	1) N 2) N 3) N 4) N	Project components have been just proposed in 2012, EIA report has yet to be prepared. At this moment, Initial Environmental Examination (IEE) level study was implemented.
	(2) Explanation to the Public	1) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? 2) Are proper responses made to comments from the public and regulatory authorities?	1) N 2) N	Official announcement of the project will be organized after the approval by the government.

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
	(3) Examination of alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	At Strategic Environment Assessment (SEA) focusing on adaptation of climate change in the Mekong Delta, structural measure, non-structural measure and zero-option are examined.
2 Pollution control	(1) Water Quality	(a) Do effluents or leachates from various facilities, such as infrastructure facilities and the ancillary facilities comply with the country's effluent standards and ambient water quality standards?	(a) N	There is no effluent from sluice gate.
	(2) Waste	(a) In the case of that large volume of excavated/dredged materials are generated, are the excavated/dredged materials properly treated and disposed of in accordance with the country's standards?	(a) -	The generated waste by the construction will be reused for other purposes, it is not a big issue to dispose the waste.
	(3) Subsidence	(a) Is there a possibility that the excavation of waterways will cause groundwater level drawdown or subsidence? Are adequate measures taken, if necessary?	(a) N	Project will not change of water level of groundwater.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(1) N	Even though there are 5 protected areas, however, there is enough distance the construction sites and the protected area. The possibility of damage to the area is low.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that hydrologic changes, such as reduction of the river flow, and seawater intrusion up the river will adversely affect downstream aquatic organisms, animals, vegetation, and ecosystems? (e) Is there a possibility that the changes in water flows due to the project will adversely affect aquatic environments in the river? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) – (d) N (e)Y and N	(d) Positive impact is expected due to prevention saline water intrusion. (e) Some endangered fish species, which migrate within Mekong river, or fresh water and sea, range in the Mekong Delta. However, the frequency of observation of those fish is very limited in the area.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the project will adversely affect surface water and groundwater flows?	(a) N	Due to sluice construction, saline water intrusion can be prevented, which bring about a positive impact.
	(4) Topography and Geology	(a) Is there a possibility that excavation of rivers and channels will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas?	(a) N	The proposed sluice will be constructed across the waterway, no topographic nor geological change is expected.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation	(a) Y (b) N (c) N (d) Y (e) Y (f) N/Y (g) N	(a) Proposed construction sites are determined considering minimization of resettlement. (b) After the approval of project, official announcement of the project will be done. (c) Replacement cost is

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
		with full replacement costs, restoration of livelihoods and living standards developed based on socio-economic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(h) N (i) Y (j) N	estimated following governmental regulations. In addition, considering JICA Guideline, support for livelihood recovery (cash for job training) is included in the cost estimation. (d) Prior to resettlement, compensation shall be paid following the regulations. (e) It is included in the report. (f) There is a case that a PPC supported those who do not have official certificate considering their conditions. However, it is case-by-case, not regulated (g) At the consultation meeting, the document will be signed by implementer and affected persons after the official declaration of project implementation. (h) Board for Compensation, Support and Resettlement, which is responsible for resettlement, will be established based on the regulations. (i) A proposed monitoring plan is documented in the report. (j) Board for Compensation, Support and Resettlement, will handle complaints.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect the downstream fisheries and other water uses? (c) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced?	(a) N (b) N (c) N	(a) Prevention of saline water intrusion is beneficial for the local population. (b) The project does not consume water. (c) No new water way is planned, water related diseases cannot be newly introduced.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no heritage around the sites.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	There is no special landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) - (b) -	There are no minority people among the affected persons.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?	(a) N (b) Y (c) Y	(a) (b) (c) DARD will check the safety of construction sites regularly.

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
		(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(d) Y	(d) Security guards will be hired and they will stay within construction sites surrounded by fence, therefore, there is low possibility that any conflict between local people and the security guard will be caused.
5. Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) - (c) -	(a) Some mitigation measures such as temporary enclosure are proposed. (b) Severe negative impact on the natural environment is not expected. (c) Due to resettlement some damage to social institution are expected, however, the scale will not be significant.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) Are the items, methods and frequencies of the monitoring program adequate? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) Monitoring parameters are proposed. (c) Department of Natural Resource and Environment (DONRE) and DARD will monitor the environmental impacts in construction phase. DARD, which cover water resource, is the center of monitoring, since DONRE covers all sectors. For resettlement, internal and external monitoring will be organized. PMU is the final responsible organization for all impacts. (d) Draft monitoring format is attached in the report.
6. Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)N	(a) The construction sites are located on the downstream of the Mekong River, no trans-boundary environmental impact is anticipated.

CHAPTER 7 PROJECT EVALUATION

7.1 Condition of Economic Evaluation of the Project

Saline intrusion is one of the major problems in the coastal provinces in the Mekong Delta. High salinity water has affected on a wide range of farm land. Preventing salinity intrusion damage, the Government has been constructing a number of sluice gates. In fact, the governmental officers have prioritized sluice gate construction projects at second rank in the workshop. Also, SIWRP has identified a lot of projects regarding construction of sluice gates in their Master Plan.

Furthermore, it is pointed out that the impact of saline intrusion will be severe over the years coupled with sea level rise under climate change simulation. Therefore, it is important to install sluice gates from downstream to upstream of the River depending on saline intrusion expansion into inland areas. This proposed Project is a sub-sector Project under canal rehabilitation/ dredging and canal embankment Project which is mentioned in the master plan prepared by SIWRP.

The proposed Project is to construct and rehabilitate sluice gates. This includes standard design and estimation of work quantities and cost with identifying appropriate construction schedule. There are 68 sluice gates proposed in the Project; 10 sluice gates in Tien Giang province, 16 in Ben Tre, 12 in Tra Vinh, 5 in Soc Trang, 9 in Kien Giang, 4 in Bac Lieu and 12 in Ca Mau province.

Economic benefit from constructing sluice gates is estimated at the prevention of expected damage to fruit, paddy, and shrimp production. In addition, damage recovery from saline intrusion will be counted as a major benefit. This is because yield of the crops and shrimp has already been damaged by saline intrusion, and the productivity will recover after installing sluice gates.

The economic evaluation of the Project is conducted to estimate of the Economic Internal Rate of Return (EIRR), the B/C, and the Net Present Value (NPV). Also, as a financial analysis of the Project, a farm budged analysis will be carried out to estimate the impact of the Project on farm income. The following are the basic assumptions of the economic evaluation:

1) Referring to other similar projects in the sector, the economic life of the Project designed at 30 years.
2) Prices employed in the evaluation refer to the prevalent market ones in year 2011.
3) The opportunity cost of capital in Vietnam is considered at 12% based on National Standard for Project evaluation in Vietnam. It is judged that the Project is economically feasible when the EIRR of the Project exceeds it.
4) A Standard Conversion Factor (SCF) of 0.9 is applied for converting the financial price to the economic price. Conversion factors for specific items are shown in Table 7.1.1.
5) Transfer cost such as tax is eliminated from the economic cost. Also, price contingency (inflation) cost is not counted in the economic evaluation.
6) Regarding climate change impact, sea level rise estimated under B2 scenario (mid greenhouse gas emission scenario) is applied for the calculation of saline intrusion impact on yield as a base case. This is because B2 scenario is one of the most frequently referred by other climate change relate projects in Vietnam.
7) Average discharge of Mekong River between 1991 and 2000 is applied with the above-mentioned sea level rise for the calculation of saline intrusion impact. Mekong River Commission has predicted an increase of Mekong River flow at some years; however, the future discharge is predicted under uncertain situation. Hence, the Project evaluation will be carried out under conservative assumptions with average discharge of Mekong River between 1991 and 2000.

Table 7.1.1 Applied Conversion Factors[1]

Standard Conversion Factor	0.9
Rice	1.128
Fertilizer	0.95
Skilled Labor	1.0
Unskilled Labor	0.8
Agricultural Inputs	0.9
Fruit	1.057
Shrimp	1.0
Land acquisition and Compensation	0.265

Source: the World Bank and Others. Refer to the footnote

7.2 Project Cost

There are 68 sluice gates proposed in this Project. Size of the gates ranges from 15m to 390m. 20m is the most common size. 24 sluice gates are proposed with 20m wide followed by 12 sluice gates with 30m wide, and 10 sluice gates with 60m wide. The largest number of sluice gates, 16 gates, is proposed in Ben Tre Province. While, there are only 4 sluice gates proposed in Bac Lieu Province.

Sluice gates proposed in Tien Giang, Soc Trang, and Ca Mau Provinces are concentrated on under 60m size, whereas those in Ben Tre, Tra Vinh, and Ken Giang Provinces cover a wide variety of sizes from 20m to 390m wide.

Table 7.2.1 Size of the Proposed Sluice Gates

Province	Size of the Gates (Width m)													Total No.
	15m	20m	24m	30m	40m	50m	60m	64m	70m	80m	100m	130m	390m	
Tien Giang		6		4										10
Ben Tre		3		2	4	1	2		1	1	1	1		16
Tra Vinh		3		3			4			2				12
Soc Trang		5												5
Ca Mau		7		2	1		2							12
Bac Lieu	2		2											4
Kien Giang				1	4		2	1					1	9
Total	2	24	2	12	9	1	10	1	1	3	1	1	1	68

Source: JICA Study Team

Total Project cost (68 proposed sluice gates) will reach VND 22,687 billion at financial price (US$ 1,106 million) and VND 16,571 billion (US$ 807 million) at economic price. Proposed projects in Kien Giang have the largest amount of share with 29% of the total project cost followed by Ben Tre with 28%.

Table 7.2.2 Project Cost

	No. of Gates	Financial Price Total Project Cost	Economic Price Total Project Cost	Share in Total Cost
Bac Lieu	4	558,784,000	400,311,000	2%
Ben Tre	16	6,322,770,000	4,747,969,950	28%
Ca Mau	12	2,568,450,000	1,840,011,400	11%
Kien Giang	9	6,571,024,000	4,707,471,000	29%
Soc Trang	5	762,650,000	546,379,250	3%
Tien Giang	10	1,816,880,000	1,301,619,400	8%
Tra Vinh	12	4,087,410,000	3,027,589,650	18%
Total	68	22,687,968,000	16,571,351,650	100%
US$		$ 1,106,204,025	$ 807,974,337	-

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

[1] Note: Major conversion factors refer to appraisal documents prepared by the World Bank "Mekong Delta Water Resource Management for Rural Development Project".
Conversion factors for Fruit and Vegetable are estimated based on the Project "Restore, Upgrading North Nghe An Irrigation System"

Average Project cost for 20m width gate is estimated at VND 146 billion at financial price and VND 106 billion at economic price. Average Project cost for 40m and 70m width gates is estimated at approximately VND 309 billion and VND 534 billion at financial price respectively. The cost of gate with 390m is estimated to reach VND 3,624 billion at financial price and VND 2,596 billion at economic price.

Table 7.2.3 Average Project Cost by Gate Size

	Financial Price (VND '000)	Economic Price (VND '000)	No. of Gates
Gate Width	Project Cost/ Gate	Project Cost/ Gate	
15m	104,380,000	74,777,550	2
20m	146,258,750	106,996,733	24
24m	175,012,000	125,377,950	2
30m	218,760,000	156,721,200	12
40m	309,481,111	221,709,433	9
50m	431,340,000	309,010,600	1
60m	387,284,000	284,291,970	10
64m	552,124,000	395,538,700	1
70m	534,370,000	464,715,150	1
80m	663,463,333	475,302,983	3
100m	795,950,000	570,218,800	1
130m	828,970,000	708,097,250	1
390m	3,624,860,000	2,596,844,100	1
Total	-	-	68

Source: JICA Study Team

Operation and Maintenance (O&M) cost is estimated at 1% of the construction cost of each sluice gate and the canal. This cost is calculated based on the O&M cost estimated by other similar projects in Mekong delta. Considering simplicity of the proposed gates, 1% of the construction cost is applied for O&M cost. Annual O&M cost of total 68 gates is estimated at VND 115 billion at economic price.

The Project is divided into four investment stage; Stage A is between 2013 and 2020, Stage B is between 2021 and 2030, Stage C is between 2031 and 2040, and Stage C is between 2041 and 2050. Investment will be carried out for 18 gates in Stage A, 26 gates for Stage B, 17 gates for Stage C, and 7 gates for Stage D. Stage A and Stage B account approximately 30% of total project cost respectively. Each of Stage B and Stage C shares around 20% of total project cost.

Table 7.2.4 Disbursement of the Project Cost

Investment Stage	Project Cost (Economic Price) VND '000	No.of Gate	Share in total %
Stage A (2013-2020)	**4,465,574,050**	**18**	27%
Ben Tre	2,923,296,100	10	
Soc Trang	327,827,550	3	
Tien Giang	104,477,700	1	
Tra Vinh	1,109,972,700	4	
Stage B (2021-2030)	**4,664,876,400**	**26**	28%
Ca Mau	1,840,011,400	12	
Kien Giang	935,904,700	4	
Soc Trang	218,551,700	2	
Tien Giang	273,166,000	2	
Tra Vinh	1,397,242,600	6	
Stage C (2031-2040)	**3,738,296,250**	**17**	23%
Bac Lieu	400,311,000	4	
Ben Tre	1,824,673,850	6	
Kien Giang	779,183,500	3	
Tien Giang	213,753,550	2	
Tra Vinh	520,374,350	2	
Stage D (2041-2050)	**3,702,604,950**	**7**	22%
Kien Giang	2,992,382,800	2	
Tien Giang	710,222,150	5	
Total Project Cost	**16,571,351,650**	**68**	100%

Source: JICA Study Team

7.3 Project Benefit

7.3.1 Basic Concept of the Project Benefit

As a Climate Change Adaptation Project, the proposed project has two main aspects considering as monetary value for the Project benefit; 1) damage recovery and 2) damage prevention from saline intrusion.

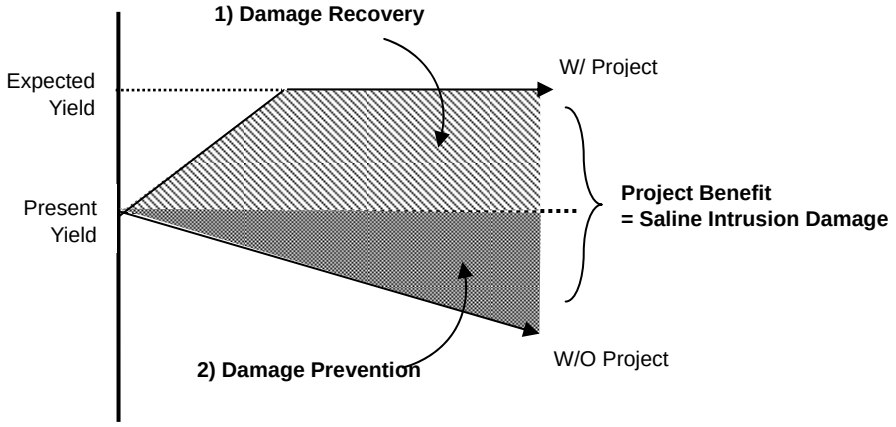


Figure 7.3.1 Basic Concept of the Project Benefit

1) Damage Recovery

Yield of paddy and fruit is expected to recover after implementation of the Project. This is because crop yield in coastal Mekong Delta Provinces has already been affected by saline intrusion. It is found that present crop yield is lower than the expected yield under less salinity water environment. Salinity level will decrease in the Project area upon the installation of the gates so that yield of paddy and fruit is expected to recover. Thus, the value of damage recovery is counted as a major economic benefit of the Project

Yield of paddy is assumed to recover by 7%- 12% from the present yield. This recovery is calculated by comparing between average area yield and the highest area yield by province. For example, in Tien Giang province, average area yield is 6,560kg/ha and the highest area yield is 7,020kg/ha in Cai Lay district. The difference between the average yield and the highest yield is 7%.

Constructing sluice gates and canal extension are expected to narrow this gap because average yield of the targeted area has already been damaged by saline intrusion at some degree, whereas it is thought that the district with the highest yield has not seriously been affected by saline intrusion yet. Therefore, yield of paddy is expected to recover by at least 7% in Tien Giang province. This recovery rate is calculated for both paddy and fruit in all the targeted provinces in the same manner. Table 7.3.1 shows the expected recovery yield.

Table 7.3.1 Expected Recovery for Paddy and Fruit by Province

Province	Expected Paddy Yield (kg/ha)	Recovery rate	Expected Fruit Yield (kg/ha)	Recovery rate
Tien Giang	5,128	7.0%	7,653	15.1%
Ben Tre	5,301	10.6%	7,511	12.9%
Tra Vinh	5,367	12.0%	7,712	16.0%
Soc Trang	5,399	12.7%	7,250	9.0%
Kien Giang	5,444	13.6%	7,447	12.0%

Source: Statistical Yearbook 2010, Tien Giang, Ben Tre, Tra Vinh, Soc Trang, and Kien Giang

Protecting shrimp production from saline intrusion is also counted as a project benefit in Ca Mau and Bac Lieu provinces. According to the vulnerability assessment carried out a JICA funded Master Plan Study, shrimp production has already been damaged by 13.5% in Ca Mau and 13.3% in Bac Lieu provinces. Shrimp farmers will be able to control water volume in shrimp field properly; thus, shrimp production is also expected to recovery by 13% from the present yield.

2) Prevention of Expected Saline Intrusion Damage

Preventing damage by saline intrusion is one of the main roles of constructing sluice gates. Saline intrusion damage is estimated based on the predicted trend of paddy and fruit yield examined under the Vulnerability Assessment carried out by the Master Plan. Figure 7.3.2 shows the trend of paddy yield in 5 provinces between 2012 and 2080. Paddy yield in all the 5 provinces shows downward trend.

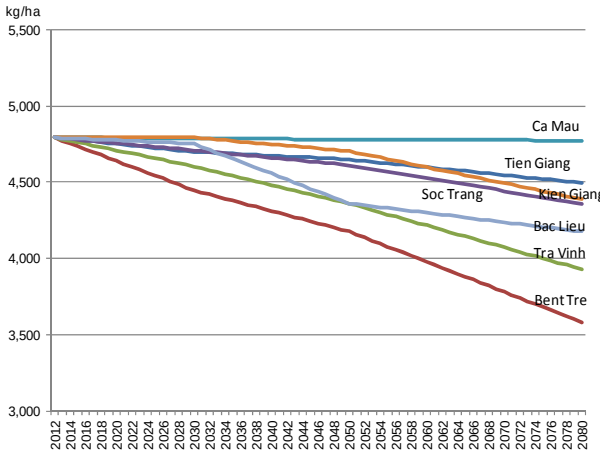


Figure 7.3.2 Yield Trend of Paddy between 2012 and 2080

One of the most damaged provinces by saline intrusion is Ben Tre. Yield of paddy in Ben Tre is expected to drop to 3,583kg/ha in 2080. This is around 25% decrease of the present yield. By contrast, there is no significant saline intrusion impact on Ca Mau. Yield of paddy in 2080 is almost the same as the present yield with 4,792ka/ha.

Figure 7.3.3 shows the trend of fruit yield between 2012 and 2080. As mentioned, Ben Tre is the most affected by saline intrusion. Yield of fruit in Ben Tre is expected to decrease to 4,932kg/ha in 2080 from the present yield of 6,650kg/ha. This is 26% decrease of the present fruit yield. On the other hand, fruit production in Kien Giang and Tien Gian has less impact of saline intrusion. Yield of fruit in Kien Giang and Tien Giang will decrease by approximately 9% with 6,100kg/ha.

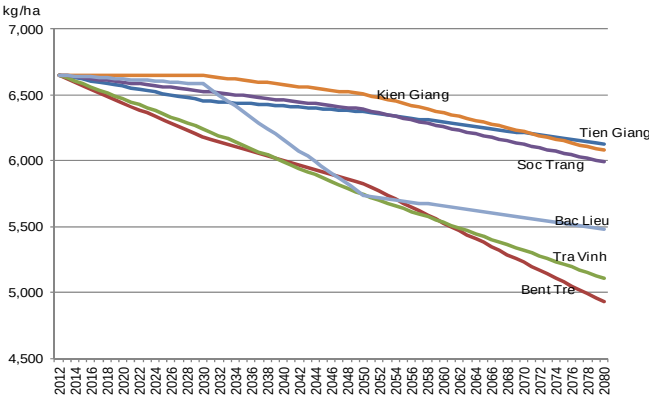


Figure 7.3.3 Yield Trend of Fruit between 2012 and 2080

7.3.2 Economic Value of the Project Benefit

Total Project benefit between 2013 and 2080 reaches VND 207,828 billion (US$ 10 billion) at economic price. Project benefit from damage recovery is valued at VND 144,939 billion (US$ 7 billion) with 70% the total project benefit; while damage prevention is valued at VND 62,888 billion (US$ 3 billion) with 30% of the total project benefit.

In respect of the project benefit by provinces, project benefit from Ben Tre accounts for 35% of the total project benefit followed by Kien Giang with 27.4%. While minimum amount of benefit by province is VND 5,922 billion in Bac Lieu with 2.8% of the project benefit. In addition, damage prevention in Bac Lieu and Ca Mau is not expected to be accrued from the Project. This is because shrimp production will not be damaged seriously by the saline intrusion. Therefore, damage prevention in Bac Lieu and Ca Mau is not counted as project benefit.

Table 7.3.2 Total Project Benefit in Project period (year 2014-2080)

	Area (ha)	Damage Prevention (VND'000)	Damage Recovery (VND'000)	Total (VND'000)	%
Bac Lieu	10,367	0	5,922,046,243	5,922,046,243	2.8%
Ben Tre	36,033	36,235,341,983	37,202,205,666	73,437,547,648	35.3%
Ca Mau	36,900	0	21,079,437,912	21,079,437,912	10.1%
Kien Giang	54,000	10,479,649,865	46,454,679,452	56,934,329,317	27.4%
Soc Trang	11,267	1,800,070,312	4,744,045,539	6,544,115,851	3.1%
Tien Giang	29,600	5,215,895,346	16,988,590,465	22,204,485,811	10.7%
Tra Vinh	27,833	9,157,969,713	12,548,107,993	21,706,077,707	10.4%
Total	206,000	62,888,927,219	144,939,113,270	207,828,040,489	100.0%
Share %		30%	70%	100%	
US$		$3,066,294,188	$7,066,839,589	$10,133,133,777	

Source: JICA Study Team

7.4 Project Economic and Financial Evaluation

EIRR is calculated for Stage A (investment between 2013 and 2020) and the whole Project period (investment between 2013 and 2050). B/C and Net Present Value (NPV) are also calculated using the opportunity cost of capital in Vietnam, namely 12% as a discount rate. As shown in Table 7.4.1, the EIRR for the whole Project and short term Project period is estimated at 16.8% and 18.6% respectively. This result exceeds the opportunity cost of capital in Vietnam, i.e. 12%.

In addition, other economic indicators show positive results; B/C is calculated at 1.38 for the whole Project and 1.56 for Stage A, and NPV is approximately VND 1,401 billion for the whole Project and VND 1,127 billion for Stage A[2]. Therefore, it is concluded that the Project is economically feasible.

Table 7.4.1 Results of the Economic Indicators

	EIRR	B/C	NPV '000VND
Whole Project (68 sluice gates: investment period 2013-2050)	16.8%	1.38	1,401,743,826
Stage A (18 sluice gates investment period 2014-2020)	18.6%	1.56	1,127,265,463

Source: JICA Study Team

The EIRR of each gate is calculated and the result is plotted on Figure 7.4.1. The major characteristic of the provinces with high EIRR is higher proportion of fruit production. Fruit is more profitable and susceptible to saline intrusion than paddy; thus, fruit production has a big influence on these EIRRs. For example, as a general trend, the EIRRs in Soc Trang and Kien Giang provinces are lower because fruit crops are not much produced in these areas.

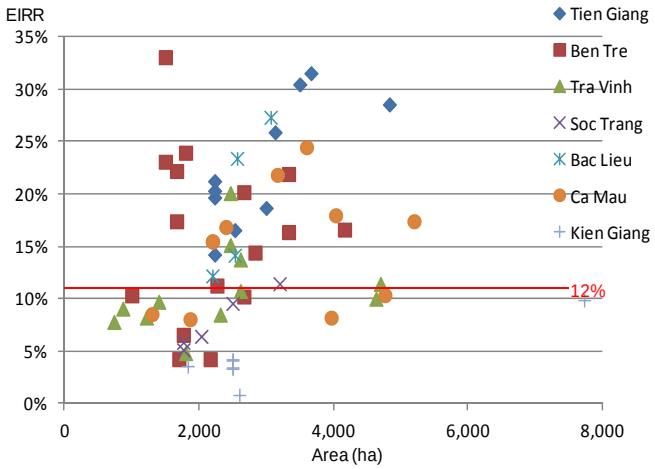


Figure 7.4.1 Results of the EIRR for Each Gate

[2] The investment of the whole Project will be carried out from 2013 to 2050. Thus, the EIRR for the whole Project is calculated from the first 2014 to 2080.

Figure 7.4.2 shows the relationship between Project area and Project cost. The regression line is drawn in the graph by referring to feasible project area for the proposed Projects. For example, if the Project cost is estimated at VND 450,000 million, around 6,000ha target area should presumably be targeted by the Project. In other words, projects in the upper area of the line would be expected over 12% of EIRR, while projects plotted on under the line would be less than 12% EIRR. Present proposed Project is plotted in the graph.

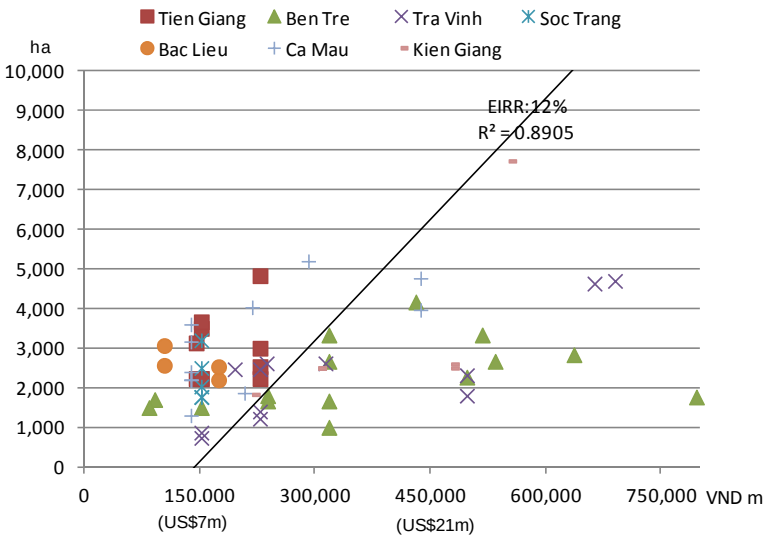


Figure 7.4.2 Relationship between Project Area and Cost

This border line of EIRR 12% will be changed depending on the area characteristics. For example, slope of the line would be smaller if a project targeted on fruit production area. This means that a project would still be economically feasible even if target area becomes small since the target crop is more vulnerable and profitable. For this reason, although the proposed sluice gates in Ben Tre province are plotted on the graph area under the line, these EIRRs are not all below the 12%.

The graph indicates if project cost is VND 300,000 million (US$ 14 million), a project should target at least around 3,000ha. In case project cost estimated at VND 450,000 million (US$ 21million), a project should target more than 6,000ha in order to make a project feasible.

7.5 Sensibility Analysis

As a result of sensibility analysis, 1) if the investment cost would increase by 10%, the whole Project of EIRR would be reduced to 15.2%. 2) If the Project benefit would decrease by 10%, the total EIRR would be decreased to 15.0%. 3) The effect of both 10% increase cost and 10% decrease benefit events would result in an EIRR 13.6%. 4) In case of 20% increase of estimated cost, the EIRR would drop to 13.9%. 5) If the Project would reduce by 20% of the expected benefit, the EIRR would be decreased to 13.3%. These results indicate that the proposed Project would be strong enough to overcome adverse circumstances.

Table 7.5.1 Results of Sensibility Analysis for the Whole Project

Whole Project (68 sluice gates between 2013 and 2050)	EIRR	B/C	NPV '000VND
Base Case	16.8%	1.38	1,401,743,826
1) 10% increase of cost	15.2%	1.25	1,028,298,530
2) 10% decrease of benefit	15.0%	1.24	888,124,147
3) 1)+2)	13.6%	1.13	514,678,850
4) 20% increase of cost	13.9%	1.15	654,853,233
5) 20% decrease of benefit	13.3%	1.10	374,504,468

Source: JICA Study Team

With regards to sensibility analysis for the Project in short term, the result is shown in Table 7.5.2. The results also show the economic efficiency with all the cases.

Table 7.5.2 Results of Sensibility Analysis for Short Term Sluice Gate Project

Short Term Period (18 sluice gates between 2013 and 2020)	EIRR	B/C	NPV '000VND
Base Case	18.6%	1.50	1,127,265,463
1) 10% increase of cost	16.9%	1.37	903,437,253
2) 10% decrease of benefit	16.7%	1.35	790,710,707
3) 1)+2)	15.1%	1.23	566,882,496
4) 20% increase of cost	15.4%	1.25	679,609,043
5) 20% decrease of benefit	14.8%	1.20	454,155,950

Source: JICA Study Team

7.6 Farm Budget Analysis

A farm budget representing typical rural household in Project area is modeled into 2 cases; 1) paddy and fruit cultivation and 2) paddy and shrimp cultivation. An increase of paddy and fruit cultivation will be 15.0% of net income. Crop pattern of paddy and shrimp, a typical pattern in Ca Mau and Bac Lieu, is expected to increase by 20.64%. Constructing sluice gate will contribute to increasing net income by 15% to 20% depending on the farming system.

Table 7.6.1 Farm Budget Analysis for Paddy and Fruit

			Present (Without)		With Project		Net Income Increase
	Area (ha)	Unit Price (VND/kg)	Yield (kg/ha)	Total Value (VND)	Yield (kg/ha)	Total Value (VND)	
SA Paddy	0.65	6,365	4,314		4,314		
(A) Gross Income				17,848,097		17,848,097	
(B) Production Cost				12,348,827		12,348,827	
(C) Net Income				5,499,269		5,499,269	0.0%
AW Paddy	0.71	6,591	4,612		4,612		
(A) Gross Income				21,582,361		21,582,361	
(B) Production Cost				13,488,719		13,488,719	
(C) Net Income				8,093,642		8,093,642	0.0%
WS Paddy	0.69	6,398	5,781		6,359		
(A) Gross Income				25,520,918		28,072,569	
(B) Production Cost				13,108,755		13,108,755	
(C) Net Income				12,412,163		14,963,813	3.5%
Fruit	0.5	16,408	8,568		9,596		
(A) Gross Income				70,291,872		78,725,584	
(B) Production Cost				23,076,277		23,076,277	
(C) Net Income				47,215,595		55,649,307	11.5%
Total	2.55			73,220,669		84,206,032	15.0%

Source: Household Economic Survey, JICA Study Team (2011) and Statistical Yearbook 2010

Table 7.6.1 Farm Budget Analysis for Paddy and Shrimp

			Present (Without)		With Project		Net Income Increase
	Area (ha)	Unit Price (VND/kg)	Yield (kg/ha)	Total Value (VND)	Yield (kg/ha)	Total Value (VND)	
SA Paddy	0.65	6,365	5,390		5,390		
(A) Gross Income				22,299,778		22,299,778	
(B) Production Cost				11,567,365		11,567,365	
(C) Net Income				10,732,413		10,732,413	0.0%
Shrimp	1.8	158,000	409		462		
(A) Gross Income				116,319,600		131,392,800	
(B) Production Cost				54,022,979		54,022,979	
(C) Net Income				62,296,621		77,369,821	20.64%
Total Net Income	2.45			73,029,034		88,102,234	20.64%

Source: Household Economic Survey, JICA Study Team (2011) and Statistical Yearbook 2010

7.7 Project Indirect Benefit

1) Fresh Water Recruitment

One of the indirect benefits of constructing sluice gates is to make fresh water available for the rural population. In fact, saline intrusion causes not only the damage to agricultural production, but also to drinking water, particularly canal water and shallow ground water. There are still lots number of people who have to depend on canal water for their domestic use during latter part of dry season[3]. The Project is to prevent saline intrusion as well as recruit fresh water from the upstream area, and therefore keeping fresh water for domestic use is expected to be an indirect benefit.

2) Enhancement of Mobility

Enhancing mobility is also expected as another indirect benefit from the Project. Most of the sluice gates have a function as a bridge besides saline intrusion prevention. People who usually take a long way around will be able to save time by using the bridge attached to the gate. Thus, the Project will contribute to enhancing the mobility of people's daily life.

3) Narrowing Disparities between Urban and Rural

The Project will contribute to narrowing disparities between urban and rural areas. This is because the Project is expected to increase farm income as a result of recovering crop productivity. This makes farm income level in rural area higher; hence, the Project will contribute to narrowing income disparities between urban and rural people.

4) Promoting High Value Added Crops

The Project will encourage farmers to cultivate high value added crops such as fruit. This is because the Project is to protect agricultural production from saline intrusion damage. Constructing sluice gates will play a role of promoting value added crops by preventing one of the major farming risks. Therefore, farmers will be able to cultivate more high value added crops.

[3] Rural population who do not have piped water usually use stored rainwater for their domestic use during rainy and dry seasons. However, the stored water often run shortage towards the end of dry season, by which they have no other option but to go to canal water for the domestic use.

CHAPTER 8 CONCLUSION AND RECOMMENDATION

8.1 Conclusion

8.1.1 Construction Project

Necessity of sluices in the project is proved in simulation and field survey. Saline intrusion is considered to expand its affected area in future; so that implementation of this project is essential for the coastal area of Mekong delta. Through a series of evaluation conducted in this study, this project is considered feasible because of the following aspects.

1) Economic evaluation

On the economic evaluation, overall EIRR for 68 sluices construction showed 16.8%, higher than the opportunity cost of 12% in Vietnam. If project is divided into four terms 2013-2020, 2021-2030, 2031-2040, and 2041-2050, estimated EIRR for saline intrusion prevention came to 18.6%, 13.5%, 14.9%, and 11.6% respectively. Even though the project in the last term does not exceed he opportunity cost of 12% in Vietnam, the sluice under this term has the main purpose of flood prevention; benefit of both saline intrusion prevention and flood prevention will contribute EIRR increasing over 12%.

2) Environment evaluation

On the environmental issue, except for resettlement, the proposed project does not give severe adverse impact on the surrounding environment. Some impacts such as noise and air pollution may take place during construction period; however, these impacts are limited and temporary, and still possible to mitigate by available measures to be taken by contractor(s).

On the resettlement, numbers of households to be relocated will be many. The legal frame of resettlement in Vietnam is well developed where each PPC has its original unit price of compensation considering local conditions together with the national level regulation. The system has been functioning, so that the resettlement required under the project could be managed

3) Technical evaluation

On the technical issue, there are no specific difficulties for implementing the project and in addition materials to be used under this project are common and available in Vietnam. Therefore, the project is technically feasible to implement, and in addition the construction schedule is not tight taking into account actual similar practices in Mekong delta. Further, each responsible office to implement and manage this project has enough human resources with similar experiences, whereby construction and management thereafter could well be done.

4) Institutional evaluation

Each responsible office to implement and manage this project has enough human resources with experiences on construction of sluices. Roles and responsibility are clear after adjustment by responsible implementation organization by the minister for MARD. Responsible organizations have enough capacity for project implementation and management.

8.1.2 Rehabilitation Project

Since rehabilitation works are regular activity in maintenance works undertaken by a water resource management company of each province, the project itself does not deviate from rules and regulations of each water resource management company. Each company has budget for rehabilitation and techniques for the project with well experienced staff and human resources. This is why this project is considered to be feasible.

8.2 Recommendations

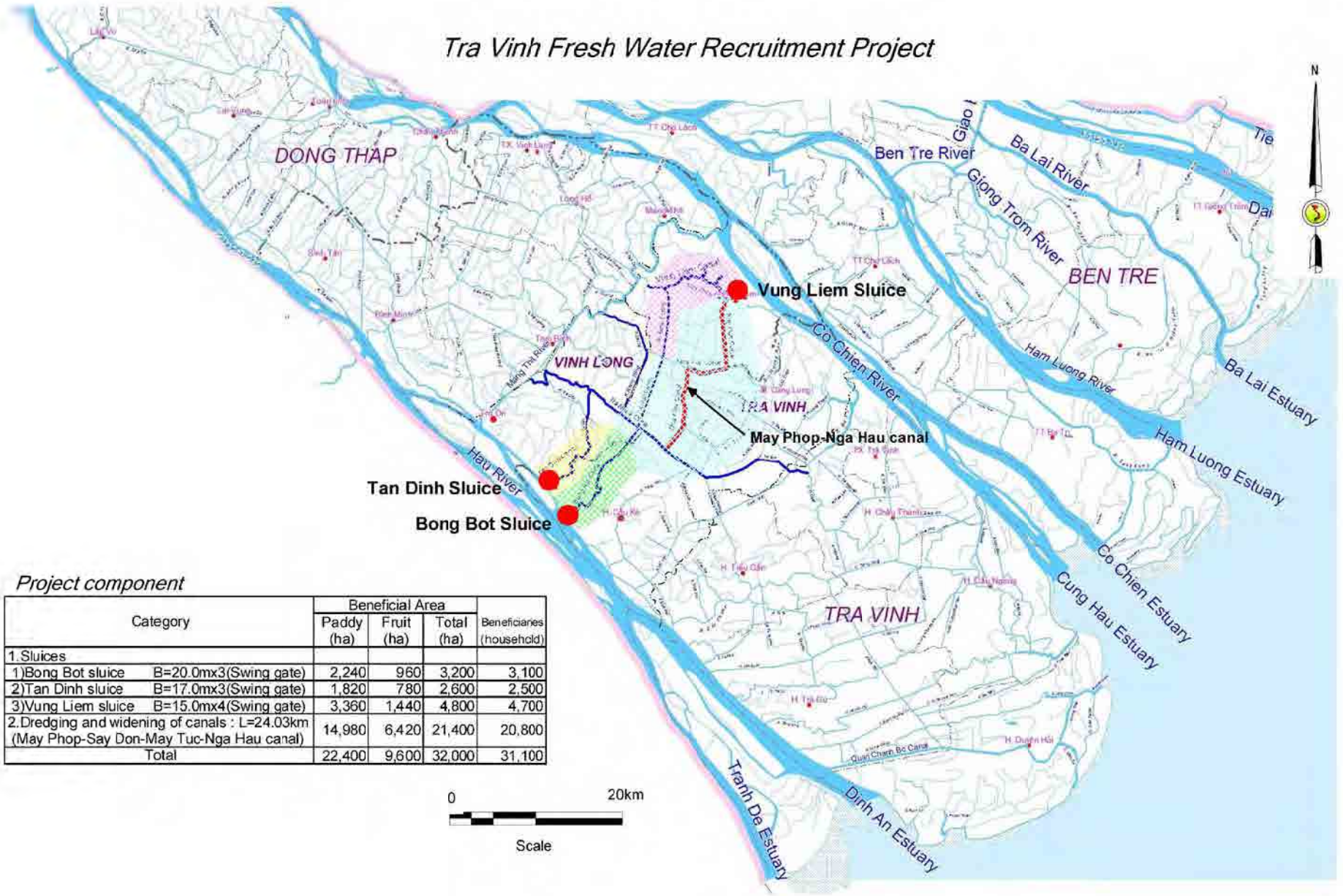
As for resettlement and land recovery, it is recommended to pay further attention to the people to be affected; e.g. application of WB policy 4.12 is recommended in addition to the existing resettlement frame to increase opportunity for the affected persons to participate in the preparation of the resettlement plan, and to minimize a gap between market price and prescribed price of land compensation. In sum, it is recommended to involve the persons to be affected at an earlier stage and also to fill the gaps between the prices.

Preparation of resettlement plan and its implementation shall be commenced in advance of proposed project period because there are a lot of procedures for resettlement implementation and it take quite long time until its completion.

It is recommended to implement the sluice construction by ODA assistance while the rehabilitation of sluices by the Vietnamese government budget. This is because; impact of climate change, especially saline intrusion coupled with sea level rise, is an urgent issue in the Ben Tre and Tra Vinh provinces. To prevent the saline intrusion at an early stage of time, it is thought to be better to seek assistance from donor(s) taking into account budgetary constraint for the Vietnamese government. On the other hand, sluice rehabilitation work is regular works by Water Resource Management Company, and the work shall be continued without end.

PART III

TRA VINH FRESH WATER RECRUITMENT PROJECT (3 SLUICE GATES)



Project component

Category		Beneficial Area			Beneficiaries (household)
		Paddy (ha)	Fruit (ha)	Total (ha)	
1.Sluices					
1)Bong Bot sluice	B=20.0mx3(Swing gate)	2,240	960	3,200	3,100
2)Tan Dinh sluice	B=17.0mx3(Swing gate)	1,820	780	2,600	2,500
3)Vung Liem sluice	B=15.0mx4(Swing gate)	3,360	1,440	4,800	4,700
2.Dredging and widening of canals : L=24.03km (May Phop-Say Don-May Tuc-Nga Hau canal)		14,980	6,420	21,400	20,800
Total		22,400	9,600	32,000	31,100

EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Master Plan formulated under 'Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta in Vietnam' has identified total 9 priority projects (long list project), and out of them 4 projects were short-listed for feasilibty examination and/or detail project designing. One of the 4 short listed projects is Tra Vinh Fresh Water Recruitment Project, which is composed of two major components; one is 3 numbers of sluice construction and the other is rehabilitation of existing sluices.

1.2 In national plans, it is stated to keep the paddy production and increase the aquaculture products in the next five years. However, it is expected that, by the year 2050, temperature rises by 1.0 degree Celsius; annual rainfall increase 3.0%, concentrating only during rainy season; and sea level increases by 31 cm under climate change 2 scenario. As a result, yield losses are expected due to the increased temperature, saline intrusion, and also inundation to be caused by increased rainfall. To cope with the foreseeable problems, the project is proposed to make cropping systems suitable to such an environment being affected by climate change issues.

2. THE PROJECT AREA

2.1 Tra Vinh province is located at the most downstream of the sandwiched area by 2 big Mekong tributaries composed of Co Chien River and Hau River. Saline intrusion is taking place towards upstream, and winter-spring paddy cultivation has been affected in this province in year 2011; more than 70% of harvest was lost in about 8,000 ha of winter-spring paddy and about 30-70% loss in the areas of about 3,000ha (the total paddy area in Tra Vinh province was 92,000 ha in 2010.

2.2 To protect the paddy area in the Tra Vinh province, construction of sluices at the mouths of channels (water supply and drainage canals) should be given the highest priority. In this province, there should also be canal extension towards upstream side, i.e. into Vinh Long province from which fresh water can be withdrawn without being affected by saline intrusion. The project should therefore be of combination of sluice gate construction and trans-boundary of fresh water recruitment, for which the freshwater is taken in the Vinh Long province and ferried to the downstream in Tra Vinh province.

2.3 Recorded data and climate change simulation have defined a high risk of saline intrusion onset of sea level rise. The sea level rise around the Mekong delta has arrived at certain level and an average sea level rise is approximately 5 cm per decade. Future prediction done by IMHEN shows 30cm sea level rise in 2050 under B2 scenario. Occurrence of saline intrusion without sea level rise is also confirmed in Vinh Long province by simulation employing an average discharge from 1991 to 2000. Furthermore, freshwater is not available in April and May in Tra Vinh province while it is available in Vinh Long province by simulation on sea level rise of 30cm in 2050.

2.4 Both provinces of project area have relatively high population density; 438 peoples per km^2 in Tra Vinh province, 694 peoples per km^2 in Vinh Long province in comparison with that of Mekong Delta (426 people per km^2). Total of both provinces has 3,774 km^2 of area which is about 9% of Mekong Delta (40,519 km^2). Population of the 2 provinces is shares about 12% the total population of 17.3 million of the Mekong Delta (2010).

2.5 Tra Vinh province stays at the lowest position of GDP per capita among coastal seven provinces and it is lower than the average of whole Mekong delta, and whole country as well. GDP per capita of Tra Vinh (801 USD) is less than half of the one of Can Tho (1,830 USD) while economic structure of it is quite similar to the average of coastal Mekong delta. It implies that though we can see robust agriculture and aquaculture production in Tra Vinh province while it leads to fewer value added

economy and low GDP per capita; there are fewer secondary and tertiary industries in Tra Vinh as compared with the average of Mekong delta and the national level.

2.6 Air temperature in Mekong Delta shows relatively high value as compared to other parts of Vietnam while that of Tra Vinh at Cang Long station shows relatively low temperature in comparison with other locations in Mekong delta. Rach Gia, western side of the delta, shows higher temperature than Cang Long; there is always about 1^{o}C difference in average monthly air temperature between Rach Gia (Kien Giang province) and Cang Long (Tra Vinh province).

2.7 Two seasons can be distinguished in a year; rainy season is from May to November and dry season is from December to April. A mean annual rainfall is 1,672mm in Tra Ving province while that of Vinh Long is 1,365mm. According to the annual average isohyetal map, an annual rain fall ranges over 1,800mm/year at the southern part of the project area. An average rainfall decrease toward northern side of the project area and it ranges between 1,400mm and 1,600mm at the northern part of Vinh Long province.

2.8 A ratio of agricultural land use in Tra Vinh province, Vinh Long province as well as Mekong Delta is much higher than other areas of the Country. While 65%. 78%, and 63% of the area is used for agricultural purposes in Tra Vinh province, Vinh Long province, and Mekong Delta respectively, only 29% is used in the whole Country, which is far greater than any other regions including the Red River Delta (36%). Among the project area, Tra Vinh province and Vinh Long province show different land use; land use in Tra Vinh province is composed of 45% for paddy and 17% for perennial crop while that of Vinh Long province is composed of 47% for paddy and 30% of perennial crop.

2.9 As for the paddy cropping calendar in the Project area, there are four major seasons, among which summer-autumn paddy (May-August) and winter-spring paddy (December-February) constitute the major part of paddy production in the Project area. In rain-fed areas where irrigation water is barely available, paddy is planted only during the rainy season. In this case, if the area is heavily flooded toward mid to end of rainy season, only summer-autumn paddy (early rainy season paddy) is cultivated once while in areas not affected by flood, autumn-winter paddy is also cultivated.

2.10 The paddy production has been on an increasing trend and in 2010 the total production reached 1,156,000 tons for Tra Vinh province and 923,000 tons for Vinh Long province against 39,989,000 tons of whole country. Both provinces produced 5% of the country's production and that shared about 10% of paddy production in Mekong Delta. Looking at the provincial production of 2010, coastal provinces have relatively less production. Tra Vinh and Vinh Long are at middle position in paddy production between the top production province of Kien Giang (3,485,000 tons) and the lowest production of Ben Tre (368,000 tons).

2.11 The overall aquaculture production of Mekong Delta (1,940,181 tons) shares as much as 72% of the national production (2,706,752 tons). As for fish production, Tra Vinh and Vinh Long produce 53,824 tons and 135,089 tons aquaculture fish respectively, which share 4% and 9% of Mekong Delta fish production. Per-capita production of aquaculture fish is estimated at 54 kg in Tra Vinh province and 132 kg in Vinh Log province while national level stays at 24 kg.

3. CLIMATE CHANGE AND IMPLICATIONS

3.1 According to long-term observation data, temperature in Mekong delta is in an increasing trend: 0.7 degree Celsius of increase in annual mean temperature in the past 30 years, corresponding to global warming. Sunshine hours per annum maintain, however, a decreasing trend: approximately 500 hours, or 20%, of decrease over the past 30 years, which correspond to the increasing trend of rainfall, although the trend of rainfall differs among the measuring stations and the period. With respect to

water levels in the East Sea, West Sea and Mekong River, continuous increases are observed at all the places: 15 cm over the past three decades—meaning 5 cm of increase per decade for both East and West Seas.

3.2 With reference to a climate change simulation, it is expected that the mean annual temperature (1980-1999) would increase by 1.0 degree Celsius by year 2050. Annual rainfall is expected to increase; monthly rainfall in October is projected to increase by more than 20% by year 2100 for the scenario B2. With regard to sea level, biggest sea level rise would occur in A2 scenario amongst scenarios B1, B2, and A2, wherein it is expected to increase by 31 cm by year 2050 and as much as 103 cm by 2100. The trend of sea level rise is quite exponential up until year 2100 for all the scenarios.

3.3 By the climate change so far having taken place and expected to occur, a range of damages are caused or to be caused. Typical problematic issues, as constraints and difficulties to farmer households on the ground, are as follows according to the results of simulation and vulnerability assessment:

- ✓ *Damage by saline intrusion*: Tra Vinh province will have much affect by saline intrusion in 2050; about lower half of province will be affected by high saline contents and some of east side of the province also be affected. Ving Long province will not have significant saline intrusion affect in the province in 2050 even though discharge is as low as that in 1998.
- ✓ *Damage by inundation:* Affect of flood inundation for Tra Vinh will be not so much as other coastal provinces. Since Vinh Long province is located at near reed plain, depth of inundation is expected 0.75m or over; it is quite different from coastal provinces including Tra Vinh province. Tra Vinh province does not have much flood inundation damage at the 'Present' case. In 2050, value loss percentage will reach at about 20% of production, and it will arrive at 45% in 2100. In case of Vinh Long provinces not calculated but it is expected that the damage by flood inundation will be the same as the case of Kien Giang or more according to inundation distribution area.

4. DESIGN OF THE PROJECT

4.1 In-depth study has revealed that saline intrusion will become sever in future and it is difficult to satisfy freshwater demand in Tra Vinh province alone, so that fresh water shall be taken from upstream side of Mekong river. For the purpose of freshwater acquisition, some large sluices coupled with canal capacity improvement are planned in Tra Vinh province and Vinh Long province.

4.1 Project Component

4.2 Total three (3) sluices are planned for fresh water recruitment for Tra Vinh province; Bong Bot, Tan Dinh, and Vung Liem. Bong Bo and Tan Dinh are located at west side (along Hau River) of Tra Vinh, and Vung Liem is planned at east side (along Co Chien river). Say Don canal will function as the main route conveying freshwater from Vinh Long province to middle and downstream area of Tra Vinh province; then, freshwater can be distributed to beneficiary area in Tra Vinh province through canal networks.

4.3 The beneficiary area of project is; 3,200 ha for Bong Bot slice, 2,600 ha for Tan Dinh sluice, 4,800 ha for Vung Liem sluice, and 21,400 ha for the waterway (Say Don canal) respectively. Beneficiary household under the project counts; 3,100 households for Bong Bot slice, 2,500 households for Tan Dinh sluice, 4,700 households for Vung Liem sluice, and 20,800 households for the waterway (Say Don canal) respectively.

4.4 The waterway improvement; is so called Say Dong canal expansion project composed of dredging and extending the waterways from Vung Liem canal to Tra Ngoa canal; including total four canals; May Phop canal connects to Vung Liem canal with 2.3km in length, Say Dong canal intermediate canal of this project with total length of 6.6km, and May Tuc-Nga Hau canals are located at the most downstream of the waterway having 15.2km in length. This project is designed to increase water convey canal of canals from 65m3/sec to 118m3/sec while peak freshwater demand is 111.4m^3/sec.

4.2 Bong Bot Sluice

4.5 Construction site of Bong Bot Sluice is proposed in Bong Bot River and 400m away from connection point with Hau River. From comparative studies for two alternatives, construction in the river has more advantage than the one on shore because the volume of soil excavation is smaller and volume of compensation for resettlement is only 1/10 as less as the on shore case.

4.6 Gate crest elevation is designed as H= 3.50 m. Even if a change of water level by climate change takes place in future, the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard).

4.7 Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

4.8 Stainless gate is selected because in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting.

4.9 Pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

4.3 Tan Dinh Sluice

4.10 Construction site of Tan Dinh Sluice is proposed in Tan Dinh River and 400m away from connection point with Hau River. This point is close to the provincial road that accessibility for traffic is excellent. Since the river course shapes almost straight, there cannot be found for suitable place of on-shore route around the site. Furthermore, there is no hydraulic advantage for construction of the sluice at on-shore because the route of it will be not straight. There is no alternative against riverbed site for construction of Tan Dinh Sluice.

4.11 Gate crest elevation is designed as H= 3.50 m. Even if a change of water level by climate change takes place in future, the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard).

4.12 Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can

meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

4.13 Stainless gate is selected because in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting.

4.14 Pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

4.4 Vung Liem Sluice

4.15 From comparative studies for two alternatives, construction in the river has more advantage and this option is proposed as construction site because the volume of excavation is small, volume of land compensation and resettlement is as ones tenth as option 1. Since construction site in option 1 is adjacent to the center of Vung Liem district and close to district roads, compensation cost for houses, residential land and crop land amount to as three times as agricultural land.

4.16 Gate crest elevation is designed as H= 3.50 m. Even if a change of water level by climate change takes place in future, the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard).

4.17 Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

4.18 Stainless gate is selected because in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting.

4.19 Pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

5. EVALUATION OF THE PROJECT

5.1 On the economic evaluation, overall EIRR showed 26.7%, higher than the opportunity cost of 12% in Vietnam, in case of the project composed of three sluices construction plus canal extension. If only the sluices are taken up as an individual project separating from the canal extension, estimated EIRR came to; 20.9% for Bong Bot sluice gate, 14.4% for Tan Dinh sluice gate, and 19.6% for Vung

Liem sluice gate, all of which are higher than that of opportunity cost of Vietnam.

5.2 On the environmental issue, except for resettlement, the proposed project does not give severe adverse impact on the surrounding environment. Some impacts such as noise and air pollution may take place during construction period; however, these impacts are limited and temporary, and still possible to mitigate by available measures to be taken by contractor(s).

5.3 On the resettlement, numbers of households to be relocated are estimated at; 8 for Bong Bot sluice gate, 16 for Tan Dinh sluice gate, 11 for Vung Liem sluice gate, and approximately 260 for the canal extension. The legal frame of resettlement in Vietnam is well developed where each PPC has its original unit price of compensation considering local conditions together with the national level regulation. The system has been functioning, so that the resettlement required under the project could be managed.

5.4 On the technical issue, there are no specific difficulties for implementing the project and in addition materials to be used under this project are common and available in Vietnam. Therefore, the project is technically feasible to implement, and in addition the construction schedule is not tight taking into account actual similar practices in Mekong delta. Further, each responsible office to implement and manage this project has enough human resources with similar experiences, whereby construction and management thereafter could well be done.

6. CONCLUSION AND RECOMMENDATIONS

6.1 As for resettlement and land recovery, it is recommended to pay further attention to the people to be affected; e.g. application of WB policy 4.12 is recommended in addition to the existing resettlement frame to increase opportunity for the affected persons to participate in the preparation of the resettlement plan, and to minimize a gap between market price and prescribed price of land compensation. In sum, it is recommended to involve the persons to be affected at an earlier stage and also to fill the gaps between the prices.

6.2 It is recommended to implement the sluice construction by ODA assistance while the canal extension by the Vietnamese government budget. This is because; impact of climate change, especially saline intrusion coupled with sea level rise, is an argent issue in Tra Vinh province. To prevent the saline intrusion at an early stage of time, it is thought to be better to seek assistance from donor(s) taking into account budgetary constraint for the Vietnamese government. On the other hand, canal extension work may take longer time than planned due mainly to the many households to be relocated. Therefore it is needed for the government to proceed step by step, utilizing the government own budget.

6.3 Of the 3 sluices, priority should be given to the Bong Bot and Tan Dinh sluices which are planned on the Tien river side while Vung Liem planned on Co Chien river side can be implemented later than those 2 gates taking into account the current level of saline intrusion. Vung Liem should also be constructed in parallel with the canal extension, so that the water recruitment starting at an upstream point from the Vung Liem sluice gate can be achieved to the maximum expected level.

CONTENTS (TRA VINH)

ATTACHMENT:

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AHDNS	Acute Hepatopancreatic Degenerative Necrotic Syndrome
AMSL	Above Mean Sea Level
AusAID	Australian Agency for International Development
B/C	Benefit Cost Ratio
CP	Counterpart
DARD	(Provincial) Department of Agriculture and Rural Development
DONRE	Department of Natural Resources and Environment
DPC	District People's Committee
EU	European Union
ERR	Economic Rate of Return
FAO	Food and Agriculture Organization
FY	Fiscal Year
GDP	Gross Domestic Products
GOJ	Government of Japan
GOV	Government of Vietnam
GCM	Global Climate Model (or General Circulation Model)
GSO	General Statistical Office
HDI	Human Development Index
IAS	Institute of Agricultural Science for Southern Vietnam
ICB	International Competitive Bidding
IDA	International Development Association
IDMC	Irrigation and Drainage Management Company
IMC	Irrigation (and Drainage) Management Company, under DARD
IMF	International Monetary Fund
IMHEN	Institute of Metrology, Hydrology and Environment
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IRR	Internal Rate of Return
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau (German government-owned development bank)
MARD	Ministry of Agriculture and Rural Development
MBV	Monodon Bacuro Virus
MDG	Millennium Development Goal
M&E	Monitoring and Evaluation
MKD	Mekong Delta
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
MRC	Mekong River Commission
NACA	Network of Aquaculture Centres in Asia-Pacific
NCB	National Competitive Bidding
NPK	Nitrogen, Phosphate, Potassium

NPV	Net Present Value
O&M	Operation and Maintenance
PCR	Polymerase Chain Reaction
PRA	Participatory Rural Appraisal
PRECIS	Providing Regional Climates for Impacts Studies (a regional climate model system)
PCM	Project Cycle Management
PPC	Provincial People's Committee
RCM	Regional Climate Model
RIA No.2	Research Institute for Aquaculture, No.2 (located in Ho Chi Minh City)
SIWRP	Southern Institute of Water Resources Planning (the CP organization)
SIWRR	Southern Institute of Water Resources Research
SWOT	Strengths, Weaknesses, Opportunities, and Threats
Sub-NIAPP	Sub-national Institute of Agricultural Planning and Projection
GIZ	(Deutsche) Gesellschaft für Internationale Zusammenarbeit

UNIT CONVERSION

1 meter (m)	=	3.28 feet
1 kilometer (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
1 acre	=	0.405 ha
1 inch (in.)	=	2.54 cm
1 foot (ft.)	=	12 inches (30.48 cm)
1 ac-ft		1233.4 cum

CURRENCY EQUIVALENTS (AS AT DECEMBER 2012)

US$ 1.00	=	VND 21,053 (TTB)
US$ 1.00	=	82.11 Japanese Yen (TTB)
VND 1.00	=	0.0039 Yen

VIETNAM FISCAL YEAR

January 1 to December 31

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MAIN REPORT

CHAPTER 1 INTRODUCTION

High priority is given to an issue of saline intrusion under a climate change prediction according to workshop results at village level, provincial level, and regional level; other aspects are also taken into account for this prioritization such as discussions with relevant officers, vulnerability assessment results on the climate change, and the results of in-depth studies etc. Shortage of water is also one of serious issues in the coastal areas and it is expressed as 'draught' in the workshops. Climate change will accelerate damage and impact of these issues on agricultural product and human activities, so that intervention has to be taken before it becomes serious situation. Tra Vinh province can be considered one of seriously affected areas by saline intrusion and draught simultaneously. This chapter describes necessity and importance of the project for sluice construction in Tra Vinh province to cope with climate change.

1.1 Rationale of the Project

Sea level has been rising with certain extent in the last several decades according to IPCC 4th assessment report (2007)[1]; the global average sea level has risen at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003 and at an average rate of about 3.1 [2.4 to 3.8] mm per year from 1993 to 2003. Around the Mekong delta, sea level rise has been recorded; the record shows continuous sea level rise trend with an average of approximately 15 cm in 30 years. It means about 5 mm per year; a bit higher pace than the IPCC 4th assessment report. This sea level rise gives gradual but strong impact on product/activities of agriculture and aquaculture in the coastal areas of Mekong delta.

Tra Vinh province is located at the most downstream part of the sandwiched area by 2 big Mekong tributaries of Co Chien River and Hau River. Saline intrusion is taking place towards upstream, and winter-spring paddy cultivation has been affected in this province. For example, in year 2011 it is said that more than 70% of harvest was lost in about 8,000 ha of winter-spring paddy and about 30-70% loss in the areas of about 3,000ha (the total paddy area in Tra Vinh province was 92,000 ha in 2010, GSO).

To protect the paddy area in the Tra Vinh province, construction of sluice gates at the mouths of channels (water supply and drainage canals) should be given the highest priority, and in fact there has been number of construction of sluice gates. In this province, there should also be canal extension towards upstream side, i.e. into Vinh Long province from which fresh water can be withdrawn without being affected by saline intrusion. The project should therefore be of combination of sluice gate construction and trans-boundary of fresh water recruitment, for which the freshwater is taken in the Vinh Long province and ferried to the downstream in Tra Vinh province.

1.2 Objective of the Project

The objective of this project to secure water resource for farming area in Tra Vinh province during dry season by means of freshwater recruitment from Vinh Long province. Recorded data and climate change simulation have defined high risk of saline intrusion onset of sea level rise. The sea level rise around the Mekong delta has arrived at certain level and an average sea level rise is approximately 5 cm per decade. Future prediction done by IMHEN shows 30cm sea level rise in 2050 under B2 scenario. Occurrence of saline intrusion without sea level rise is also confirmed in Vinh Long province by simulation employing an average discharge from 1991 to 2000. Furthermore, freshwater is not available in April and May in Tra Vinh province while it is available in Vinh Long province by simulation on sea level rise of 30cm in 2050.

[1] An Assessment of the Intergovernmental Panel on Climate Change (IPCC; November 2007), Climate Change 2007: Synthesis Report

These data and prediction imply further area expansion of saline water intrusion in future, so that there is necessity of urgent construction of sluice gates with appropriate plan and schedule. This program can be typical program in the Mekong delta which can copy to other coastal areas for saline water intrusion prevention and water recruitment from other provinces.

1.3 Implementing Organizations

Institutional structure relating to this project is shown as Figure 1.3.1. The figure show the case of Tra Vinh province, and Vinh Long province has also a similar organization structure with this case. In principle, Ministry of Agriculture and Rural Development (MARD) is the primary institute that governs the entire sectors including sluice gate construction, operation, management, and maintenance. For sluice construction implementation, there is clear demarcation according to budget sources. If budget comes from Vietnamese government, Department of Construction Management (DCM) deals with projects. If a project is provincial scale, Department of Agriculture and Rural Development (DARD) is the implementing organization while DCM handles a regional project such as the project concerns two or more provinces.

In case of foreign budget such as ODA projects, CPO controls all projects and there are three candidates to implement the project depending on budget and areal scale. If budget is small and provincial scale, DARD is usually appointed as an implementation organization for the project. If a project scale is medium and regional scale in Mekong Delta, Permanent Representative Office under DCM acts as an implementation organization. In case of a project with large budget and regional scale, Central Project Office unit 10 for Mekong Delta handles project implementation.

From start to completion of projects, DCM has to monitor projects' implementation procedure in terms of policy, laws, and decrees on investment and technical aspects of Vietnamese government. A project implementation organization has to be monitored by DCM on such as; procurement procedure of engineers and contractors, budget disbursement procedures, approval and mandate, technical procedures, and others. Without approval by DCM, each project implementation organization cannot receive and disburse project budget.

Historically, Mekong delta development has started from canal network development for waterway extension purpose. This is because there are dense canal networks throughout the delta. Waterway transportation shares about 70% of total freight in the delta, so that the waterway transportation still plays important role in the regional economy. Ministry of Transportation (MoT) is the responsible organization to control waterway transportation and navigation. Therefore hydraulic projects require mutual understanding with MoT. At the central level, MoT is responsible for all aspects of navigation and transportation. At the regional level, there are several branch offices for this purpose in Mekong delta.

DARD and peoples' committee at provincial level have different responsibilities and authorities. In general, DARD is responsible in technical matters, while peoples' committee takes care of management aspects. For example, peoples' committee maintains an authority in budget allocation within the province; the department drafts a construction implementation plan or a specific project plan, and submits it to peoples' committee for approval.

As for the coordination between implementation organization and controlling organization such as DARD and the MoT, provincial council functions as a coordination body in which the representative from the provincial peoples' committee chairs the meetings. As provincial council is connected to the prime minister's office of the central government, issues such as related policies, decisions and orders can be reflected into the provincial policies through the discussions by provincial council.

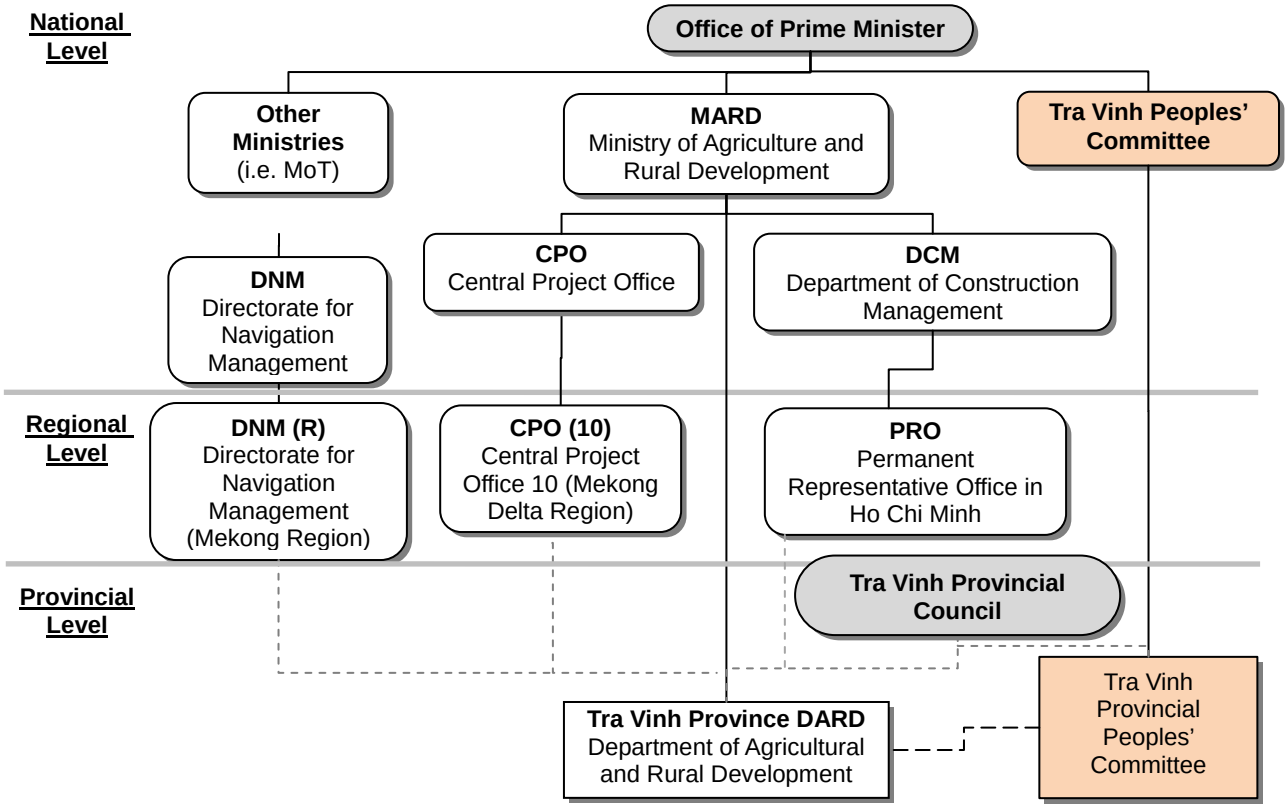

Figure 1.3.1 Governmental Agencies for Sluice Construction in Tra Vinh Province

Source: SIRWP

For project implementation, responsible organization has to address climate change issues both for planning and implementation. Since required budget becomes large for sluice gate construction, budget allocation plan becomes quite important. Prioritization shall be given in accordance with regional environmental condition; saline water intrusion situation should be revised at least every 5 years. Climate change affects the area of saline intrusion, the fresh water available area, and farming practices. Thus, climate change will be a key issue for the project planning, and whereby it shall be revised within certain time period in order to keep budget allocation efficiently.

1.4 Project Area

The project area is located at downstream of Can Tho city. Can Tho is the sub-central province of Mekong Delta in terms of administration, business, and human resources. This is why both provinces of project area have relatively high population density; 438 peoples per km^2 in Tra Vinh province, 694 peoples per km^2 in Vinh Long province in comparison with that of Mekong Delta (426 people per km^2). Total of both provinces has 3,774 km^2 of area which is about 9% of Mekong Delta (40,519 km^2). Population of the 2 provinces is shares about 12% the total population of 17.3 million of the Mekong Delta (2010).

Table 1.4.1 Area and Population of the Project Area

Province/ Region	Area, km2	Population (2010)	Pop. Density Persons/km2
Tra Vinh	2,295	1,005,900	438
Vinh Long	1,479	1,026,500	694
Total Project Area	3,774	2,032,400	539
Can Tho	1,402	1,197,100	854
Total Mekong Delta	40,519	17,272,200	426
Whole Country	331,051	86,927,700	263

Source: Statistical Year Book of Vietnam 2010 (General Statistics Office)

A figure below summarizes GDP per capita at year 2009 by Mekong Delta's province with national

average. Tra Vinh province stays at the lowest position among coastal seven provinces and it is lower than the average of whole Mekong delta, and whole country. GDP per capita of Tra Vinh (801 USD) is less than half of the one of Can Tho (1,830 USD) while economic structure of it is quite similar to the average of coastal Mekong delta. It implies that though we can see robust agriculture and aquaculture production in Tra Vinh province while it leads to fewer value added economy and low GDP per capita; there are fewer secondary and tertiary industries in Tra Vinh as compared with the average of Mekong delta and the national level.

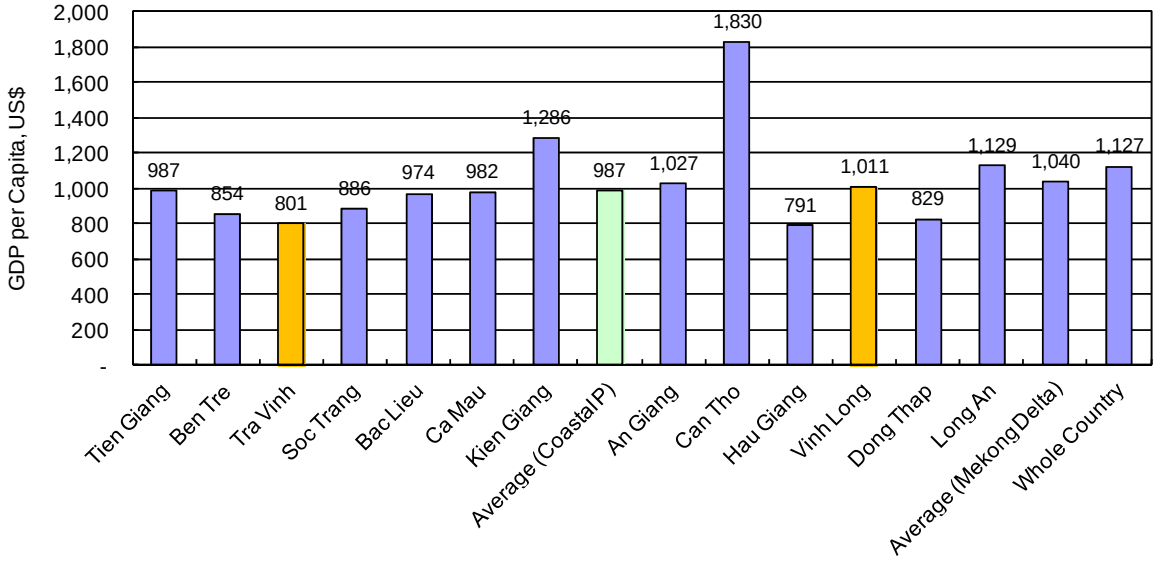

Figure 1.4.1 GDP Per Capita in 2010 for Tra Vinh province, Coastal Provinces, and Mekong Delta as Compared with Whole Country (Estimated at constant 1994 Prices with Exchange Rate of 11,045 VND/US$)

Source: Statistical Year Book of Vietnam 2010 (General Statistics Office of Vietnam), Provincial Statistical Offices

1.5 Project Scope

Mekong Delta has history of canal development network since its initial development stage under Nguyen dynasty. Canal network runs throughout the delta and it crosses over the border of provincial administration boundary. Tra Vinh is a province of coastal area in Mekong delta and it has similar economic structure as other coastal provinces of coastal provinces; however, due to sandwiched area between Co Chien river and Hau river, tidal regime and flood discharge will directly affect this area through 2 big branches of the Mekong River. In order to protect Tra Vinh against saline water intrusion and shortage of fresh water, appropriate works are required for sluice gate construction planning and construction implementation. After the construction, gate operation has to be carried out with proper maintenance of facilities. This project has scope of;

1) To review a plan for major sluices which can control saline intrusion mainly from the Mekong River, and convey freshwater mainly from upstream side in accordance with simulation results on sea level rise and saline water intrusion,
2) To prioritize project implementation of proposed sluice gate in accordance with climate change scenario and possible budget allocation,
3) To conduct project implementation according to priority and budget allocation.

Tra Vinh is located at the most downstream of the Mekong river, and saline water intrusion along the Mekong River is now in progress. It is reported that there is saline intrusion during dry season at some of proposed sluice construction places along the Mekong River in Tra Vinh province, then, freshwater recruitment from upstream at Vinh Long province shall be considered as urgent issue. A sluice has functions of not only saline intrusion prevention but also canal network formulation by shutting off

waterway between river and canals. This project utilize the shutting-off function of sluice coupled with diversion canals utilization from Vinh Long province.

1.6 Priority in Relevant Projects and Plans

There is an overarching Vietnamese development strategy; Socio-economic Development Strategy for the period 2011 – 2020. Under this strategy, every 5 year development plan is formulated and further climate change related programs and plans were established. Major climate change related program is the national Target Program to Respond to Climate Change (NTP-RCC). It has the target year of 2020. Under the NTP-RCC, there are relevant development sector action plan frameworks, also established in the rural and agriculture sector in Vietnam. It is called Action Plan Framework of Rural and Agriculture Sector (2008-2020). Following sections brief the contents of those strategy and plans:

1.6.1 Socio-Economic Development Strategy for the Period 2011 – 2020

The Congress of Vietnam communist party revised the Socio-Economic Development Strategy for the Period 2011-2020 and the prime minister approved it in January 2011. Agriculture is one of important sectors in Vietnam, and then, it is described in 'main objectives of economic development'; agriculture shall develop toward modern, effective, and sustainable directions; the agriculture in Vietnam has advantage of tropical features and the sector is required to quickly increase output and export turnover of agricultural products to improve income and living standards for farmers and to firmly ensure national food security.

It also mentions that aquaculture is also a part of comprehensive agriculture development in accordance with the plan focusing on products that shall have strength and high value. In order to achieve such development, appropriate scientific technology and facilities are required in breeding and production of aquaculture. Aquaculture sector shall keep its productivity, quality, and competitiveness as well as it shall meet requirements on food safety. Building up the Vietnamese aquaculture to reach advanced level in the region, it shall need to foster the application of advanced science and technology in production and processing, so that the region can improve develop the socio-economic condition.

In order to materialize those strategies, development direction is also indicated that it shall pay attention to the development of industry that serves agriculture and rural areas. It emphasize to take advantages of tropical agriculture to develop the massive production of goods with high productivity, quality, effectiveness and competitiveness, to encourage the gathering of cultivated land to develop households' camps, farms and agricultural enterprises that are suitable with the scope and conditions of each region, to keep close control of conversion of agricultural land, especially from land for rice cultivation to land used for other purposes, with the assurance of benefits of rice planters and rice planting localities.

For the delta area, it describes that it shall develop high-tech agriculture. It shall establish areas for concentrated goods manufacturing based on reorganization of agricultural production and application of technical advances. The strategy further maintains that it shall undertake planning for large areas specializing in rice cultivation as goods and strengthening rice intensive cultivation. Huge amount of rice is produced over Mekong delta, and the coastal area is not an exception. However, extensive paddy area is now at risk of saline intrusion due mainly to sea level rise.

In order to fulfill the above development strategies, prevention of saline water intrusion is in fact essential for rice farming development, and fresh water supply and brackish water control are also indispensable issues. Sluice gate construction can be considered to contribute to achieving the strategy by adapting to and/or coping with present and future climate change, especially in the form of saline intrusion associated with sea level rise.

1.6.2 National Target Project to Respond to Climate Change (NTP-RCC)

NTP-RCC was approved by the prime minister on December 2, 2008, and the strategic objectives are to assess climate change impacts on sectors and regions in specific periods and to develop feasible action plans to effectively respond to climate change in the short-term and long-term period so as to ensure sustainable development of Vietnam. The standing agency is the Ministry of Natural Resources and Environment, which is in charge of collaboration with relevant agencies and institutions.

The NTP-RCC maintains that tasks to respond to climate change must be integrated into development strategies, programs, plans, planning in all the sectors and at all levels; into legal documents and policy institutions; into development of legal documents and their implementation. The NTP-RCC is planned to implement over the country in three phases such as; 1) first phase (2009-2010) as starting-up stage, 2) second phase (2011-2015) as implementation stage, and 3) third stage (after 2015) as development stage.

To achieve the objectives, there are 9 concrete tasks e.g. assessment of climate change extent and impacts, identification of measures to respond to climate change, awareness raising and human resources development, enhancement of international cooperation, etc. Of them, Task-8 urges relevant authorities to develop their own Action Plan of the ministries, sectors, and localities to respond to the climate change. Given the Task-8, MARD has also formulated the Action Plan covering rural and agriculture sector in responding to the climate change.

1.6.3 Action Plan Framework of Rural and Agriculture Sector (2008-2020)

Responding to the Task-8 in the Target Program to Respond to Climate Change (NTP-RCC), MARD has formulated the Action Plan Framework for Adaptation and Mitigation of Climate Change of the Agriculture and Rural Development Sector Period 2008 – 2020. The general objective is to enhance capability of mitigation and adaptation to climate change to minimize its adverse impacts and to ensure sustainable development of the agriculture and rural development sector.

Pursuing the general objective, there are 7 specific objectives; 1) develop a policy system integrating climate change in sectoral development programs, 2) develop an action plan and propose support policies for the climate change affected regions, 3) strengthen capacity of research and forecast of climate change, 4) strengthen international cooperation, 5) develop human resources, 6) enhance awareness of relevant stakeholders, and 7) ensure equal benefit sharing for rural communities in implementing climate change mitigation and adaptation.

Since it is an action plan, there is a list of concrete activities to respond to the climate change. Activities are summarized in 5 areas as; 1) to conduct the communication and information program to disseminate knowledge and experiences to enhance people’s awareness on climate change impacts, 2) to develop human resources and conduct studies to develop and consolidate scientific foundation for providing solutions for climate mitigation and adaptation, 3) to develop policy system, integrating climate change in sectoral development program, 4) to promote international cooperation in mitigation and adaptation, and 5) to carry out priority activities for implementing mitigation and adaptation.

In connection with above 5) priority projects, there are some concrete program plans such as 1) strengthening of standing office’s capacity (office of climate change adaptation chaired by the department of personnel), 2) formulation of national standard and technical criteria, 3) conduct of research and planning programs for climate change adaptation and mitigation, 4) tree planting program for wave protection of sea dyke system, 5) upgrading of water resource system, dyke protection system, storm and flood control system, 6) rural infrastructure consolidation program, and 7) establishment of disaster management support organizations. Most of them are now under implementation either by the government or in collaboration with relevant donors.

Taking into account the above 2 plans; National Target Program to Respond to Climate Change (NTP-RCC), and Action Plan Framework of Rural and Agriculture Sector (2008-2020), measures to adapt to and cope with climate change in agriculture sector is highly needed. One of the structural measures is to construct sluice gates and also rehabilitate existing sluice gates in order to prevent saline intrusion from coming into agricultural production areas. Therefore, the proposed programme is highly in line with the above 2 national plans.

CHAPTER 2 THE PROJECT AREA

Chapter 2 describes about Tra Vinh province together with the other coastal provinces of Mekong delta. Agriculture production in the coastal area is affected by the Mekong River flow as well as by tidal regime. Mekong River originates in the Tibet Plateau and flows in the mountainous regions of Yunnan Province of China, and then it goes through Myanmar, Laos, Thailand, and Cambodia. Then, it finally flows into Vietnam, and out to the East Sea of Vietnam. The project area is located at the most downstream of the river. The area used to have nine estuaries[1] up to about 100 years ago, and it used be called as nine dragons' area (Cuu Long area).

2.1 Location and Salient Feature of Tra Vinh and Vinh Long Provinces

2.1.1 Spatial Settings

Tra Vinh province, the Project area, is one of 7 coastal provinces in Mekong delta. The delta locates at the most southern part of Vietnam. Vinh Long province neighbors Tra Vinh province at the upstream of the Mekong River; both province are sandwiched by Co Chien River and Hau River which are major tributaries of the Mekong River. Since the Mekong Delta is a flood plain, the area has generally very flat topography and its elevation ranges from 0.7 to 1.2 m AMSL only. Given this very low altitude especially near the coastal area, sea water tends to intrude during low water season, say, from January to May. The sea water intrusion affects Tra Vinh province first, and then, saline water comes up to near administration boundary of Vinh Long Province. Saline water intrusion is expected to go further upstream in future and it will surround whole Tra Vinh province in dry season.

2.1.2 Demography

The Project area is located at Tra Vinh province Vinh Long province sandwiched by Co Chien river and Hau river. Table 2.1.1 summarizes the area and demography by province in the Mekong Delta and also by regions in Vietnam. As indicated, provincial population in the Project area has about 2 million of population with relatively high population density; 438 peoples per km^2 in Tra Vinh province, 694 peoples per km^2 in Vinh Long province in comparison with that of Mekong Delta (426 people per km^2). Total of both provinces has 3,774 km^2 of area which is about 9% of Mekong Delta (40,519 km^2). Population of the 2 provinces is shares about 12% the total population of 17.3 million of the Mekong Delta.

As for the population growth ratio, it is not high; 0.27% in Tra Vinh province and 0.14% in Vinh Long province. The population growth ratio of whole Mekong Delta arrives at 0.42%; it shows relatively higher value than that of the project area. Nationwide population growth ratio comes to a higher one, i.e. 1.05%. As compared to other areas, population growth ratio of the project area is obviously low. The relatively low population growth ratios of the Project area as well as for the Mekong Delta may be attributed to high out-migration trend as indicated in the most right column of Table 2.1.1.

[1] There are two major branched of Mekong river in Vietnam; one is Tien River (Mekong River) with six branches and their estuaries are Cuu Tieu, Cua Dai, Ba Lai, Ham Luong, Co Chien and Cung Hau. The other one is Hau River (Bassac River) with three branches and their estuaries are Dinh An, Tran De, and Bat Tha but Bat Tha has been filled up about 100 years ago (Source: SIWRP).

Table 2.1.1 Land and Demography of the Project Area as compared with Other Areas

Province/ Region	Rural Districts	Population (2010)	Area, km2	Pop. Density, P/km2	Pop. Growth Rate, %	Net-migration
Tra Vinh	7	1,005,900	2,295	438	0.27	-4.1
Vinh Long	7	1,026,500	1,479	694	0.14	-13.4
Tien Giang	8	1,677,000	2,484	675	0.25	-0.2
Ben Tre	8	1,256,700	2,360	532	0.05	-12.9
Soc Trang	10	1,300,800	3,312	393	0.59	-10.0
Bac Lieu	6	867,800	2,502	347	1.28	-10.6
Ca Mau	8	1,212,100	5,332	227	0.41	-27.3
Kien Giang	13	1,703,500	6,346	268	0.89	-8.7
An Giang	8	2,149,500	3,537	608	0.09	-8.3
Can Tho	4	1,197,100	1,402	854	0.71	-1.7
Hau Giang	5	758,600	1,601	474	0.09	-6.9
Dong Thap	9	1,670,500	3,375	495	0.23	-6.7
Long An	13	1,446,200	4,494	322	0.69	-3.5
Total/Average: Mekong Delta	106	17,272,200	40,519	426	0.42	-8.4
Red River Delta	95	19,770,000	21,063	939	0.77	0.5
N. Midlands & Mountain	119	11,169,300	95,339	117	0.87	-3.9
N. Central & Central Coastal	140	18,935,500	95,885	197	0.42	-5.7
Central Highlands	52	5,214,200	54,641	95	1.66	-0.3
South East (including HCM)	41	17,272,200	40,519	426	2.95	19.9
Whole Country	553	86,927,700	331,051	263	1.05	-

Source: Statistical Year Book of Vietnam 2010 (General Statistics Office of Vietnam)

2.1.3 Meteorology (Mekong Delta)

Meteorological data are available from meteorological stations in Mekong delta. There is no meteorological station in Tra Vinh and Vinh Long, so that this section explains meteorology in Mekong delta.

1) Temperature

Air temperature in Mekong Delta shows relatively high value as compared to other parts of Vietnam and its annual average over Mekong Delta is about 27°C; annual accumulation of daily average air temperature is stable over years and it counts at about 9,800°C. Temperature at Cang Long station is available in the project area which shows relatively low temperature in comparison with other locations in Mekong delta as shown in the following figure. Rach Gia, western side of the delta, shows higher temperature than other places; there is always about 1°C difference in average monthly air temperature between Rach Gia (Kien Giang province) and Cang Long (Tra Vinh province).

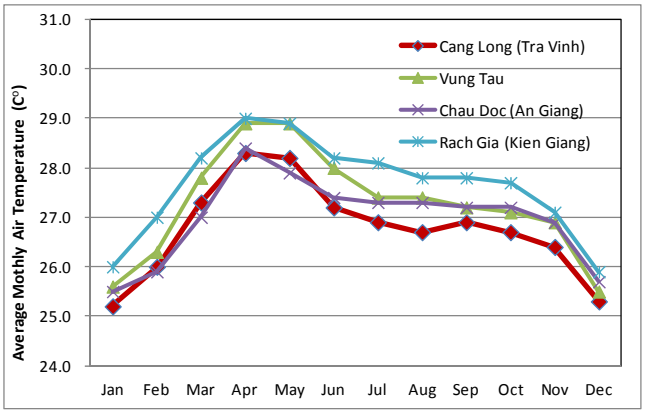

Figure 2.1.1 Average Monthly Air Temperature at Major Locations in Mekong Delta

Source: Southern Institute for Water Resources

Note; Record periods are different by station; mostly 1978 – 2010

The highest monthly average air temperature at Cang Long is 28.3°C in April, and May follows as the second highest air temperature month by 28.2°C. An annual average air temperature in Cang Long is 28.2°C, and the lowest monthly average air temperature is 25.2°C in January followed by December by 25.3°C. It is only about 3.0°C difference between the highest and the lowest average monthly air temperature. A descending process of average monthly air temperature can be said to be smooth while that of an ascending tendency shows a rapid increase from January to April. A daily fluctuation of temperature in the delta ranges between 6°C and 10°C.

2) Rainfall

In the Mekong Delta, rainfall stations are distributed quite evenly through the region. Meteorological data are available mostly after 1978, 3 years after the end of the war when the IMHEN started systematic data collection. Rainfall data are available from meteorological stations in Tra Vinh province and Vinh Long province; the Cang Long station locates in Tra Vinh province, near the administration boundary for Vinh Long province, the Vinh Long station locates at northern point in Vinh Long province.

Two seasons can be distinguished in a year; rainy season is from May to November and dry season is from December to April. A mean annual rainfall is 1,672mm in Tra Ving province while that of Vinh Long is 1,365mm. According to the annual average isohyetal map as shown below, an annual rain fall ranges over 1,800mm/year at the southern part of the project area. An average rainfall decrease toward northern side of the project area and it ranges between 1,400mm and 1,600mm at the northern part of Vinh Long province.

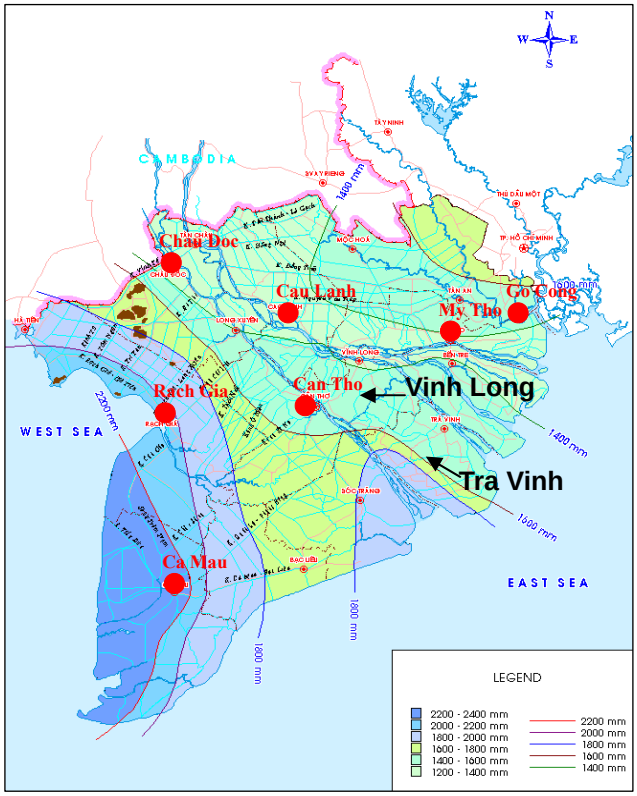

Figure 2.1.2 Annual Average Isohyetal Map in Mekong Delta

Source: Southern Institute for Water Resources Planning

The following figure shows the mean monthly rainfall at Vinh Long in Vinh Long province and Cong Long in Tra Vinh province. As is shown, the mean monthly rainfall starts rising from May and keeps increasing, and then it peaks in October. After October, it starts descending quickly, and the minimum

mean monthly rainfall shows up in February. Cang Long receives more rainfall in May, June and August than Ving Long; it results 300mm annual rainfall difference between these two stations. About 90 % of the total annual rainfall is obtained in the rainy season; and thereby the rain in the dry season remains only about 10%.

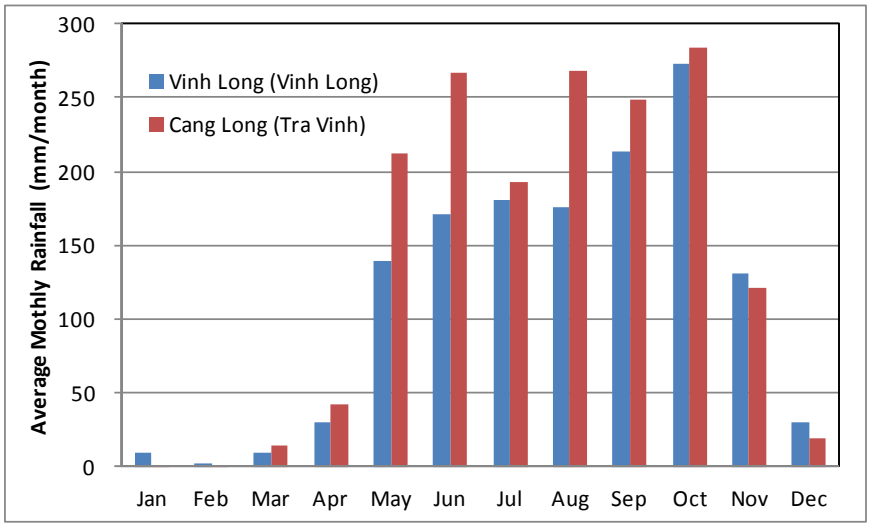

Figure 2.1.3 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month

Source: Southern Institute for Water Resources Planning

2.1.4 Hydrology

1) Runoff

Water resource in the Mekong Delta is of course the Mekong River, which is also a key regional resource in Southeast Asia for not only agriculture sector but also fisheries and power generation sectors. The River is the world's 8th largest in discharge, annual discharge of 400 billion cubic meter, 12th largest in length (4,350 km), and 21st largest in drainage area (795,000 km2). Note that the 400 billion cum was estimated as the annual mean discharge based on the average daily discharges recorded at Kratie station established in Cambodia from 1985 to 2010, and other data were derived from 'Flood and Salinity Management in the Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Fiona Miller and Bach Tan Sinh'.

The Mekong meets Tonle Sap River at a point of west of Phnom Penh, and then is divided into the Tien and Hau Rivers. The River discharge at Tan Chau station on the Tien River is 3-5 times larger than that of Chau Doc station on the Hau River. The Vam Nao, which connects both rivers 20 km downstream of Tan Chau and Chau Doc stations, conveys water from the Tien River to the Hau

Figure 2.1.4 Map of the Lower Reaches of Lower Mekong River Basin (After Kratie Station)

River, augmenting the flow of Hau River downstream from this point.

The Tien River branches into six tributaries and the Hau River into three tributaries and together they form what is called in the Vietnamese language the “Nine Dragons” (Cuu Long). With these 9 estuaries and also a dense canal network, the Mekong Delta shows very much complicated hydraulic network. The development of the dense canal network started about 300 years ago, and through the French colonial era to date, extensive canal network with some control gates have been established.

Flood season starts from July and ends in December, and during this period the areas from the Tonle Sap River in Cambodia to the East Sea of Vietnam are covered with water. A large part of the Delta, especially upstream and midstream parts of the Delta, is very much inundated from both the overflow from the Mekong River and rainfall while downstream of the delta is less affected by floods. Due to the effect of the tropical monsoon, flood flows are about 25-30 times greater than those of dry season which takes place between March and April.

The flooded area ranges from 1.2 to 1.4 million ha in years of low and medium flooding, and goes up to around 1.9 million ha in years of high flooding[2]. It is reported by MARD that about 50 % of the Mekong Delta experiences flooding and these areas are also susceptible to serious damages by floods about every 5 years. The floods are associated with prolonged deep inundation, causing river bank erosion and transportation difficulties, which altogether disrupt economic activities to a greater extent.

On the other hand, during dry season sea water intrusion takes place and saline water comes to upstream from all the estuaries of the Mekong tributaries. During the dry season, the flow discharges in the Mekong River are at their lowest, especially in March and April, and the saline water intrudes into the lower to as far as mid parts of the Mekong Delta. All the coastal provinces are thus susceptible to saline intrusion during dry season. It is reported by MARD that approximately 1 million ha of agricultural lands are affected by tidal flooding and 1.7 million ha (about 45% of the delta area) by salinity intrusion[3].

2) Discharge and Water Level

Mekong River Commission (MRC) has been monitoring water level of the Mekong River at different places and converting them into discharge. Among the monitoring stations, Kratie is located about 300 km upstream from the border with Cambodia. Though this Kratie is located deep in Cambodian territory, it hydrologically represents the starting point of lower parts of the Lower Mekong Basin, from which flood and inundation takes place. It means that simulation models undertaking Mekong Delta’s flood inundation as well as saline intrusion should start from this point of Kratie. With this fact, discharge data at Kratie has often been referred to in many literatures.

Figure 2.1.5 shown below is the long term daily discharge data from 1985 to 2000 at the Kratie station with the thick line being the average. As is shown, flood season starts from June, or sometimes from late May, and ends in December. During the peak flood season, the daily discharge goes over 30,000 cum/s, and in some years it reaches 40,000 cum/s and sometimes even over 50,000 cum/s. As for the average discharge during the flood season, it starts going over 30,000 cum/s from around mid August and stays there, being more than 30,000 cum/s, till late September. The average discharge peaks at around 35,000 cum/s in early September.

[2] Flood and Salinity Management in ht Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Filna Miller, and Bach Tan Sinh.
[3] Flood and Salinity Management in ht Mekong Delta, Vietnam, Le Anh Tuan, Chu Thai Hoanh, Filna Miller, and Bach Tan Sinh.

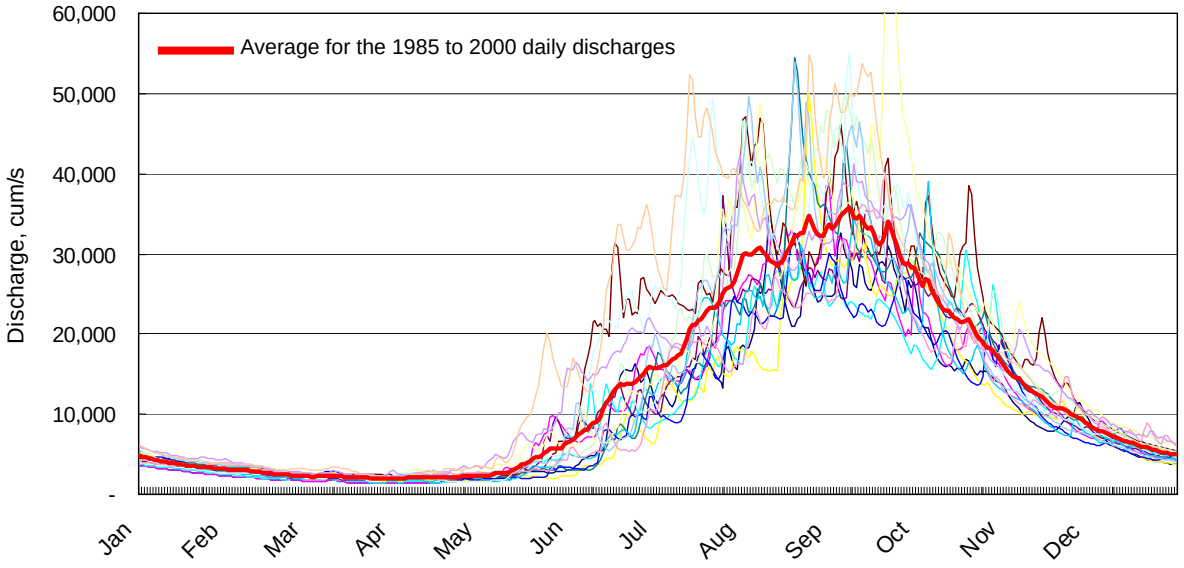

Figure 2.1.5 Daily Discharge Data Recorded at Kratie Station from 1985 to 2000

Source: Mekong River Commission

Note; Thick line shows the average of the discharge from 1985 to 2000

On the other hand, dry season's discharge remains very low. At the beginning of January, the daily discharge marks around 5,000 cum/s and continuously decreases towards the end of dry season. The average daily discharge goes down to less than 3,000 cum/s in February, and further down to less than 2,000 cum/s from late March to early April. After that, the reverse starts in as early as April, but the discharge in April still stays just over 2,000 cum/s. In May, the average daily discharge is now increasing quickly, starting from about 2,300 cum/s at the beginning of May and goes to 6,500 cum/s at the end of the month.

There are two gauging stations in the upper most reaches of Mekong River near the border with Cambodia; Tan Chau on Tien River and Chau Doc on Hau River. These gauging stations monitor water levels at every hour interval, and can estimate daily discharges based on rating (Q-H) curves established for the river sections with the daily averaged water level. However, the estimation of discharges during the dry season is greatly influenced by back-water effect; namely, whether the measurements are taken during a rising or falling stage on the hydrograph. Thus, quality of the discharge data during the dry season may not be as accurate as those estimated at an upstream station, like the one at Kratie station.

With this in mind, Figure 2.1.6 shows the discharges for the both stations for years from 2000 – 2008 except for 2007. The discharges are very different between the 2 stations: much more flow in Tan Chau station than Chau Doc station. While the flood season's discharge at Tan Chau station goes over 20,000 cum/s, the discharge at Chau Doc station remains at around 7,000 cum/s. Totaling the both discharges, the average peak discharge during flood season arrives at about 28,000 cum/s. This discharge is lower than that of Kratie (about 35,000 cum/s), and this is because of the existence of the Great Lake in Cambodia. During flood seasons, a great deal of river water reverses to the Great Lake via Tonle Sap River.

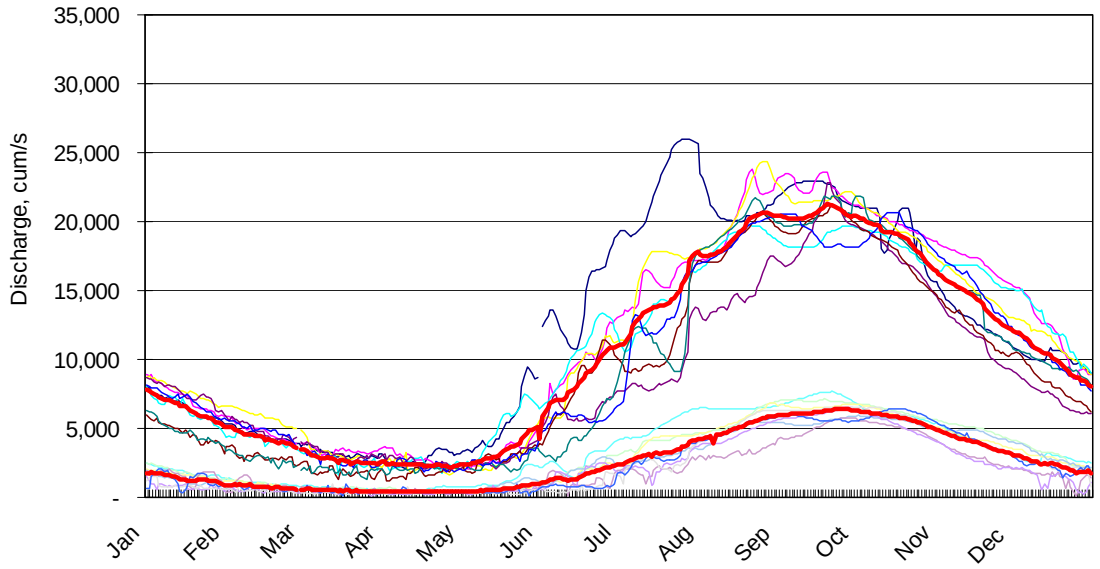

Figure 2.1.6 Daily Discharge at Tan Chau Chau Doc Stations

Source: Mekong River Commission;
Note; Lower group lines are for Chau Doc station, upper group lines are for Tan Chau station,and the bold lines sholw respective average discharge.

Instead, the Great Lake discharges the stored water back into the Mekong River during dry season. This discharge from the Great Lake augments the dry season flow at Tan Chau and Chau Doc stations. The total discharge of the 2 rivers at the beginning of January is about 10,000 cum/s while that of Kratie station is only about 5,000 cum/s, about half of it. During the driest season, April and May, the total discharge of the 2 rivers stays at around 3,000 cum/s, while that of Kratie station drops to about 2,000 cum/s (about two-third). It means that the Great Lake works in mitigating the flood magnitude in Mekong Delta during flood seasons while augmenting the freshwater during the dry seasons.

2.1.5 Irrigation and Drainage Network

Irrigation and drainage networks in the Mekong Delta originate in waterway and its total length arrives at approximately 4,785 km. The waterway network connects major cities each other, e.g., Phnom Penh, Kampong Cham[4], Ho Chi Minh City, My Tho[5], Vinh Long, Cao Lanh[6], Can Tho and Long Xuyen[7] and East Sea, and then, it plays a vital role in the economy and human life of the area. There are three types of inland navigation in the Mekong Delta: local movement by 10 - 15 ton boats; inter-city movement by 15-600 ton ships; and inter-country movement by 600 - 3,000 ton barges or barge convoys, normally comprising one tugboat and three barges of 250 to 300 tons each (source: UN 2001)[8]. These waterways can act as irrigation and drainage network at the same time.

1) Canal Networks

Waterway network in Mekong Delta had been developed for navigation purpose at the beginning period in Nguyen dynasty as aforementioned, and then drainage function and irrigation function were added from those days in French colonial time. In nowadays time, canals provide multifunctional services and are classified into several levels as follows;

[4] Phnom Penh is the capital of Cambodia and Kampong Cham is located about 90km north of Phnom Penh.
[5] My Tho is the capital of Tien Giang province.
[6] Cao Lanh is the capital of Dong Thap province.
[7] Long Xuyen is the capital of An Giang province.
[8] "Guidelines for the Harmonization of Navigation Rules and Regulations, Volume 1. Aids to Navigation", UNITED NATIONS, New York, 2001

Table 2.1.2 Classification of Canals in Vietnam

Canal Type	Main	Level 1	Level 2	Level 3
Bottom Width (m)	15m= <	10m	6 – 8m	2 -3m
Bottom Elevation (MSL m)	- 3m	- 3m	- 1.5m	- 1m

Source: Southern Institute for Water Resources Planning

Classification mentioned above can not always apply to all the canals in Mekong Delta because features of canals differ from one place to the others. Sometimes it is difficult to classify an intermediate type of canal. According to a statistics of SIWRP, total length of canals in Mekong Delta is estimated at over 90,000 km; this length is over twice circles of the Globe. Canal network in each area is summarized by type[9] as follows (for the areas, refer to the following figure);

Table 2.1.3 Canal Networks in Mekong Delta

Canal Type	Whole Mekong		Plain of Reeds		Long Xuyen Quadrangle		Ca Mau Peninsula		Trans Bassac	
	Project	L (Km)	Project	L (Km)	Project	L (Km)	Project	L (Km)	Project	L (Km)
		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)		Density (km/km^2)
Area (km^2)		38,143		8,131		4,989		16,922		8,101
Main Canal	133	3,190	45	1,068	20	450	36	633	32	1,039
		0.08		0.13		0.09		0.04		0.13
Canal Level 1	1,015	10,961	343	3,116	44	606	428	5,294	200	1,945
		0.29		0.38		0.12		0.31		0.24
Canal Level 2	6,556	26,894	2,187	6,742	1,100	3,100	3,297	13,689	1,072	3,363
		0.71		0.83		0.62		0.81		0.42
Canal Level 3	35,640	50,019	3,400	7,200	1,213	4,274	7,467	16,692	24,773	21,853
		1.31		0.89		0.86		0.99		2.70
Total	43,344	91,064	5,975	18,126	2,377	8,430	11,228	36,308	26,077	28,200
		2.39		2.23		1.69		2.15		3.48

Source: Southern Institute for Water Resources Planning

Note: Trans Bassac means the area located in between Tien and Hau Rivers.

Figure 2.1.7 Location of the 4 Hydraulic Areas

Source: Southern Institute for Water Resources Planning

[9] Usually in statistics, the main canals and level 1 canals are counted as main canals, and level 2 canals and level 3 canals are grouped together into level 2 canals. According to SIWRP, construction of medium and small scale canals is required for the purpose of improving drainage capacity.

The project area is categorized as Trans Bassac, the area between Tien River and Hau River. This area has more waterway density than that of other areas with 3.48 km/km^2, which is mainly composed of Level 3 canals. Vinh Long province is known as confluence area between river flow and tidal water, and thus 2-way water flow, back and forward, natural channels have been created in the project area more than those of other areas. Level 3 canals in this area are therefore developed from natural canals in many cases and its density, with 2.70 km/km^2, shows rather high value than other areas (0.86 – 0.99 km/km^2).

Water level change in Mekong Delta differs by place; downstream side water level fluctuates more than that of upstream side influenced by tidal fluctuation. There is difference of mean water level amplitude with two times or more by areas between upper part and downstream part of Mekong Delta. Observed water level amplitudes in April 2008 are shown below, from which one can see about 1 meter fluctuation at the most upstream parts of Mekong Delta, and about 1.5 to 2.0 m at around mid parts of the Delta, and more than 2 m to over 2.5 m at the downstream parts of Mekong Delta;

Table 2.1.4 Observed Mean Water Level Amplitude in April 2008

Tien River	Tan Chau	Cao Lanh	My Thuan	My Tho	Vam Kenh
Amplitude (cm)	100	150	185	218	236
Hau River	Chau Doc	Long Xuyen	Can Tho	Dai Ngai	My Thanh
Amplitude (cm)	115	147	195	265	250

Source: Southern Institute for Water Resources Planning

2.2 Major Economic Activities (Agriculture and Aquaculture)

Mekong delta itself has a name so-called “rice bowl”; rice production is dominantly practiced in flooded areas which are central parts of the delta. Due to availability of freshwater, rice cultivation is popular in Vinh Long province and northern part of Tra Vinh province. Freshwater aquaculture is dominant in Vinh Long province while shrimp culture is popular in Tra Vinh province which includes a quite unique land use of paddy-shrimp alternation farming.

2.2.1 Agriculture

There used to be single paddy crop area over such flooded area of the Mekong delta but it has turned to double or triple paddy cropping area after introduction of new varieties of paddy, mainly short maturity variety. Coastal areas are affected by sea water intrusion whereby paddy cultivation is limited mostly during rainy season only. However, there is another type of farming in this coastal area. An example is a combination of paddy production (in rainy season) and aquaculture especially shrimp (in dry season); this combination practice can be carried out in a same farm plot.

In the project area, given the seasonal saline intrusion during dry season while abundant precipitation coupled with the increased water level of Mekong river during rainy season—salinity can be washed away or leached out by fresh water in the rainy season. Thus, farmers orchestrate different types of crops/commodities given the availability of brackish/fresh water, technical competency, and financial capability. Furthermore, combination is not just paddy and brackish shrimp. It includes fresh water shrimp and fish as well.

1) Land Use

Referring to the statistical data for Rural, Agricultural and Fishery Census (2006), difference of land use types in each province is clarified. A ratio of agricultural land use in Tra Vinh province, Vinh Long province as well as Mekong Delta is much higher than other areas of the Country. While 65%. 78%, and 63% of the area is used for agricultural purposes in Tra Vinh province, Vinh Long province, and Mekong Delta respectively, only 29% is used in the whole Country, which is far greater than any other regions including the Red River Delta (36%).

Among the project area, Tra Vinh province and Vinh Long province show different land use; land use in Tra Vinh province is composed of 45% of paddy land, 17% of perennial crop land, and 3% of other purpose while that of Vinh Long province is composed of 47% of paddy land, 30% of perennial crop land, and 1% of other crop. In the Mekong Delta, agricultural land use, especially for paddy purpose, shares much percentage than lower reached of the delta. Vinh Long province can be considered to be intermediate province among the delta; land use for paddy is nearly the same as Tra Vinh, but land use of agriculture is nearly the same as upper reach provinces of the delta.

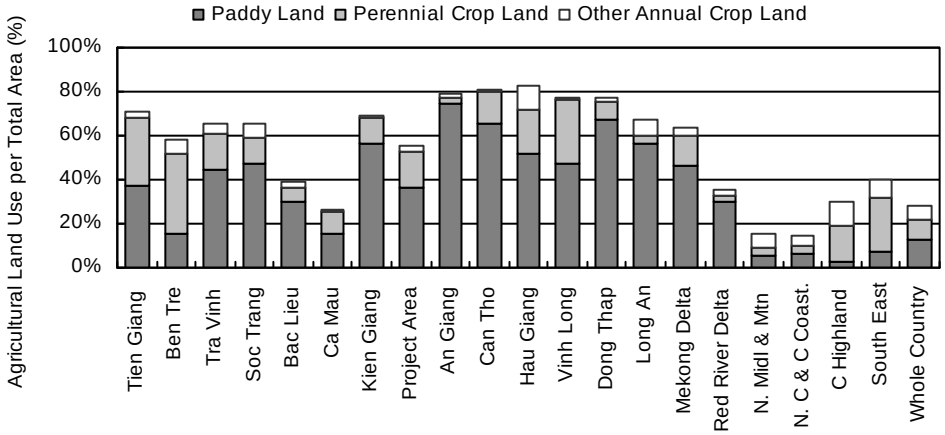

Figure 2.2.1 Agricultural Land Use per Total Land Area (%)

Source: Rural, Agricultural and Fishery Census, Data in 2006

2) Cropping Calendar

Paddy cropping in the Mekong delta has four major seasons: winter-spring, summer-autumn, autumn-winter and spring-summer. Among the four cropping seasons, summer-autumn paddy (May-Aug) and winter-spring paddy (Dec-Feb) constitute the major part of paddy production in the coastal area. A typical cropping in the coastal areas is the combination between paddy cultivation and brackish shrimp culture. In addition, such combination has some diverse conditions; irrigation water, fresh water and schedule of other crops or commodities (e.g. brackish shrimp, fresh water shrimp, freshwater fish).

Two cropping of winter-spring (dry season) paddy and summer-autumn (rainy season) paddy can be organized only where irrigation water is available for the dry season. In some cases, three cropping of paddy can be also possible in such areas of northern part of upper part of Tra Vinh province and Vinh Long province. In rain-fed areas where irrigation water is barely available, paddy is planted only during the rainy season.

Table 2.2.1 Major Cropping Calendar in Project Area

Land Use Type	Month												Remarks
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Irrigated land use													
2 paddy crops (WS-SA)	WS				SA						WS		Shallow flooded areas
2 paddy crops (WS-SA) + Fish					Fish								Shallow flooded areas
3 paddy crops (WS-SA-AW)	WS				SA			AW			WS		Shallow flooded areas
Perennial crops (e.g. fruits)	Planting												Shallow flooded areas
Rainfed land use													
1 paddy crop						SA							Saline intrusion areas
1 paddy crop + fish						Fish							Saline intrusion areas
2 rainfed paddy crops (SA-AW)					SA			AW					Saline intrusion areas
1 paddy crop (SA) - Shrimp	Shrimp						SA					Shrimp	Saline intrusion areas
Shrimp culture (1 or 2 crops)		Shrimp 1st					Shrimp 2nd						Saline intrusion areas

WS: Winter - Spring paddy; SA: Summer-Autumn paddy; AW: Autumn - Winter paddy
Source: Southern Institute of Agricultural Planning and Investment (2011)

Salinity is usually seen as a harmful feature to paddy production and it is often prevented by dikes and sluice gates. Yet, some farmers have chosen the way to adapt to this kind of extreme environment rather than coping against it by introducing brackish shrimp culture during dry season. Though shrimp culture entails high risk of diseases when the culture continues intensively without consideration on environment, it can fetch better income than paddy cultivation in most cases. As a result, those farmers who introduced brackish shrimp culture can maximize its profitability.

3) Paddy Production

The major agriculture production in Tra Vinh province and Vinh Long province is paddy. The paddy production has been on an increasing trend and in 2010 the total production reached 1,156,000 tons for Tra Vinh province and 923,000 tons for Vinh Long province. In the same year 2010, the paddy production of the whole County was 39,989,000 tons. It means both provinces produced 5% of the country's production and that shared about 10% of paddy production in Mekong Delta.

Looking at the provincial production of 2010, coastal provinces have relatively less production. Tra Vinh and Vinh Long are at middle position in paddy production between the top production province of Kien Giang (3,485,000 tons) and the lowest production of Ben Tre (368,000 tons), which are all in line with the land use pattern.

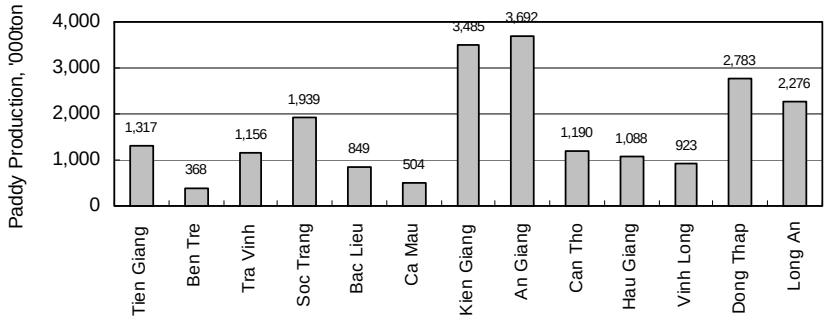

Figure 2.2.2 Paddy Production by Province in the Mekong Delta

Source: Rural, Statistical Year Book 2010, GSO

2.2.2 Aquaculture

Overall coastal areas of the Delta are characterized as brackish shrimp (Penaeus monodon) cultivation area under the condition that saline water intrusion takes place.

Table 2.2.2 summarizes the aquaculture production in the Mekong Delta as compared with other parts of the Country, and Figure 2.2.3 (left) illustrates per-capita aquaculture production of fish and Figure 2.2.3 (right) depicts that of brackish shrimp aquaculture production. As is well illustrated, the aquaculture production of the Mekong Delta by far surpasses the production of other regions. In fact, the overall aquaculture production by Mekong Delta (1,940,181 tons) shares as much as 72% of the national production (2,706,752 tons).

With regards to the aquaculture production of fish, the intensive production areas can be seen in the upper-mid parts of Mekong Delta; Tra Vinh and Vinh Long, located at the lower part and mid-lower part of delta, still produce 53,824 tons and 135,089 tons aquaculture fish respectively, which share 4% and 9% of Mekong Delta fish production. Per-capita production of aquaculture fish is estimated at 54 kg in Tra Vinh province and 132 kg in Vinh Log province as shown in the Figure 2.2.3, which is far bigger than the national per-capita production of 24 kg. Note that the population employed in estimating the per-capita production is the total number of people in the respective provinces or regions (not the population engaged in the aquaculture).

As is well known, the aquaculture shrimp production in the coastal provinces by far exceeds those of other regions including mid-upper parts of Mekong Delta. The total production of aquaculture shrimp in 2010 was 331,760 tons while that of national level was 450,364 tons. It means Tra Vinh province produced as much as 76%, three-quarters of the national production. Per-capita production of the aquaculture shrimp arrives at 36.8 kg while those of other provinces and regions remain less than 5 kg per capita only.

Table 2.2.2 Aquaculture Production (2010) in the Project Area as Compared with Other Regions

Province/ Region	Aquaculture Production, ton	Per-capita Aquaculture Production, kg	Aquaculture Production of Fish, ton	Per-capita Aquaculture Production of Fish, kg	Aquaculture Production of Shrimp, ton	Per-capita Aquaculture Production of Shrimp,kg
Tien Giang	120,188	72	87,925	52	12,833	7.7
Ben Tre	168,148	134	122,150	97	30,485	24.3
Tra Vinh	82,777	82	53,824	54	20,944	20.8
Soc Trang	98,493	76	37,490	29	60,830	46.8
Bac Lieu	143,725	166	65,370	75	68,003	78.4
Ca Mau	235,550	194	117,216	97	103,900	85.7
Kien Giang	97,673	57	46,637	27	34,765	20.4
An Giang	279,773	130	276,941	129	916	0.4
Can Tho	172,360	144	172,331	144	22	0.0
Hau Giang	44,430	59	43,482	57	15	0.0
Vinh Long	135,181	132	135,089	132	16	0.0
Dong Thap	331,373	198	327,757	196	1,727	1.0
Long An	30,510	21	23,751	16	6,661	4.6
Mekong Delta	1,940,181	112	1,509,963	87	341,117	19.7
Red River Delta	406,280	21	309,573	16	16,422	0.8
N. Midlands & Mountain	67,909	6	65,673	6	367	0.0
N. Central & Central Coastal	177,397	9	86,725	5	71,292	3.8
Central Highlands	20,603	4	20,252	4	68	0.0
South East	94,382	5	67,379	4	21,030	1.2
Whole Country	2,706,752	31	2,058,465	24	450,364	5.2

Source: Statistical Year Book of Vietnam (2011)

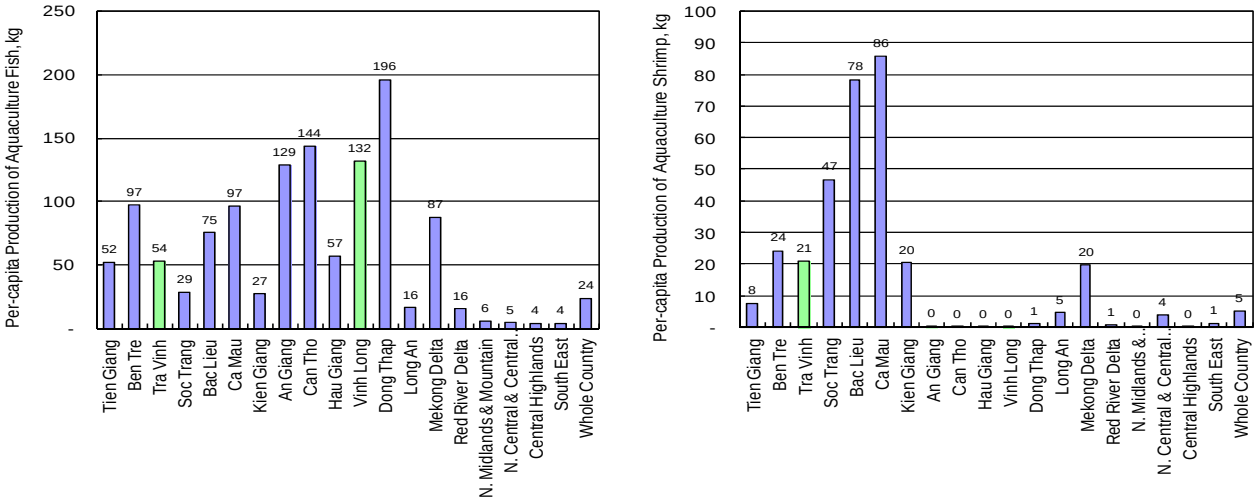

Figure 2.2.3 Per-capita Fish production (Left) and Shrimp Production (Right) in 2010

Source: Statistical Year Book of Vietnam 2010, GSO

2.3 Climate Change Impact on the Coastal Mekong Delta Area

This sub-chapter discusses past trend of climate, future climate change based on simulation results by PRECIS[10] model (a high resolution regional climate change simulation model), flood and saline intrusion simulation, and then carries out vulnerability assessment under climate change.

2.3.1 Temperature and Rainfall Change

1) Past Trend in Temperature

Long term climate data were collected at such 4 stations as Vung Tau, Can Tho, Ca Mau, and Rach Gia over a period from 1978 to 2008 or 2009 (refer to Figure 2.3.1 for the stations). Figures 2.3.2 shows long term trend of annual mean air temperature at the 4 stations of Vung Tau, Can Tho, Ca Mau, and Rach Gia.

Figure 2.3.1 Location of the 4 Meteorological Stations

Annual mean temperature ranges approximately from 26.5 °C to 27.5 °C by station and sometimes goes up over to 28.0 °C. Annual mean maximum temperature shows bigger range of fluctuation by station and so does the annual mean minimum temperature. In general, the annual mean maximum temperature ranges from 31 °C to nearly about 34 °C while the annual mean minimum temperature does 22 °C to over 24 °C.

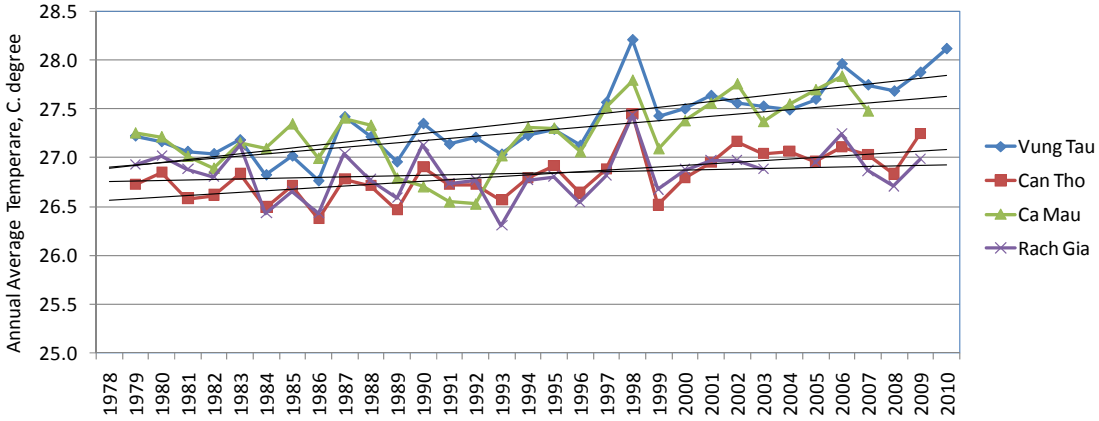

Figure 2.3.2 Annual Mean Temperature at 4 Major Locations in Mekong Delta

Source: Southern Institute for Water Resources, Sub-Institute of Hydrometeorology and Environment

One obvious observation from the long term trend is the increase in the temperatures for all the 4 stations. Though these annual mean temperatures fluctuate by year, we can see an increase trend over years for all the 4 station. The rate of increase can be said about 0.7 °C, about 1.0 °C, and about 1.0 °C for annual mean over the period of about 30 years. This increase trend could be corresponding to global warming.

2) Future Prediction of Temperature

Figure 2.3.3 shows isolines of mean annual temperature rise at year 2050 under climate change

[10] PRECIS stands for 'Providing Regional Climates for Impacts Studies', which is a regional climate model system whose resolution is 25-30 x 25-30 km, much higher resolution than GCM.

Scenario B2 in terms of percentage against the average annual mean temperature of 1980 – 1999. The mean annual temperature in future would rise by having two poles; one in Ca Mau and the other in Ho Chi Minh area. The least temperature rise area lies in north-western area of Mekong Delta including Kien Giang Province.

Figure 2.3.4 shows change of mean annual temperature for overall average of Mekong Delta simulated under three scenarios of B1, B2, and A2. The temperature rise was estimated in percentage against the average temperature of the period from 1980 to 1999. The mean temperature increases continuously though the increase for scenario B1 seems to curve down toward year 2100. The mean annual temperature is expected to rise by about 1 ^{o}C in year 2050 for the 3 scenarios and by 1.4 ^{o}C to as much as 2.7 ^{o}C in year 2100 depending on the scenario.

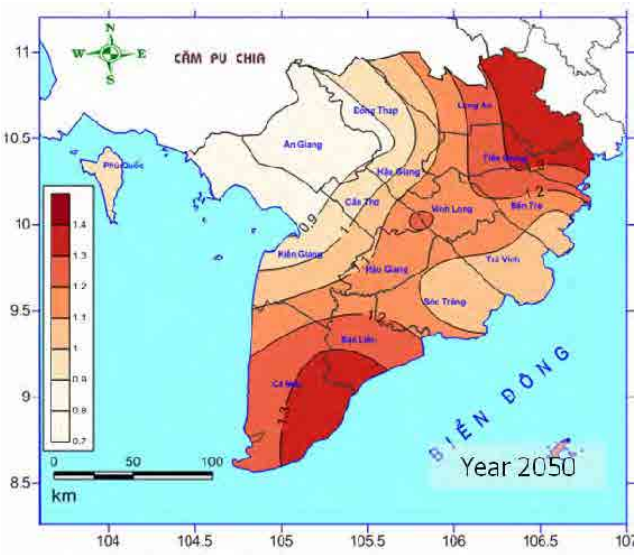

Figure 2.3.3 Mean Annul Temperature Rise at Year 2050 in Percentage under Scenario B2

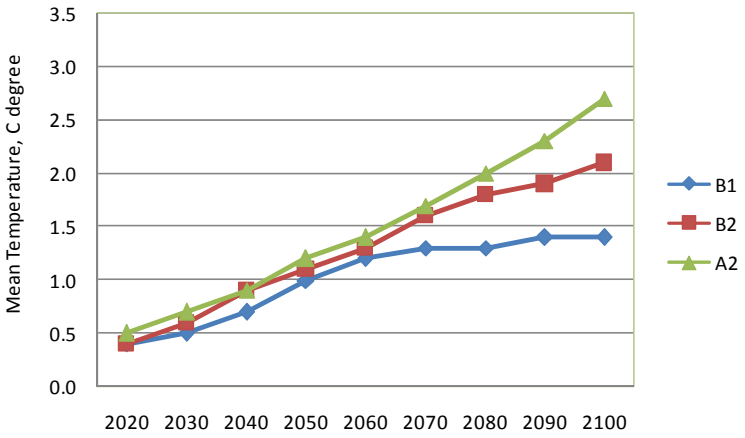

Figure 2.3.4 Mean Annul Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS simulation

3) Past Trend in Rainfall

Following figure shows long term trend of annual rainfall for the 5 meteorological stations of Can Tho, Ca Mau, Rach Gia, My Tho, and Vung Tau. The figure reveals that the annual rainfalls for the 3 stations of Ca Mau, Rach Gia, and My Tho have been increasing while the rest of the 2 stations show a reverse trend, though there are fluctuations by year.

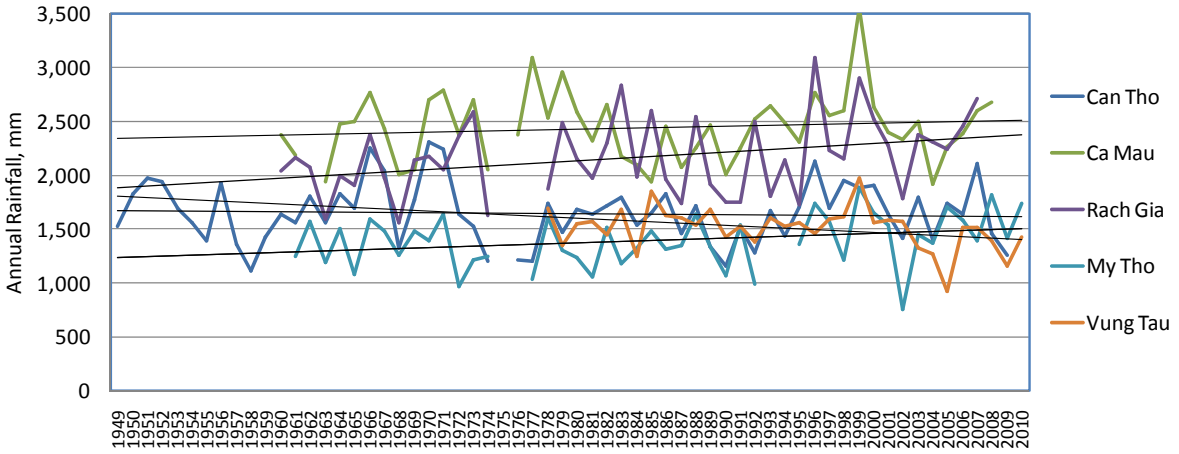

Figure 2.3.5 Long Term Trend of Annual Rainfall for 5 Stations in Mekong Delta

Source; Sub-institute of Hydrometeorology and Environment, SIWRP

4) Future Prediction of Rainfall

Figure 2.3.6 shows simulated annual rainfall change in percentage at year 2050 under climate change Scenario B2 against the average annual rainfall between 1980 and 1999. The figure shows overall rainfall increase over the Mekong Delta with a pole at northern part of the delta where Dong Thap province is located. It is found that Ben Tre province to Soc Tran province via Tra Vinh province will have more rainfall in future along the coastal zone, while inner parts of Tien Ginag, Ben Tre and whole of Ca Mau provinces will have less increase of rainfall.

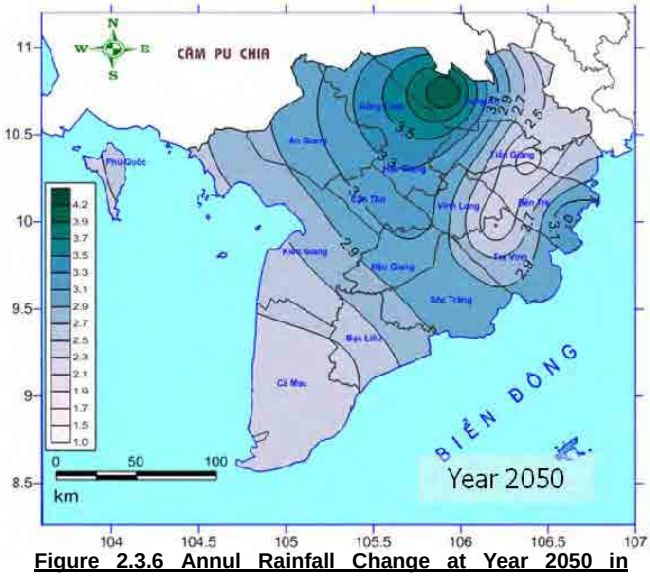

Figure 2.3.6 Annul Rainfall Change at Year 2050 in Percentage under Scenario B2

Figures 2.3.7 show monthly rainfall change for the B2 scenario against the average of between 1980 and 1999. The change of the monthly rainfall fluctuate by month; during dry season the change falls in a negative range meaning the dry season rainfall in future becomes less than the past. In March, rainfall is expected to decrease by 30% at year 2100.

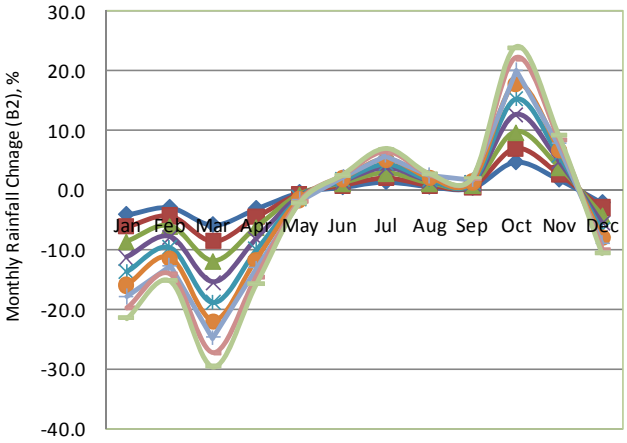

Figure 2.3.7 Monthly Rainfall Change in Mekong Delta under Scenario B2, Source; PRECIS simulation

On the other hand, during rainy season the monthly rainfall is projected to increase in future. The increase during rainy season shows up in July and October. July is still early part of the rainy season while October is almost end of the rainy season where usually the highest amount of monthly rainfall is recorded. In October, monthly rainfall is projected to increase by more than 20% at year 2100. It can be said in future, it is projected that the rainfall tends to increase especially at the end of rainy season.

2.3.2 Saline Water Intrusion associated with Sea Water Level Rise

1) Past Trend in Sea Water Level

There are water level stations in the East Sea at Vung Tau and West Sea at Rach Gia; long term trend of mean annual water levels is summarized in the following figures. The recorded period covers from 1982 to 2011 for the Vung Tau and Rach Gia, say about 30 years. As is shown, the 2 stations show continuous increasing trend, and the sea level rise for Vung Tau and Rach Gia stations arrives at an average of approximately 15 cm over the recorded period of about 30 years. It means that the sea levels for the both East and West Seas has been increasing with an average sea level rise by approximately 5 cm per decade.

In fact, IPCC 4th Assessment Report reported that the average sea level rise from 1993 – 2003 was 3.1 cm + & - 0.7mm by satellite observation, whereby about 4 cm rise at maximum may be suggested, which is corresponding to the 5 cm rise per decade recorded in the above East and West Seas. In other

areas of Vietnam, e.g., Hon Dau (Red River Delta area, north Vietnam) shows about 4 cm rise per decade from 1960 – 2005, and Son Tra (Da Nan, central Vietnam) does 2.1 cm rise per decade.

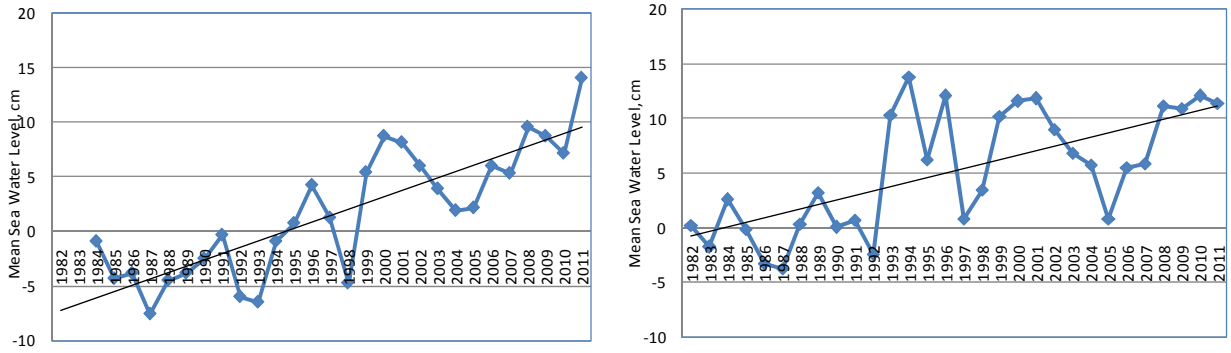

Figure 2.3.8 Past Sea Water Level Trend at Rach Gia (left) in West Sea and at Vung Tau (right) in East Sea
Source; Data obtained from SIWRP graphed by the Project Team

2) Future Prediction of Sea Water Level

Figure 2.3.9 shows the sea level rise of Mekong coastal area by scenario. It is shown that high green gas emission scenario, A2, shows the biggest sea level rise as 31 cm at year 2050 and as much as 103 cm at year 2100. Scenario B1 shows the lowest sea level rise; 27 cm at year 2050 and 70 cm at year 2100. The trend is somewhat exponential for all the scenarios, meaning that increase ratio becomes more towards 2100.

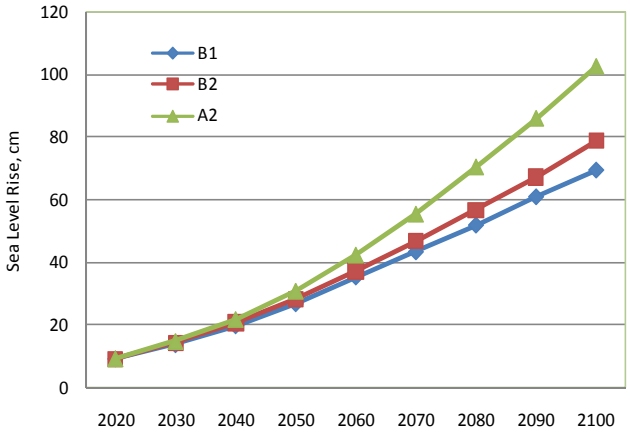

Figure 2.3.9 Sea Level Rise of Mekong Coastal Area under 3 Scenarios, Source; PRECIS simulation

3) Impact on Crop Production by Saline Water Intrusion under CC

Saline intrusion primarily affects crop production, reducing the yield and when the salinity reaches certain level crops can hardly grow. Examination of the impact caused by saline intrusion focuses on paddy being the primary concern, fruit, vegetables and forest (Melaleuca). There are experiments and researches which show relationships between salinity level and the reduction of the yield.

Following table summarizes the relationships to be taken into the assessment of damage loss under saline intrusion. R. S. Ayers and D.W. Westcot (1989) [11] presented tables regarding crop tolerance against saline content in irrigation water and yield loss in percentage for some selected crops including paddy.

Saline tolerance of paddy is summarized in Figure 2.3.10 where total yield loss is estimated to take place at 4.9g/L of saline level in irrigation water. Damage index is thus calculated from the average at each range of saline content level in the Table 2.3.1, namely, yield damage at a range of 2.5 – 4 g/L of

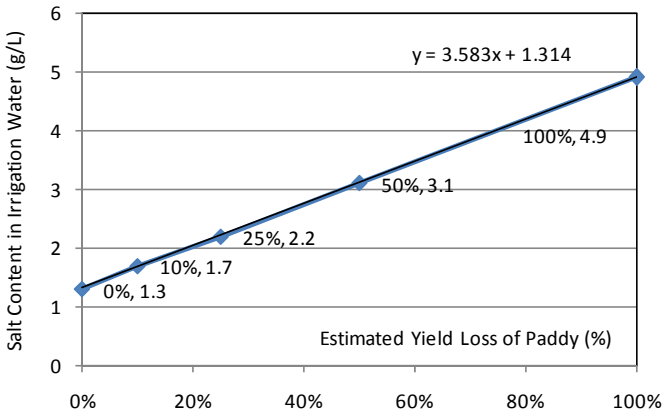

Figure 2.3.10 Paddy Yield Loss against Irrigation Water Salinity
Source; Ayers & Wescot (1989), FAO, modified by Project Team

[11] R. S. Ayers and D.W. Westcot (1989), Water quality for agriculture, FAO Irrigation and Drainage Paper, 29 Rev. 1, 1989

saline level is estimated at 54% which is the average between 33% (salt content at 2.5g/L) and 75% (salt content at 4g/L), and likewise damage 17% is estimated for the range of salt content 1.0 – 2.5 g/L.

Table 1.1.1 Damage Index for Saline Water Intrusion

No	Items	Salinity Level (g/L: PPT)							Remarks
		<0.5	**0.5 – 1.0**	**1.0 – 2.5**	**2.5 – 4**	**4 – 10**	**10 – 20**	**>20**	
1	Paddy	0%	0%	17%	54%	100%	100%	100%	FAO
2	Fruit	0%	0%	19%	55%	100%	100%	100%	FAO
3	Vegetable	0%	0%	29%	71%	100%	100%	100%	FAO
4	Forest (Melaleuca)	0%	0%	0%	0%	50%	100%	100%	SIWRP

Source: JICA Project Team

4) Saline Water Intrusion and Yield Loss/Damage

Figure 2.3.11 shows the salinity level change by month under the case of dry year (DY) 1998 Mekong River discharge with the 30 cm sea level rise, equivalent to year 2050's expected rise under climate change scenario B2. The figure indicates;

1) Most of the coastal areas are affected by large extent of saline water intrusion except for Kien Giang province where there are already numbers of saline water prevention sluice gates in operation.
2) The province most affected is Ca Mau province as expected, excluding a small area located in western-mid area where paddy fields are well protected by saline water prevention sluice gates.
3) The Mekong River discharge sharply affects decrease of saline content level at the coastal areas of Tien Giang, Ben Tre, Tra Vinh, and Kien Giang provinces; saline content level in these areas decreases in June while other areas keep nearly the same condition as being in April at such areas of Soc Trang, Bac Lieu, Ca Mau provinces.

Figure 2.3.12 indicates the change (damage) in terms of percentage and monetary value by province. As shown in the figure, in terms of percentage change, Ca Mau province comes first except for year 2100 case, followed by Ben Tre, Bac Lieu, Soc Trang, and Tra Vinh. In terms of monetary change (damage), Ben Tre province shows the biggest loss, which is due to the loss of valuable fruit production, and followed by Soc Trang, Ca Mau, Kien Giang and Tra Vinh.

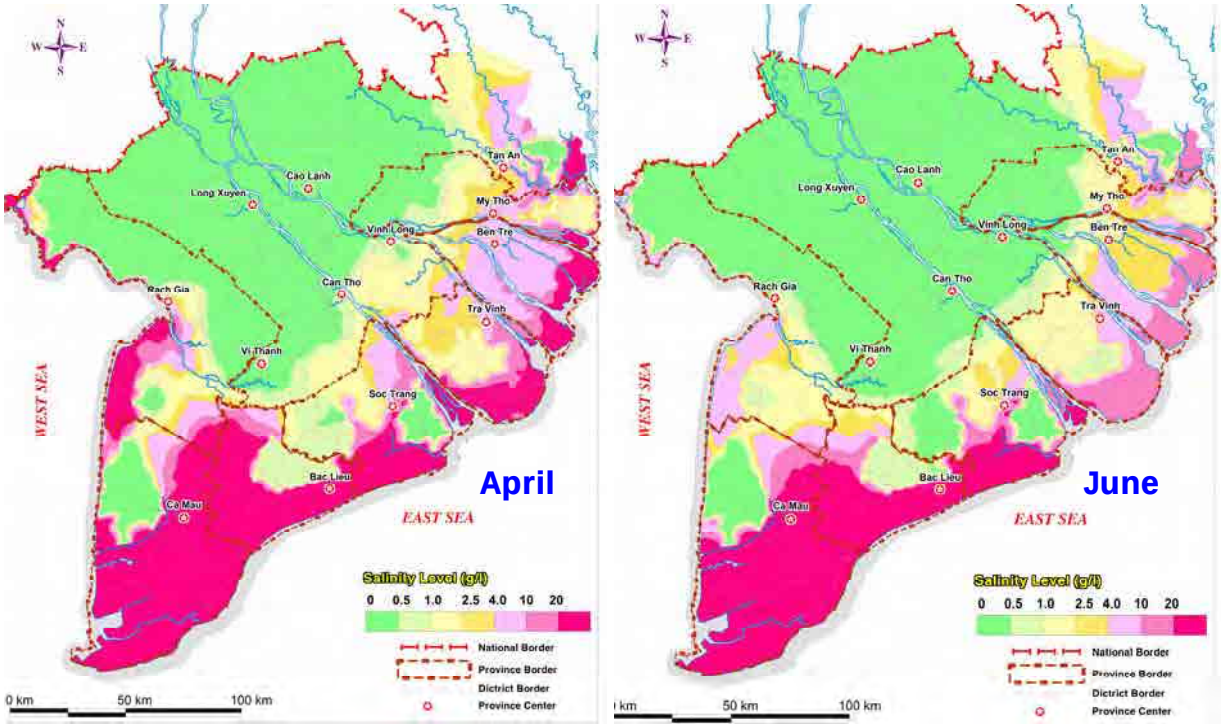

Figure 2.3.11 Saline Isolines of Driest Month (left: April) and Beginning of Flood Month (right: June)

Source; the Project Team

Note: Salinity intrusion simulation covers January to July, for which the results only April and June are presented above with April being the severest months, with June being the beginning of Flood season.

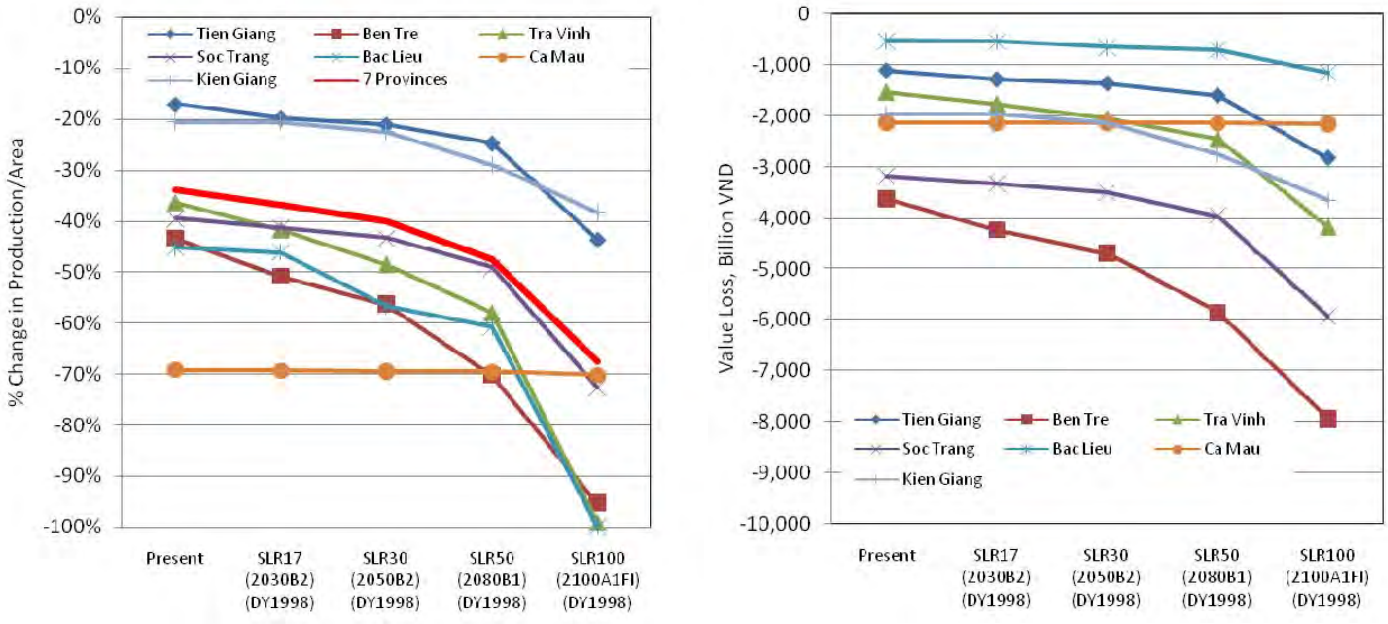

Figure 2.3.12 Predicted Production Loss by Saline Water Intrusion in Percentage (left) and in Price (right) for DY 1998 Discharge by Province

(DY 1998 MR Discharge with Different SRL, Source; the Project Team)

2.3.3 Flood Intensification associated with Sea Water Level Rise

1) Damage Indexes under Flood Inundation

Flood inundation affects crop production and gives some damage to infrastructure such as houses and road. Damage index for flood inundation established in this section referred to the relevant research results including those by IAS-South Vietnam, SIWRP and also actual flood damage records in Mekong Delta in 2011. Interview and field investigation were done in provincial offices, commune office, and to farmers in Dong Thap and Tien Giang provinces which are generally prone to receive flood inundation. Table 2.3.2 shows the damage indexes in percentage corresponding to flood inundation depth;

Table 1.1.2 Damage Index for Flood Inundation

No	Items	Inundation depth (meter)							Remarks
		0.00 - 0.25	0.25 -0.50	0.50 -0.75	0.75 -1,00	1,00 -2,00	2,00 -3,00	>3,00	
1.1	Paddy (10 days inundation)	10%	29%	37%	46%	63%	100%	100%	IAS-SV
1.2	Paddy (over 10 days inund'n)	10%	50%	100%	100%	100%	100%	100%	IAS-SV
2	Fruit (3 weeks inundation)	10%	100%	100%	100%	100%	100%	100%	Study Tm
3	Vegetable (1 day inundation)	10%	100%	100%	100%	100%	100%	100%	Study Tm
4	Shrimp	0%	0%	0%	50%	75%	100%	100%	Study Tm
7	Forest (Melaleuca)	0%	0%	0%	0%	0%	25%	50%	SIWRP

Source: Institute of Agriculture Science in South Vietnam(IAS-SV), SIWRP, and the Project Team

With regard to estimating damage loss for paddy yield, there are two critical periods for growth against inundation; one is tillering stage and the other is maturing stage. Le Sam (2006)[12] had examined relationship between flood inundation depth and relevant paddy production loss in 1988 and 1989. Inundation with different depths was applied to experimental plots of paddy at tillering stage, flowering stage, and maturing stage, and the results are summarized in the following figure. Based on the liner approximation established for those data experimented by Le Sam, damage indexes in Table 2.3.2 were estimated.

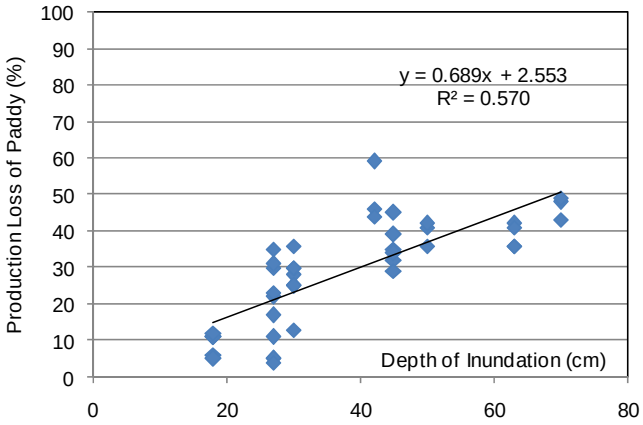

Figure 2.3.13 Inundation Depth and Yield Loss of Paddy

Source; Le Sam (2006), data processed and graphed by the Project Team

2) Yield Loss and Damages under Flood Inundation

Figure 2.3.15 shows the isoline of flood inundation in August (a beginning month of flood inundation) and October (the peak month of flood inundation) under the case of flood year (FY) 2000 Mekong River discharge with the sea level rise of 30 cm, equivalent to year 2050's expected rise under climate change (CC) scenario B2. These figure indicates;

1) As expected, severe flood takes place upper most reach of the Mekong Delta such as Dong Thap and An Giang provinces. Along the coastal areas, the flooding level is not as severe as those in the upper reach of the Delta. However, since Kien Giang province is located upstream of the Delta bordering An Giang province, the province tends to be affected more as compared to other coastal provinces. In addition, upper reach of Tien Giang province is also affected by flood since this area receives not only Mekong River's flood discharge but also runoff coming from

[12] Le Sam (2006), Irrigation in the Mekong Delta, Agricultural Publishing house, Ho Chi Minh

Dong Thap province.

2) In Ca Mau, Bac Lieu and Soc Trang provinces, there are lower areas which are more affected by flood inundation. In these areas, paddy is planted during rainy season. To avoid flood inundation becoming severe towards the end of the rainy season, farmers in these areas usually try to plant and harvest paddy as early season as possible.

3) October is the peak flood inundation month for coastal area of the Mekong delta, which the peak inundation comes a bit later than upstream side such as Dong Thap. This trend corresponds to the flooding from the Mekong River spreading almost all over the Delta starting from the upstream to the tail end (coastal areas) of Delta.

Figure 2.3.15 shows the change in production/area in terms of percentage and monetary value by province. As shown in the figure, in terms of percentage change, Kien Giang province comes first except for the 'Present' case, followed by Tien Giang. Other 5 provinces show more or less same damage percentage. In terms of monetary change (damage), Kien Giang province again shows the biggest loss till year 2080, which is due to the loss of vast areas of paddy production, and followed by Tien Giang till year 2050. At year 2100, Ca Mau, Soc Trang and also Bac Lieu provinces show bigger value loss as in these provinces loss of shrimp takes place to a large extent given 100 cm sea level rise.

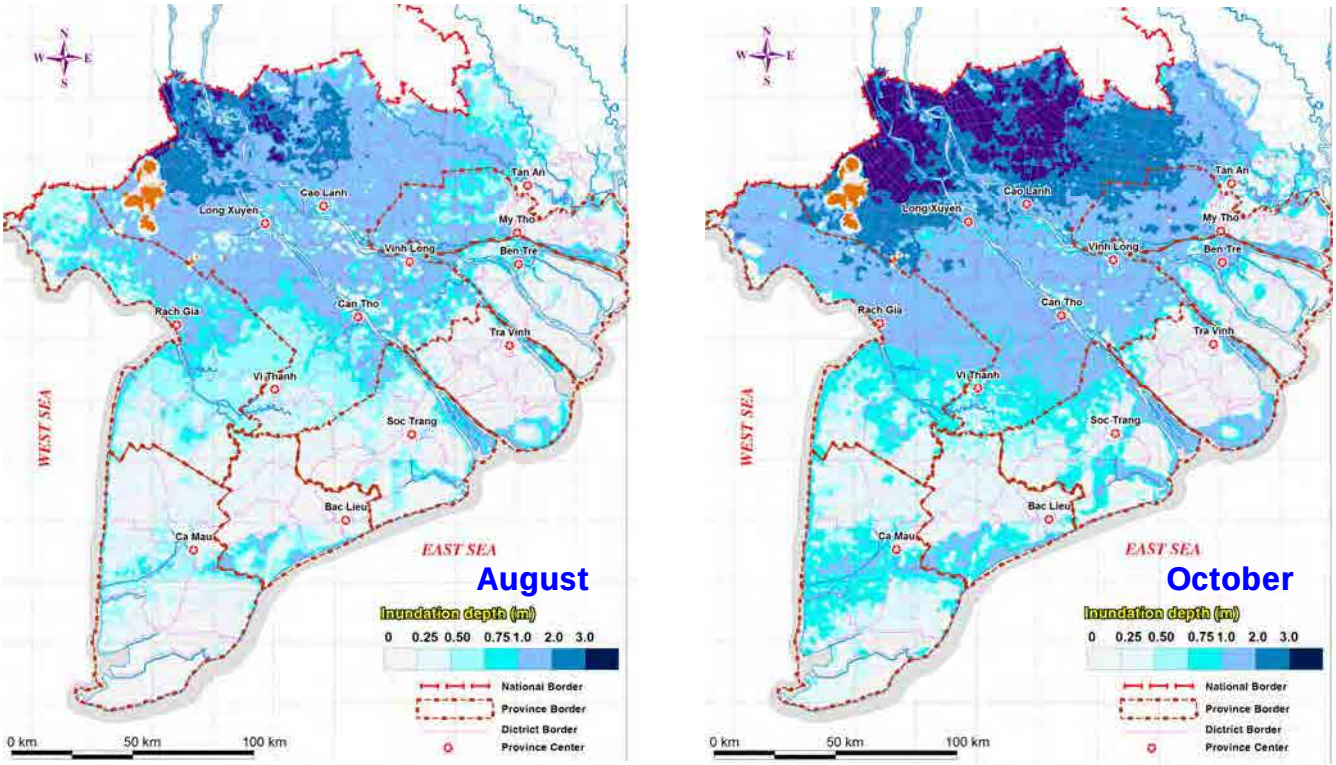

Figure 2.3.14 Flood Inundation Isoline of August (left) and October (right) for FY 2000 Discharge with 30cm SLR (2050; B2 Scenario)

Source; the Project Team

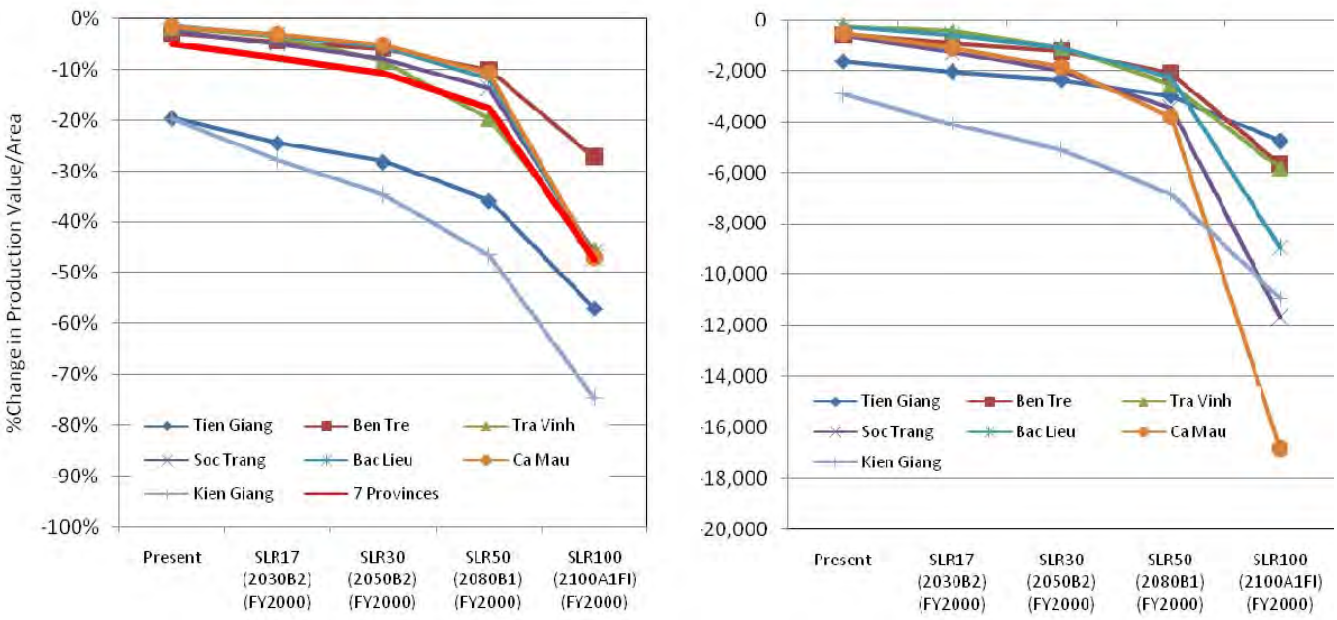

Figure 2.3.15 Production Loss by Flood Inundation of August (left) & October (right) for FY 2000 Discharge

Source; the Project Team

2.3.4 Areas to Focus in the Context of Climate Change: Saline Intrusion Prevention

The Government has been constructing sluice gates in order mainly to prevent saline water from intruding into irrigation canals. In fact, sluice gates had been ranked at 2nd position after sea dyke construction project during a government officers workshop held on October 27, 2011 in terms of number of priority projects. Also, the Master Plan (2011) prepared by SIWRP has identified a lot number of projects, of which sluice gate project shares 2nd largest part after canal rehabilitation/ dredging and canal embankment.

Being so, there is a lot of need to establish sluice gate, and in cases to rehabilitate existing sluice gates. In fact, saline intrusion along the Mekong River becomes severer over years coupled with sea level rise under climate change as aforementioned. The province at the end of Mekong River is now facing high risk of losing freshwater resources in and around the province as similar as Tra Vinh province; such province shall take water from upstream province through canal networks; otherwise saline intrusion will destroy the paddy field, fresh water aquaculture and fruits. Therefore, sluice construction coupled with canal network improvement is proposed.

From a sense of upcoming risks mentioned above in the context of climate change, Tra Vinh province shall be a targeted area for this project because saline water intrusion has already affected some downstream areas of Tra Vinh province. The prioritization on sluice will be conducted according to not only saline water intrusion simulation coupled with predicted sea level rise but also site survey for candidate canals. Through these activities, diversified agriculture as well as environment can be maintained to the future generation.

CHAPTER 3 DESIGN OF THE PROGRAM

This chapter describes about water recruitment from upstream side of Mekong river; in-depth study has revealed that saline intrusion will become sever in future and it is difficult to satisfy freshwater demand in Tra Vinh province alone, so that fresh water shall be taken from upstream side of Mekong river. For the purpose of freshwater acquisition, some large sluices coupled with canal capacity improvement are planned in Tra Vinh province and Vinh Long province as follows.

3.1 Overall Project Plan for the 3 Sluice Gates including Say Don (May Phop) Canal

Total three (3) sluices are planned for fresh water recruitment for Tra Vinh province; Bong Bot, Tan Dinh, and Vung Liem. Bong Bo and Tan Dinh are located at west side (along Hau River) of Tra Vinh, and Vung Liem is planned at east side (along Co Chien river). Say Don canal will function as the main route conveying freshwater from Vinh Long province to middle and downstream area of Tra Vinh province; then, freshwater can be distributed to beneficiary area in Tra Vinh province through canal networks.

3.1.1 Beneficiary Ares Covered by the Project

Beneficiary areas covered by three sluices and a waterway under this project are reviewed and revised based on "Dicision 1397/QD-TTg (approved by the Prime Minister) on 25 September 2012 and statistics; the they are summarized in Table 3.1.1 as follows.

Table 3.1.1 Beneficiary Areas and Households covered by the Project

Project	Beneficiary Area (ha)	Beneficiary H/H (nos)
Bong Bot	3,200	3,100
Tan Dinh	2,600	2,500
Vung Liem	4,800	4,700
Waterway (Say Don canal)	21,400	20,800
Total	32,000	31,100

Source: DARD of Tra Vinh Province and Project Team

Figure 3.1.1 Locations of Sluices with their beneficiary areas

3.1.2 Brief Description on Waterway of May Phop - Say Don - May Tuc - Nga Hau Canals

A project for dredging and extending the waterways from Vung Liem canal to Tra Ngoa canal is so called Say Dong canal expansion project. The project is composed of total four canals; May Phop canal connects to Vung Liem canal with 2.3km in length, Say Dong canal intermediate canal of this project with total length of 6.6km, and May Tuc-Nga Hau canals are located at the most downstream of the waterway having 15.2km in length. This project is designed to increase water convey canal of canals from 65m^3/sec to 118m^3/sec while peak freshwater demand is 111.4m^3/sec.

A beneficiary area of this project is located not only in Cang Long, Chau Thanh, and Cau Ngang districts of Tra Vinh province but also in Vung Liem district in Ving Long province; Total beneficiary area counts as over a hundred thousand hectares of paddy field. Among them there are about 30,000 hectares paddy area of which suffer severe water shortage in dry season. In order to relieve from water shortage in those areas, route of waterway was examined through improvement of existing canal networks. The most part of May Phop canal requires much resettlement at both sides of banks; this is why utilization length of May Phop canal for this project was limited as short as possible and it was resulted as 2.3km only while total length of this canal is 10.5km. Figure 3.1.2 shows location of major canals under this project.

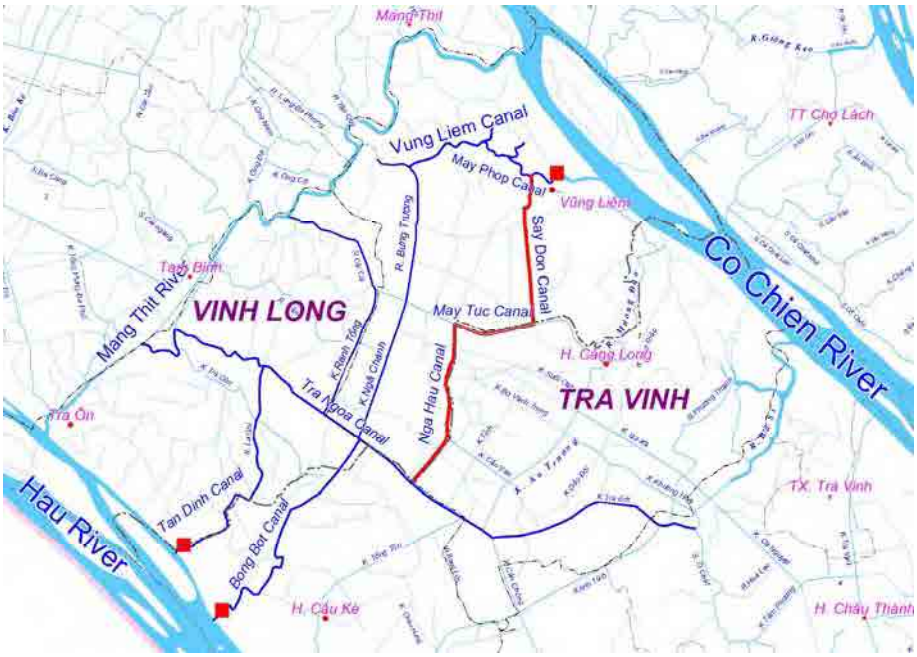

Figure 3.1.2 Locations of Proposed Waterway and Sluices

3.2 Design of Bong Bot Sluice Gate

3.2.1 Selection of construction site

Construction site of Bong Bot Sluice is proposed in Bong Bot River and 400m away from connection point with Hau River. From comparative studies for two alternatives, construction in the river has more advantage than the one on shore because the volume of soil excavation is smaller and volume of compensation for resettlement is only 1/10 as less as the on shore case. The option 1, on shore case, requires more houses near the construction site have to be resettled. Moreover, since some houses on shore area were once resettled from river side due to the construction of ferry and expansion of rural road; repeated move of houses will become negative pressure on these residents, so that this option is not recommendable. Therefore option 2 is appropriate to apply to this project.

Table 3.2.1 Comparison of Construction Sites for Bong Bot Sluice

Items	Option 1 Sluice construction on the shore	Option 2 Sluice construction in water
Construction site	On the right bank of Bong Bot River and 400m away from the connection point with Hau River	In Bong Bot River 400m away from connection point with Hau River
Geological features	Almost same as Option 2	Almost same as Option 1
Hydraulic features	Since canal bed slope becomes steep, scouring is easy to happen. Flow capacity is improved by straightening of flow direction.	Since not converting natural flow direction, hydraulic condition is almost same as present.
Structural stability	Almost same as Option1 since features of foundation ground have no wide difference.	Almost same as Option2 since features of foundation ground have no wide difference.
Easiness of construction	Since construction is carried out on dry land, it is easier.	Since construction is carried out on the site surrounded by water, some difficulties involve.
Construction cost	Large amount of excavation is necessary for constructing new canal and embankment. However total construction cost is cheaper than Option2 by the cost for temporary works including cofferdam.	Excavation volume is smaller than Option1. But total construction cost is somewhat expensive because cofferdam made of steel sheet piles is required.
Environmental impact	Larger number of resettlement and compensation will occur.	Resettlement is fewer and also the environmental impact is small.
Compensation volume		
-Permanent ground area (ha)	25.1	2.6
-Steel house (piece)	30	2
-Thatched house (piece)	15	4
-Brick house(piece)	23	7
-Trees (ha)	25.1	2.6
-Graves (piece)	12	-
-Removal of electric post (piece)	9	2
Selection		X

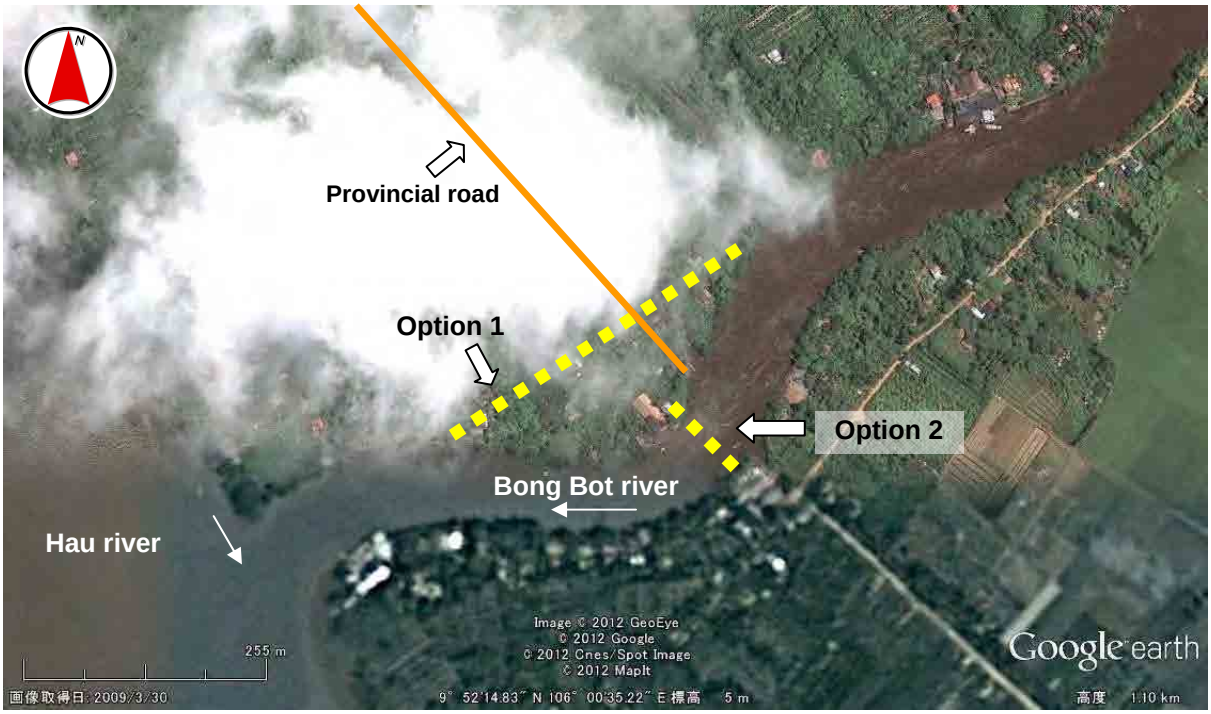

Figure 3.2.1 Selection of Construction Site for Bong Bot Sluice

3.2.2 Structural Dimensions

1) Sluice size

Grade II for irrigation works is applied for all following design works; which which follows Vietnam construction standard 'TCXDVN 285',2005.

From the facts of sluices constructed in Mekong Delta Area, especially South Mang Thit project, upon reference to the cross section of some sluices, it is not recommended to narrow more than 70% the area of the cross section compared with the natural condition. It is the best to construct sluices with the water flowing aperture in the range of 30% <Bsluice<50% the cross section of the existing rivers except for special cases.

According to the calculating results of water level, it is recommended to choose the size of canal and sluice system as proposed in Option A-2 with Bc=40m shown in following table since it can meet the demand for water in the area and can ensure the clearance for ships or boat to pass through.

Table 3.2.2 Result of hydraulic calculation on assumed sluice size

No	Option	Sluice size		Parameters corresponding with water head difference ΔZmax				Qmax (m^3/s)	Qbp (m^3/s)	Infield water level (m)		
		B (m)	Z (m)	ΔZmax (m)	H river (m)	H field (m)	Q (m^3/s)			Zmax	Zmin	Zbq
1	A0	HT	HT	0	1.25	1.25	29.25	56.80	1.70	1.25	-1.26	0.005
2	A1	35	-4.5	0.2	1.35	1.15	62.0	74.45	4.54	1.15	-0.9	0.5
3	A2	40	-4.5	0.35	1.35	1.00	70.9	85.09	5.18	1.00	-0.64	0.72
4	A3	45	-4.5	0.55	1.35	0.80	79.8	95.72	5.83	0.80	-0.38	0.84

2) Gate crest elevation

Gate crest elevation must ensure the height against design outside water level and design wave height. Design outside water level means the maximum tide level which intended for protection by tidal sluice gate. Taking North Ben Tre area as an example, 1.97m which is tidal level with 1% of occurrence

provability at My Thuan Station is selected as design outside water level. In this case, the required gate crest elevation is calculated as follows.

H=TL + d

$d = h_{s1} + a$

$h_{s1} = 3.2K \times \tan\alpha \times hs$

$hs = 0.0208V^{5/4}D^{1/3}$

where,

H : Design gate crest elevation (m)

TL : Design tidal level ; 1.97m (at My Thuan Station corresponding with frequency 1%)

d : Safety height (m)

h_{s1} : Design Wave height (m)

K : Coefficient depending on the ragged characteristics of dike roof; 1.0

α : Inclination angle of dike(^{o})

when the slope gradient =1:2, $\tan\alpha = 0.5$

hs : Wave height by AndoreIanop's formula (m)

V : Wind velocity; 15m/s (the maximum wind velocity at Ba Tri Station)

D : Wave propagation length ; $D = 0.5 \times B$

B : Average river width; 2.0 km

a : Freeboard ; 0.3-0.5m depending on work grade

$hs = 0.0208 \times 15^{5/4} \times (0.5 \times 2.0)^{1/3} = 0.61m$

$h_{s1} = 3.2 \times 1.0 \times 0.5 \times 0.614 = 0.98m$

$d = 0.98 + 0.5 = 1.48m$

H=1.97+1.48=3.45m

=3.50m

Item	Design value
1)Design tidal level (at My Thuan Station, return period 100 years)	1.97m
2)Design wave height	0.98m
3)Freeboard	0.50m
Required gate crest elevation (=1+2+3)	3.45m
Design gate crest elevation	3.50m

Although freeboard is defined within the rage of 0.3-0.5 m according to the scale of project or an importance of the facility by the Vietnamese criteria (14TCN130-2002 Design Guide), maximum value of 0.5m is employed for safety in this project. As a result, it is decided that gate crest elevation shall be H= 3.50 m. Even if a change of water level by climate change takes place in future, it can be said that the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard). These views are applicable also in other areas in Mekong Delta, though, numerical values, such as design outside water level need to be based on the latest data.

3.2.3 Gate Type

The performance required of the sluice gate is as follows.

-To take river water below predetermined salinity concentration into canal.
-To drain water of the canal into the river.
-To prevent intrusion of high tide or flood.
-To intercept river water above predetermined salinity concentration.
-Not to impede the passing of ships.

Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

3.2.4 Foundation

1) Geological features at the construction site

Geological survey is carried out at the construction site of this project; total 120m core drillings by 3 bore holes, 39 numbers of Standard Penetration Test, and laboratory analysis on 39 soil samples. Regional geological information and data are also collected. Based on aforementioned data and information, geological conditions at the site are described as follows.

Beneath the top soil layer, there are total 4 strata;

Layer 1: is detected on the entire profile cross section. Thickness varies from 12.0m (BB2 borehole) to 12.4m (BB1 borehole), average as 12.2m. This layer is represented by dark, bluish gray soft clay. SPT value varies from 0 to 2.

Layer 2: is detected on the entire profile cross section. Thickness varies from 17.8m (BB3 borehole) to 26.0m (BB1 borehole), average as 22.2m. This layer is represented by livid, brownish, white gray clay, firm. SPT value varies from 9 to 22.

Layer 3: This layer does not exist in BB1 borehole. Thickness varies from 6.3m (BB3 borehole) to 7.0m (BB2 borehole). This layer is represented by brownish, bluish gray, white gray silty sand, medium dense. SPT value varies from 12 to 27.

Layer 4: This layer does not exist in BB1, BB2 boreholes. Thickness is 2.2m (BB3 borehole), BB3 borehole is not drilled through this layer. This layer is represented by bluish gray sandy clay, soft to firm. SPT value is 28.

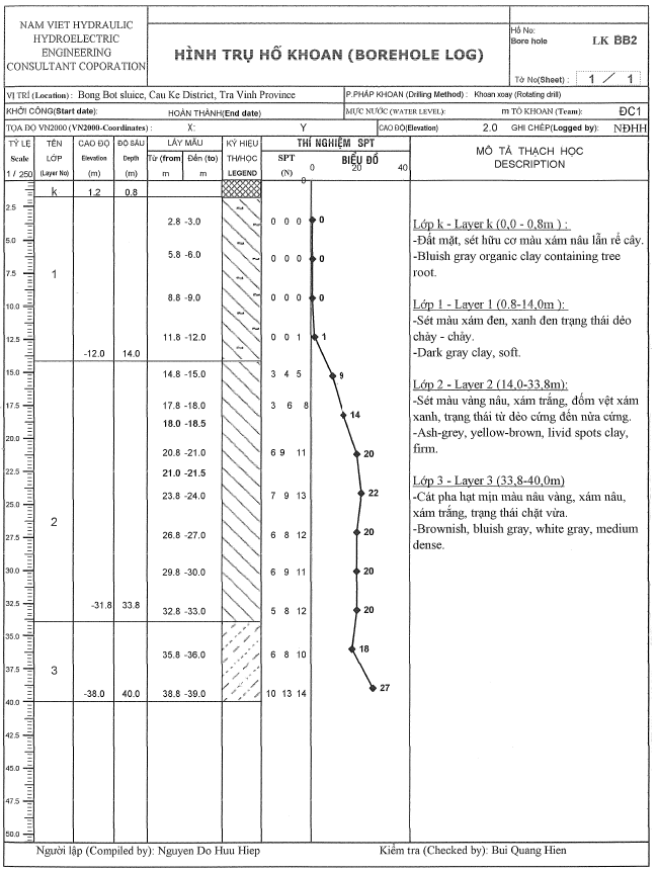

Figure 3.2.2 Log of borehole (No.BB2)

- Top soil layer and layer 1: removal or some foundation treatment is required.
- Layer 2: Engineering geological conditions are fairly good.
- Layer 3 and layer 4: Engineering geological conditions are good.

2) Foundation Treatment

3) From results of geological survey, the depth of load bearing layer is about 20m. In consideration of the depth and the amount of load, pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile

driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

3.2.5 Design parameters of sluice

+ Sluice body:
  – Open channel type made of reinforced concrete M300.
  – Number of gate: 2
  – Width of a gate: 20 m
  – Water clearance width: 40m
  – Water intake sill: -4.5m
  – Length of sluice body: 34.8m
  – Thickness of sluice bottom slab: d= 1.5m
  – Altitude of gate crest: + 3.5m
  – Traffic bridge: made of reinforced concrete M300, altitude of bridge beam bottom (+5.5m), width of bridge desk B =9m.
  – Platform for lifting, lowering and casting stoplogs: made of reinforced concrete M300, arranged with crane 60T on-off by electrical motor combined with manual manner.
  – Foundation: Ground is treated with reinforced concrete M300 with dimension of pile 35x35m, length of 25m.
+ Upstream and downstream sections:
  – Bottom altitude: -4.7m
  – Length: L=20m
  – Width: 41.5m
  – Material is gabion, laid with ashlar (D>20cm) of 100cm thick, lined with geotechnical fabric.
+ Section adjoining with upstream and downstream channel:
  – Bottom altitude: (-4.7m to -7.0m)
  – Length: L=20+10=30m
  – Width: 41.5m
  – Material is gabion, laid with ashlar (D>20cm) of 50cm thick, lined with geotechnical fabric.

Regarding fish-pass, refer to Appendix VI-4.

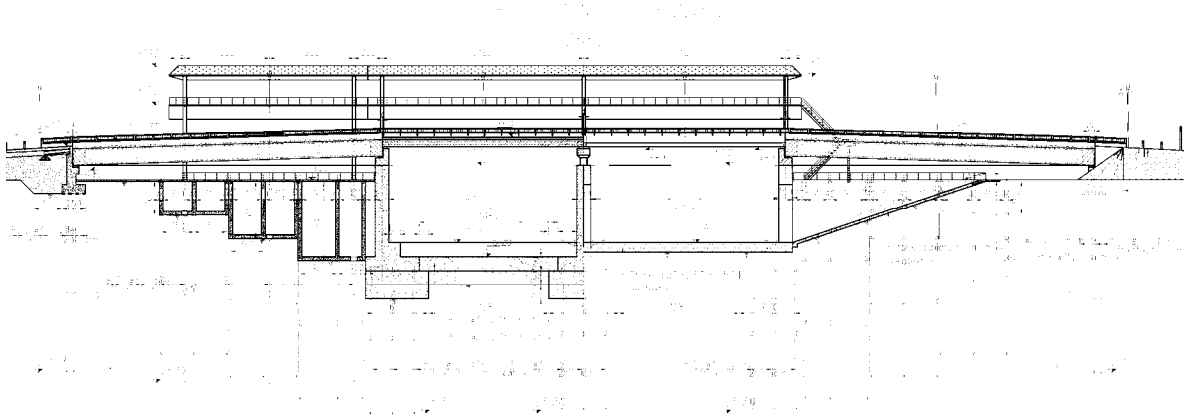

Figure 3.2.3 Front elevation of Bong Bot Sluice

3.3 Design of Tan Dinh Sluice Gate

3.3.1 Selection of construction site

Construction site of Tan Dinh Sluice is proposed in Tan Dinh River and 400m away from connection point with Hau River. This point is close to the provincial road that accessibility for traffic is excellent. Since the river course shapes almost straight, there cannot be found for suitable place of on-shore route around the site. Furthermore, there is no hydraulic advantage for construction of the sluice at on-shore because the route of it will be not straight. Thus, construction on riverbed has more advantageous and more appropriate because of low excavation volume, less resettlement and compensation cost, and minimum loss of land acquisition. Therefore, there is no alternative against riverbed site for construction of Tan Dinh Sluice.

Figure 3.3.1 Selection of Construction Site for Tan Dinh Sluice

3.3.2 Structural Dimensions

1) Sluice size

Grade II for irrigation works is applied for all following design works; which which follows Vietnam construction standard 'TCXDVN 285',2005.

From experiences of sluices construction in Mekong Delta, especially from South Mang Thit project, it is not recommended to narrow an area more than 70% of a cross section compared with the natural condition. For sluice construction in Mekong Delta, it is considered the best one of the water flowing aperture is ranged 30% <sluice<50% of the cross section of the rivers except for special cases.

According to the calculation results of water level, it is recommended to choose the size of canal and sluice system as proposed in Option A-2 with Bc=50m shown in following table since it can meet the demand for water in the area and can ensure the clearance for ships or boat to pass through.

Table3.3.1 Result of hydraulic calculation on assumed sluice size

No	Option	Sluice size		Parameters corresponding with water head difference ΔZmax				Qmax (m^3/s)	Qbp (m^3/s)	Infield water level (m)		
		B (m)	Z (m)	ΔZmax (m)	H river (m)	H field (m)	Q (m^3/s)			Zmax	Zmin	Zbq
1	A0	HT	HT	0	1.25	1.25	31.65	61.00	2.30	1.25	-1.26	0.005
2	A1	45	-4.5	0.2	1.35	1.15	79.8	95.72	5.83	1.15	-0.9	0.5
3	A2	50	-4.5	0.35	1.35	1.00	88.6	106.36	6.48	1.00	-0.64	0.72
4	A3	55	-4.5	0.55	1.35	0.80	97.5	117.00	7.13	0.80	-0.38	0.84

2) Gate crest elevation

Gate crest elevation must ensure the height against design outside water level and design wave height. Design outside water level means the maximum tide level which intended for protection by tidal sluice gate. Taking North Ben Tre area as an example, 1.97m which is tidal level with 1% of occurrence provability at My Thuan Station is selected as design outside water level. In this case, the required gate crest elevation is calculated as follows.

$H=TL + d$
$d = h_{s1} + a$
$h_{s1} = 3.2K \times \tan\alpha \times hs$
$hs=0.0208V^{5/4}D^{1/3}$

where,

H : Design gate crest elevation (m)
TL : Design tidal level ; 1.97m (at My Thuan Station corresponding with frequency 1%)
d : Safety height (m)
h_{s1} : Design Wave height (m)
K : Coefficient depending on the ragged characteristics of dike roof; 1.0
α : Inclination angle of dike (^{o})
when the slope gradient =1:2, $\tan\alpha = 0.5$
hs : Wave height by AndoreIanop's formula (m)
V : Wind velocity; 15m/s (the maximum wind velocity at Ba Tri Station)
D : Wave propagation length ; $D=0.5 \times B$
B : Average river width; 2.0 km
a : Freeboard ; 0.3-0.5m depending on work grade

$hs=0.0208 \times 15^{5/4} \times (0.5 \times 2.0)^{1/3}=0.61m$
$h_{s1} = 3.2 \times 1.0 \times 0.5 \times 0.614=0.98m$
$d = 0.98 + 0.5=1.48m$
$H=1.97+1.48=3.45m \fallingdotseq 3.50m$

Item	Design value
1)Design tidal level (at My Thuan Station, return period 100 years)	1.97m
2)Design wave height	0.98m
3)Freeboard	0.50m
Required gate crest elevation (=1+2+3)	3.45m
Design gate crest elevation	3.50m

Although freeboard is defined within the rage of 0.3-0.5 m according to the scale of project or an importance of the facility by the Vietnamese criteria (14TCN130-2002 Design Guide), maximum value of 0.5m is employed for safety in this project. As a result, it is decided that gate crest elevation shall be H= 3.50 m. Even if a change of water level by climate change takes place in future, it can be said that the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard). These views are applicable also in other areas in Mekong Delta,

though, numerical values, such as design outside water level need to be based on the latest data.

3.3.3 Gate Type and Material

1) Gate Type

The performance required of the sluice gate is as follows.

-To take river water below predetermined salinity concentration into canal.
-To drain water of the canal into the river.
-To prevent intrusion of high tide or flood.
-To intercept river water above predetermined salinity concentration.
-Not to impede the passing of ships.

Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

2) Gate Material

In Vietnam, steel gate has been widely used for sluice gates. Most of the gates had been installed in fresh water areas for the purpose of controlling water distribution in irrigation and drainage system. However, under this project, the gates are to confront high content of saline water since they are constructed in saline water intrusion areas. Therefore, stainless material gate is recommended rather than steel material gate. Though the stainless material gate is higher in cost than the steel gate, the cost difference is not so much nowadays, and there are several advantages pertinent to the stainless material gate.

As summarized in the following table, stainless gate is in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Further, when comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting. Therefore, this project proposes to adopt stainless material gate for the sluices.

Table 3.3.2 Comparison between Carbon Steel Gate and Stainless Gate

Item	Carbon Steel	Stainless Steel
Strength	Both strength and stiffness are excellent.	Both strength and stiffness are excellent.
Corrosion resistance	Inferior in corrosion resistance, hence painting is required.	Excellent in corrosion residence is.
Appearance	Various colors available by painting.	Gloss is kept for long.
Productivity	Easy to weld and fabricate.	Easy to weld and fabricate.
Maintenance	Repeated painting is required.	Painting is not necessary.
Total Cost for 30 years (M. VND)	13,574 (refer to Table 3.2.2)	13,150 (refer to Table 3.2.2)
Conclusion	Not apply	To be applied

Source: JICA Project Team

Table 3.3.3 Cost Estimation of the Gates over 30 years

Particulars			Carbon Steel	Stainless Steel
Representative Dimensions			B=10.5m, H=7.5m (common size in MD)	
Weight of gate leaf(ton):A			49.5	50.0
Unit cost for fabrication(1,000VND/ton):B			202,000	263,000
Area for painting(m^2):C			200	-
Unit painting cost(1,000VND/m^2):D			8,000	-
Painting cost per one time(1,000VND):E=CxD			1,600,000	-
Initial Cost(1,000VND):F=AxB+E			11,599,000	13,150,000
Running cost for painting (1,000VND)	Passed years	Discount Rate (12%)	Running cost	
	5	0.567	907,883	-
	10	0.322	515,157	-
	15	0.183	292,314	-
	20	0.104	165,867	-
	25	0.059	94,117	-
Total painting cost for 30 years(1,000VND):G			1,975,338	0
Initial cost +running cost(1,000VND):F+G			13,574,338	13,150,000

Source: JICA Project Team

3.3.4 Foundation Type

1) Geological features at the construction site

Besides top soil layer, there are 5 strata at the construction site;

Top soil layer: is detected in 2 boreholes onshore, represented by disturbed soil mixed with vegetation remainders, firm consistency.

Layer 1: is detected on the entire profile cross section. Thickness varies from 3.2m (TD2 borehole) to 12.1m (TD3 borehole), average as 9.0m. This layer is represented by dark, bluish gray clay, intercalated with fine sand lenses, soft. SPT value varies from 0 to 1.

Layer 2: is detected on the entire profile cross section. Thickness varies from 18.0m (TD2 borehole) to 19.0m (TD1 borehole), average as 18.5m. This layer is represented by brownish, livid, dark gray sandy clay, firm. SPT value varies from 7 to 31.

Layer 3: This is clay mixed grip, only in TD1 borehole, this layer does not exist in TD2, TD3 boreholes. Thickness is 1.5m. This layer is represented by brownish, yellow gray sandy clay, firm. SPT value is 16.

Layer 4: is detected on the entire profile cross section, TD1, TD3 boreholes is not drilled through this layer. Thickness is 15.5m (TD2 borehole). This layer is represented by brownish, yellow gray, white gray, pink gray silty sand. The composition is silky sand, medium dense, saturated. SPT value varies from 11 to 28.

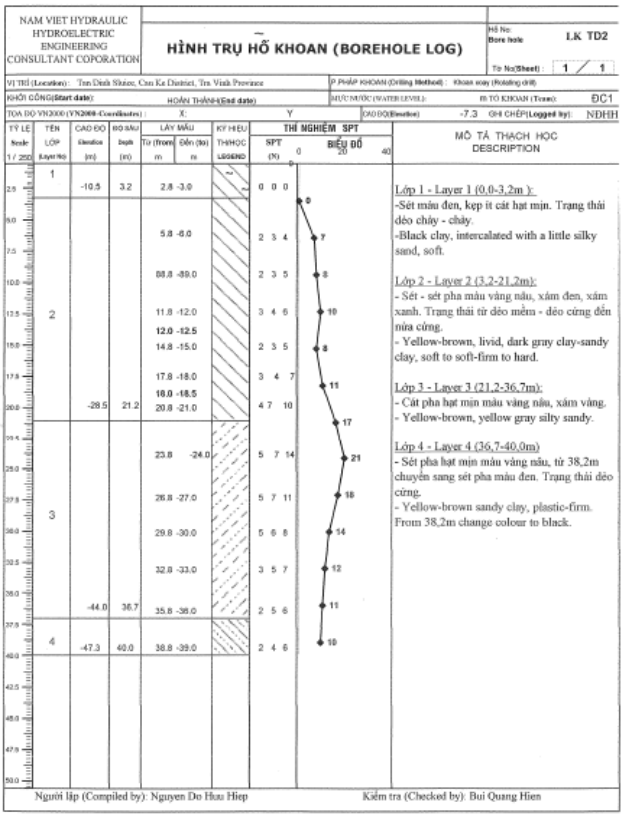

Figure3.3.2 Log of borehole (No.TD2)

Layer 5: This layer does not exist in TD1, TD3 boreholes. Thickness is 3.3m (TD2 borehole), TD2 borehole is not drilled through this layer. This layer is represented by dark gray sandy clay, firm. SPT value is 10.

- Top soil layer and layer 1: removal or some foundation treatment is required.
- Layer 2 and layer 5: Engineering geological conditions are fairly good.
- Layer 3 and layer 4: Engineering geological conditions are good.

2) Foundation Treatment

From results of geological survey, the depth of load bearing layer is about 20m. In consideration of the depth and the amount of load, pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

3.3.5 Design parameters of sluice

+ Sluice body:
  – Open channel type made of reinforced concrete M300.
  – Number of gate: 3
  – Width of a gate: 17 m
  – Water clearance width: 51m
  – Water intake sill: -4.5m
  – Length of sluice body: 34.8m
  – Thickness of sluice bottom slab: d= 1.5m
  – Altitude of gate crest: + 3.5m
  – Traffic bridge: made of reinforced concrete M300, altitude of bridge beam bottom (+5.5m), width of bridge desk B =9m.
  – Platform for lifting, lowering and casting stoplogs: made of reinforced concrete M300, arranged with crane 60T on-off by electrical motor combined with manual manner.
  – Foundation: Ground is treated with reinforced concrete M300 with dimension of pile 35x35m, length of 25m.
+ Upstream and downstream sections:
  – Bottom altitude: -4.7m
  – Length: L=20m
  – Width: 54.0m
  – Material is gabion, laid with ashlar (D>20cm) of 100cm thick, lined with geotechnical fabric.
+ Section adjoining with upstream and downstream channel:
  – Bottom altitude: (-4.7m to -7.0m)
  – Length: L=20+10=30m
  – Width: 54.0m
  – Material is gabion, laid with ashlar (D>20cm) of 50cm thick, lined with geotechnical fabric.

Regarding fish-pass, refer to Appendix VI-4.

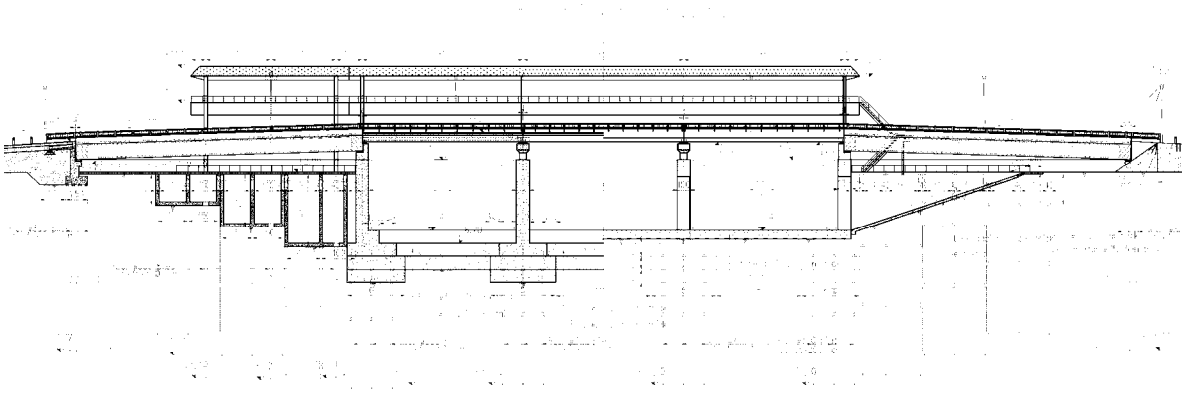

Figure3.3.3 Front elevation of Tan Dinh Sluice

3.4 Design of Vung Liem Sluice Gate

3.4.1 Selection of construction site

From comparative studies for two alternatives, construction in the river has more advantage because the volume of excavation is small, volume of land compensation and resettlement is as ones tenth as option 1. Since construction site in option 1 is adjacent to the center of Vung Liem district and close to district roads, compensation cost for houses, residential land and crop land amount to as three times as agricultural land. Therefore, site clearance and resettlement are not easy, and this option is quite difficult to carry out. Thus, option 2 is proposed for construction of Vung Liem Sluice.

Table 3.4.1 Comparison of Construction Sites for Vung Liem Sluice

Items	Option 1 Sluice construction on the shore	Option 2 Sluice construction in water
Construction site	2,500m away from connection point of Bung Liem River and Co Chien River	800m away from connection point of Bung Liem River and Co Chien River
Geological features	Almost same as Option 2	Almost same as Option 1
Hydraulic features	Since canal bed slope becomes steep, scouring is easy to happen. Flow capacity is improved by straightening of flow direction.	Since not converting natural flow direction, hydraulic condition is almost same as present.
Preventing saline intrusion	There exists an inflow canal at downstream, another sluice is necessary for preventing saline intrusion.	Only one sluice can prevent saline intrusion into the area.
Structural stability	Almost same as Option1 since features of foundation ground have no wide difference.	Almost same as Option2 since features of foundation ground have no wide difference.
Easiness of construction	Since construction is carried out on dry land, it is easier.	Since construction is carried out on the site surrounded by water, some difficulties involve.
Construction cost	Large amount of excavation is necessary for constructing new canal and embankment. However total construction cost is cheaper than Option2 by the cost for temporary works including cofferdam. There is a	Excavation volume is smaller than Option1. But total construction cost is somewhat expensive because cofferdam made of steel sheet piles is required.
Environmental impact	Larger number of resettlement and compensation will occur.	Resettlement is fewer and also the environmental impact is small.
Compensation volume		
Permanent ground area(ha)	20.0	3.1
Steel house(piece)	20	4
Thatched house(piece)	15	1
Brick house(piece)	10	4

Trees(ha)	35.1	3.1
Removal of electric post(piece)	9	3
Selection	-	X

Figure 3.4.1 Selection of Construction Site for Vung Liem Sluice

3.4.2 Structural Dimensions

1) Sluice size

Grade II for irrigation works is applied for all following design works; which which follows Vietnam construction standard 'TCXDVN 285',2005.

From experiences of sluices construction in Mekong Delta, especially from South Mang Thit project, it is not recommended to narrow an area more than 70% of a cross section compared with the natural condition. For sluice construction in Mekong Delta, it is considered the best one of the water flowing aperture is ranged 30% <sluice<50% of the cross section of the rivers except for special cases.

According to the calculating results of water level, it is recommended to choose the size of canal and sluice system as proposed in Option A-2 with Bc=60m shown in following table since it can meet the demand for water in the area and can ensure the clearance for ships or boat to pass through.

Table 3.4.2 Result of hydraulic calculation on assumed sluice size

No	Option	Sluice size		Parameters corresponding with water head difference ΔZmax				Qmax (m^3/s)	Qbp (m^3/s)	Infield water level (m)		
		B (m)	Z (m)	ΔZmax (m)	H river (m)	H field (m)	Q (m^3/s)			Zmax	Zmin	Zbq
1	A0	HT	HT	0	1.20	1.20	94.90	178.90	10.90	1.20	-1.26	-0.03
2	A1	50	-5	0.25	1.35	1.10	100.2	120.28	7.33	1.10	-0.85	0.5
3	A2	60	-5	0.35	1.35	1.00	120.3	144.34	8.79	1.00	-0.64	0.72
4	A3	70	-5	0.65	1.35	0.70	140.3	168.40	10.26	0.70	-0.28	0.84

2) Gate crest elevation

Gate crest elevation must ensure the height against design outside water level and design wave height. Design outside water level means the maximum tide level which intended for protection by tidal sluice

gate. Taking North Ben Tre area as an example, 1.97m which is tidal level with 1% of occurrence provability at My Thuan Station is selected as design outside water level. In this case, the required gate crest elevation is calculated as follows.

$H=TL + d$
$d = h_{s1} + a$
$h_{s1} = 3.2K \times \tan\alpha \times hs$
$hs=0.0208V^{5/4}D^{1/3}$

where,

H : Design gate crest elevation (m)
TL : Design tidal level ; 1.97m (at My Thuan Station corresponding with frequency 1%)
d : Safety height (m)
h_{s1} : Design Wave height (m)
K : Coefficient depending on the ragged characteristics of dike roof; 1.0
α : Inclination angle of dike(^{o})
when the slope gradient =1:2, $\tan\alpha = 0.5$
hs : Wave height by AndoreIanop's formula (m)
V : Wind velocity; 15m/s (the maximum wind velocity at Ba Tri Station)
D : Wave propagation length ; $D=0.5 \times B$
B : Average river width; 2.0 km
a : Freeboard ; 0.3-0.5m depending on work grade

$hs=0.0208 \times 15^{5/4} \times (0.5 \times 2.0)^{1/3}=0.61m$
$h_{s1} = 3.2 \times 1.0 \times 0.5 \times 0.614=0.98m$
$d = 0.98 + 0.5=1.48m$
$H=1.97+1.48=3.45m \fallingdotseq 3.50m$

Item	Design value
1)Design tidal level (at My Thuan Station, return period 100 years)	1.97m
2)Design wave height	0.98m
3)Freeboard	0.50m
Required gate crest elevation (=1+2+3)	3.45m
Design gate crest elevation	3.50m

Although freeboard is defined within the rage of 0.3-0.5 m according to the scale of project or an importance of the facility by the Vietnamese criteria (14TCN130-2002 Design Guide), maximum value of 0.5m is employed for safety in this project. As a result, it is decided that gate crest elevation shall be H= 3.50 m. Even if a change of water level by climate change takes place in future, it can be said that the function as a tide gate would be kept since the increase is considered within the limits of freeboard value (e.g. sea level rise in 2050 is 30cm under B2 scenario and 33 cm under A1FI scenario which are within the freeboard). These views are applicable also in other areas in Mekong Delta, though, numerical values, such as design outside water level need to be based on the latest data.

3.4.3 Gate Type and Material

1) Gate Type

The performance required of the sluice gate is as follows.

-To take river water below predetermined salinity concentration into canal.
-To drain water of the canal into the river.
-To prevent intrusion of high tide or flood.
-To intercept river water above predetermined salinity concentration.
-Not to impede the passing of ships.

Swing gate with non power type is spread widely in Mekong delta area for the tide gate and can meet the performance required mentioned above. And first of all, this gate has advantages in initial cost and operation cost compared with other gate types such as vertical lift gate. Therefore, swing gate is selected for this sluice. The material of it is stainless steel and one set of standby & repair stoplog with galvanized steel.

2) Gate Material

In Vietnam, steel gate has been widely used for sluice gates. Most of the gates had been installed in fresh water areas for the purpose of controlling water distribution in irrigation and drainage system. However, under this project, the gates are to confront high content of saline water since they are constructed in saline water intrusion areas. Therefore, stainless material gate is recommended rather than steel material gate. Though the stainless material gate is higher in cost than the steel gate, the cost difference is not so much nowadays, and there are several advantages pertinent to the stainless material gate.

As summarized in the following table, stainless gate is in fact maintenance free while steel gate requires periodical painting in order to prevent rust and corrosion. In most cases, paintings shall be done at least once in every 5 years according to the existing practice in Mekong delta. Further, when comparing the total costs between the 2 gates over 30 years, the aggregated cost for stainless steel gate is a little smaller than that of steel gate. Note that in estimating the 30 years cost, discount rate of 12%, equal to the opportunity cost in Vietnam, was employed to the cost of painting. Therefore, this project proposes to adopt stainless material gate for the sluices.

Table 3.4.3 Comparison between Carbon Steel Gate and Stainless Gate

Item	Carbon Steel	Stainless Steel
Strength	Both strength and stiffness are excellent.	Both strength and stiffness are excellent.
Corrosion resistance	Inferior in corrosion resistance, hence painting is required.	Excellent in corrosion residence is.
Appearance	Various colors available by painting.	Gloss is kept for long.
Productivity	Easy to weld and fabricate.	Easy to weld and fabricate.
Maintenance	Repeated painting is required.	Painting is not necessary.
Total Cost for 30 years (M. VND)	13,574 (refer to Table 3.2.2)	13,150 (refer to Table 3.2.2)
Conclusion	Not apply	To be applied

Source: JICA Project Team

Table 3.4.4 Cost Estimation of the Gates over 30 years

Particulars			Carbon Steel	Stainless Steel
Representative Dimensions			B=10.5m, H=7.5m (common size in MD)	
Weight of gate leaf(ton):A			49.5	50.0
Unit cost for fabrication(1,000VND/ton):B			202,000	263,000
Area for painting(m^2):C			200	-
Unit painting cost(1,000VND/m^2):D			8,000	-
Painting cost per one time(1,000VND):E=CxD			1,600,000	-
Initial Cost(1,000VND):F=AxB+E			11,599,000	13,150,000
Running cost for painting (1,000VND)	Passed years	Discount Rate (12%)	Running cost	
	5	0.567	907,883	-
	10	0.322	515,157	-
	15	0.183	292,314	-
	20	0.104	165,867	-
	25	0.059	94,117	-
Total painting cost for 30 years(1,000VND):G			1,975,338	0
Initial cost +running cost(1,000VND):F+G			13,574,338	13,150,000

Source: JICA Project Team

3.4.4 Foundation Type

1) Geological features at the construction site

Besides top soil layer, there are 5 strata at the construction site;

Top soil layer: is detected in 2 boreholes onshore, represented by disturbed soil mixed with vegetation remainders, firm consistency.

Layer 1: is detected on the entire profile cross section. Thickness varies from 12.7m (VL2 borehole) to 24.9m (VL1 borehole), average as 18.6m. This layer is represented by dark, bluish gray clay, intercalated with fine soft sand lenses. SPT value varies from 0 to 2.

Layer 2: Thin layer is detected on the entire profile cross section. Thickness varies from 1.6m (VL1 borehole) to 2.7m (VL2 borehole), average as 2.0m. This layer is represented by livid, yellow gray sandy clay, intercalated with a little grit and gravel, soft to firm. SPT value varies from 5 to 7.

Layer 3: is detected on the entire profile cross section. Thickness varies from 7.1m (VL3 borehole) to 9.8m (VL2 borehole), average as 8.8m. This layer is represented by brownish, livid, red gray clay, firm. SPT value varies from 12 to 28.

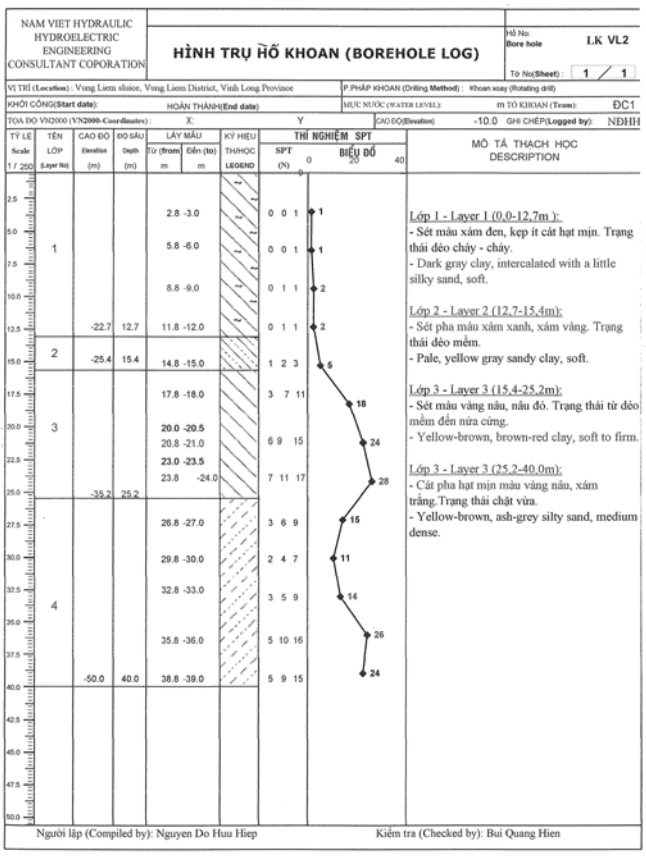

Figure 3.4.2 Log of borehole (No.VL2)

Layer 4: This layer does not exist in VL2 borehole. Thickness varies from 2.9m (VL1 borehole) to 11.4m (VL3 borehole), VL1 and VL3 boreholes are not drilled through this layer. This layer is represented by brownish, livid sandy clay, firm. SPT value varies from 13 to 25.

Layer 5: This layer does not exist in VL1 and VL3 boreholes. Thickness is 14.8m (VL2 borehole), VL2 borehole is not drilled through this layer. This layer is represented by brownish, white gray silty sand. The composition is silky sand - dust, medium dense. SPT value varies from 11 to 26.

-
- Top soil layer and layer 1: Measures are required for treating this layer during engineering implementation.
- Layer 2: Engineering geological conditions are fairly good.
- Layer 3, 4 and 5: Engineering geological conditions are good.

2) Foundation Treatment

From results of geological survey, the depth of load bearing layer is about 20m. In consideration of the depth and the amount of load, pile foundation shall be applied to this structure. Based on depth of bearing layer, pile driving is recommended as foundation treatment of this project. Pile driving is popular in Mekong Delta; it is not special construction work in this region. Proposed size of foundation pile is 35cm square.

3.4.5 Design parameter of sluice

+ Sluice body:
  – Open channel type made of reinforced concrete M300.
  – Number of gate: 4
  – Width of a gate: 15 m
  – Water clearance width: 60m
  – Water intake sill: -5.0m
  – Length of sluice body: 34.8m
  – Thickness of sluice bottom slab: d= 1.5m
  – Altitude of gate crest: + 3.5m
  – Traffic bridge: made of reinforced concrete M300, altitude of bridge beam bottom (+5.5m), width of bridge desk B =9m.
  – Platform for lifting, lowering and casting stoplogs: made of reinforced concrete M300, arranged with crane 60T on-off by electrical motor combined with manual manner.
  – Foundation: Ground is treated with reinforced concrete M300 with dimension of pile 35x35m, length of 25m.
+ Upstream and downstream sections:
  – Bottom altitude: -5.2m
  – Length: L=20m
  – Width: 68.0m
  – Material is gabion, laid with ashlar (D>20cm) of 100cm thick, lined with geotechnical fabric.
+ Section adjoining with upstream and downstream channel:
  – Bottom altitude: (-5.2m to -9.0m)
  – Length: L=20+10=30m
  – Width: 68.0m
  – Material is gabion, laid with ashlar (D>20cm) of 50cm thick, lined with geotechnical fabric.

Regarding fish-pass, refer to Appendix VI-4.

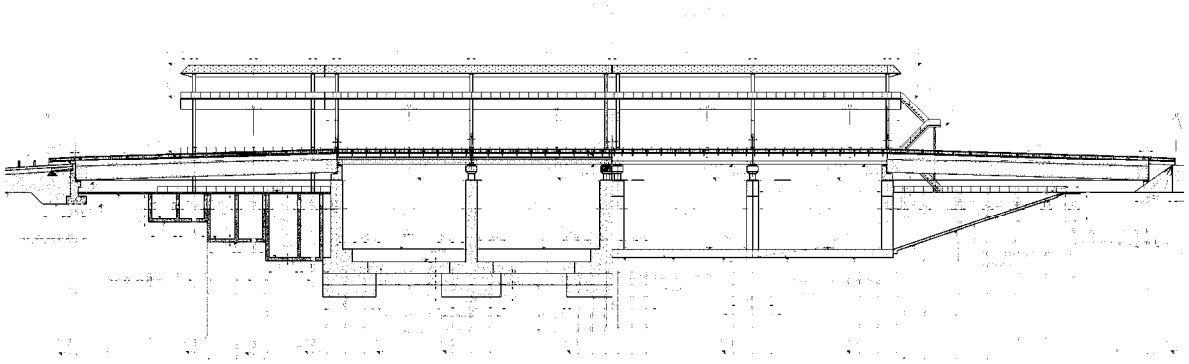

Figure3.4.3 Front elevation of Vung Liem Sluice

3.5 Operation and Maintenance of the Sluice Gates

3.5.1 Operation of the Sluice Gates

The objectives of operation are in order to meet demands for preventing saline intrusion, storing fresh water, removing acidity and sedimentation and keeping water traffic effectively. Basic operation manner of gates are as follows.

-During dry season

In order to prevent saline intrusion into the project area and to store fresh water in the canals, all the

gates of sluices must be closed.

However, they are usually opened artificially a few times per month even in this period to drain water or to allow small boats passing through the sluices.

-During rainy season
During this period, all the gates, which are powerless swing type gate, are open and move freely depending on the water difference between the river side and the field side. Basically water traffic is not obstructed by the gates.

But in case the water level expected to rise higher unusually because of storm or some other causes, gates should be closed in order to prevent flood damage in the area.

These operation rules should be established in accordance with the rules of neighboring existing sluices and in consideration of present condition of water use or water traffic in the beneficiary area and so on.

3.5.2 Maintenance of the Sluice Gates

Since a hydraulic gate is one of a social infrastructure for the purpose of water utilization or flood management, the damage which affects community life is serious when the gate loses proper functions due to a failure. Therefore, maintenance, inspection and control for a gate shall be conducted properly to well-maintain each function.

The hydraulic gate should be inspected regularly or as appropriate in order to maintain the functions and to prevent accidents beforehand. The historical records, specifications, design drawings, test records, and operation manuals for the gate should be maintained. In addition, the inspection record, operating record, and repair record, etc., should be well-maintained.

The interval of regular inspections should be set in the control standards established separately taking into account the use conditions, functions, and importance of gate. After flooding, it is desirable that the gate leaf, gate guide, and auxiliary facilities should be inspected temporarily and immediately.

The hinged supports of swing gate are generally subject to large pressure and revolve at a low speed, and so extreme care should be taken so that the lubricant is always applied throughout the entire surface of the support. With insufficient lubrication, bearings are likely to be seized, and the wheel pin tends to rotate with the wheels, thus leading to trouble in operation the gate leaf. For this reason, lubrication is one of the essential maintenance items for smooth operation.

Repair or replacement shall be made soon after the risk of malfunction of a gate is occurred because of a decrease in material thickness, deterioration and corrosion of materials, etc. Repair or replacement of a gate should be made based on the followings:

- When there is a fear that the stress of each member exceed the allowable stress for each material used, thus leading to a breakdown.
- When the gate is estimated to be in danger because of structure instability due to vibrations.
- When there is some trouble in operating the gate because of an excessive drop in performance.

Although the gate leaf itself is supposed to be maintenance-free when it is made by stainless steel, some parts such as rubber seals are generally repaired or replaced.
And a stoplog or temporary gate shall be provided for the purpose of repairing the hydraulic gate. When repairing the gate, the above is temporarily used as a substitute for the gate so that the repair work can be done without lowering the water level in a canal.

General maintenance flow or cycle of a gate is shown in following figure. On a normal maintenance

cycle, each actual operation, inspection and repair or replacement should be continuously repeated.

But when an aging degradation progresses or malfunction occurs, diagnoses should be carried out. And if necessary as the result of diagnoses, remodeling of apparatus or renewal of equipment shall be conducted, and sometimes renewal or disposal of whole facilities shall be required.

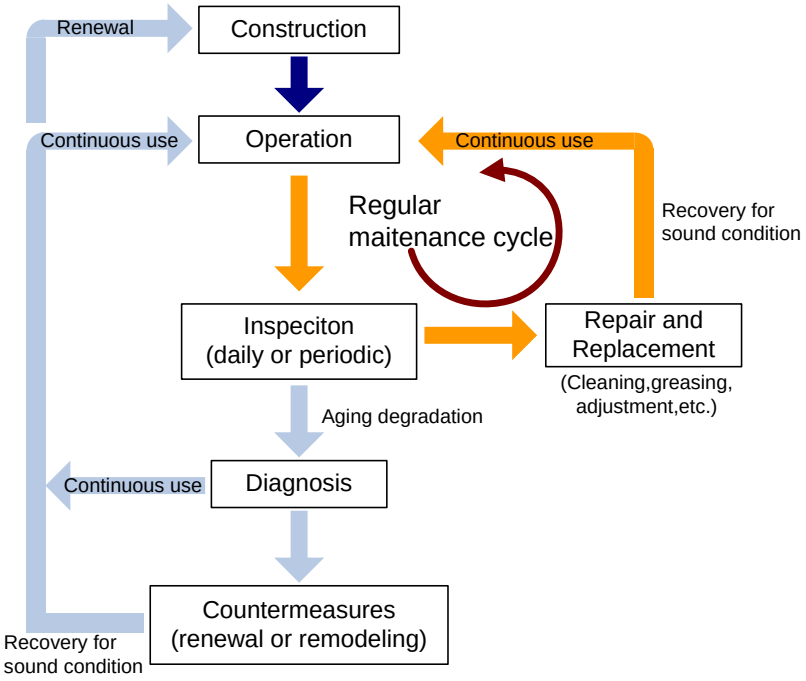

Figure3.5.1 Maintenance Flow of Gate

3.6 Monitoring of Saline Intrusion

3.6.1 Monitoring Organization

Ministry of Natural Resources and Environment is responsible for meteorological observation and data collection at national and regional level with several weather measurement stations; water level and saline content of major rivers are measured at the meteorological stations. In each province, there is an or a water resource management company (WRMC); which is responsible for monitoring of saline content of river/canal water near sluices. Much of the management responsibility for irrigation infrastructure has been transferred WRMC from DWR of DARD.

WRMC receives technical assistance from DWR and DARD but it is so called an autonomous self-financing enterprise while WRMC is a monopoly enterprise on provincial water management works in a province. Each coastal province has a such company and the management system is the same as this way. In addition to technical assistance, administrational instruction is also made by DWR and MARD. The WRMC operates and maintains water distribution systems in Mekong delta until canals reach the point at which water is delivered to a “district” level.

3.6.2 Measurement of Saline Content

Saline content of water is measured near a sluice location; whether the saline content excess 2g/L or not. This regulation comes from irrigation standard of Vietnamese government, which saline content of water equal or more than 2g/L is not suitable for irrigation purpose. If saline content of water arrives 2g/L, WRMC have to close gates of sluice in order to prevent saline intrusion into farm area.

this is why the measurement is usually once a month (=28days cycle) at the beginning of dry season. Water level of Mekong River descends and becomes lowest in April and May.

In April and May, interval of measurement on saline content becomes short such as once a two-weeks, or once a week. There is early saline intrusion sometimes in comparison with ordinary years, then, it is reported that unexpected saline intrusion occurs in some areas; a delay of confirmation for saline content of water caused a delay of closing operation of gates for saline intrusion. Consequently, there was serious damage to the crops and loss of crops was over 70% in 8,000 ha in 2011 in Tra Vinh province. IMC/WRMC will undertake monitoring of saline content for each sluices to be constructed; appropriate monitoring system establishment is necessary together with this project in the context of climate change. “Capacity Building on Water Flow Management” will be one of intervention for this purpose and detail of it is described in Part IV in this report.

3.7 Agriculture Extension (Supportive Component)

Sluice enables to prevent saline water intrusion into beneficiary areas; irrigation water condition in such places will improve in comparison with the days without sluice. It will be new circumstances for farmers, saline content of water does not increase in dry season. In some cases, there will be necessity for farmers to revise or change cropping pattern in accordance with availability of fresh water in dry season. Thus, cropping pattern shall be examined according to progress of sluice construction, and suitable agriculture extension shall be conducted coupled with the revise of cropping pattern. This is why attention shall be given to keep agricultural and/or aquacultural farm lands to be suitable for stable production in response to circumstances newly created by investment.

Aforementioned activity will save the livelihood of farmer household through a sustainable manner. Construction of sluice gates alone cannot achieve the above purpose, it should be combined with other effective measures, which may include improvement of water management and/or shifting cropping patterns to be more suitable to newly obtained water resource circumstances. Among all, an agriculture extension program is proposed as a supportive component of sluice gate construction project. Note that agricultural extension program should not be implemented without strategic conduct of sluice gate construction as sluice gate should be operated based on the introduced farming systems and farming systems should be planned based on an availability of saline water control enabled by a series of sluice gates and their operation.

3.7.1 Extension System

As for the agricultural and aquacultural extension, there are two major channels; one led by government and the other by private institutes. The government extension system, or national agricultural promotion system, is administrated through a cascading system from top to down: 1) MARD at national level represented by National Center for Agricultural Extension, 2) provincial agricultural extension centers, 3) agricultural extension stations at district level, 4) commune extension clubs for agricultural extension, which is composed of advanced farmers, and 5) common farmers on the ground (see Figure 3.7.1).

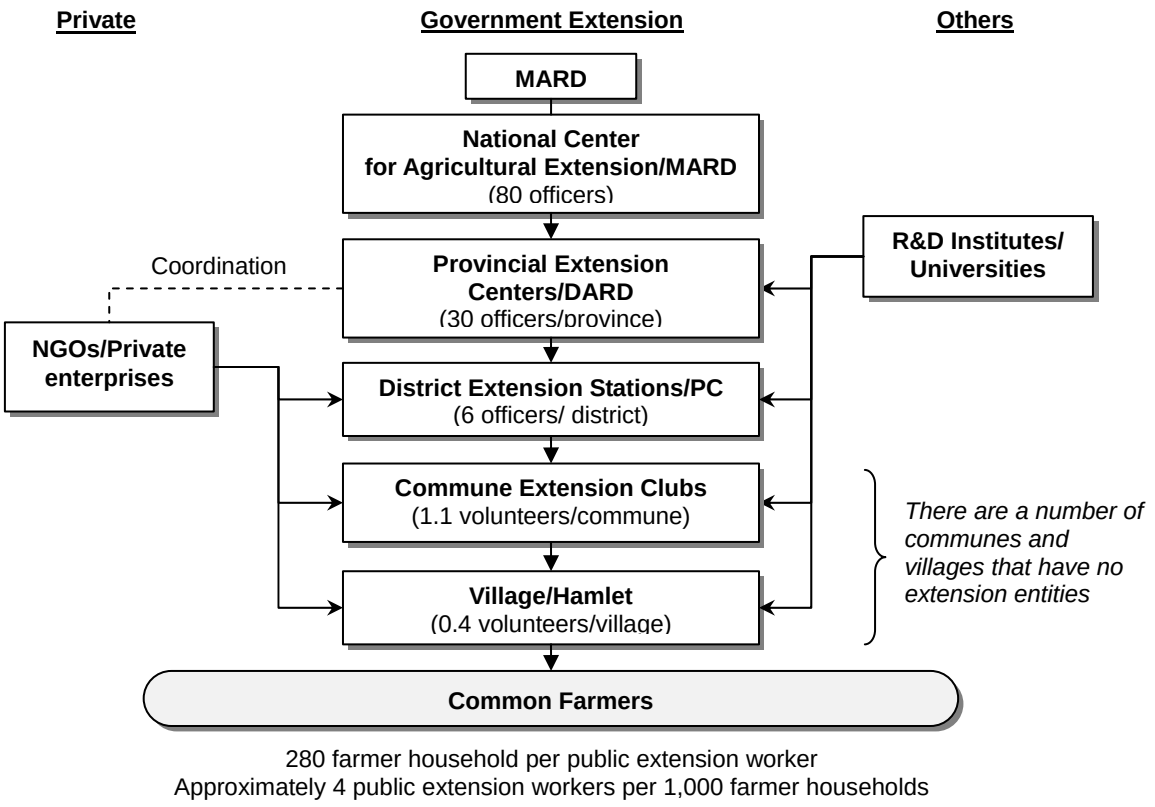

Figure 3.7.1 Agricultural Extension System

Source: "Agricultural Extension Systems of Vietnam, Vietnam Academy of Agricultural Sciences (VAAS) (year not known)
Modified based on interviews to Southern Horticultural Research Institute and Sub-NIAPP (2012)

The role of MARD in the system is to comprehend entire national agricultural extension system. Given necessary budget from MARD, the national extension center takes a leading role on technology aspect, under which several research and development institutes cooperate. In the national center, there are approximately 80 officers. At provincial level, provincial extension centers are attached to DARD in each province, in which on average 30 officers are stationed. In addition to administrative functions, those provincial officers take a role of giving technical assistance to officers at district level.

Officers at district level usually take charge of 3-5 communes, that is, those officers are working as generalists not specialists of specific commodities. The governmental system maintains its offices down to district level, at commune level, district officers sometimes stays at peoples' committees' office to work on demonstration, lectures and other technology dissemination activities on the ground. At commune level, there are sometimes groups of advanced farmers called "club." Those advanced farmers are the key personnel who then transmit any information or technologies to other common farmers in villages.

Aside from the government agricultural extension system, a number of independent institutions carry out extension activities at provincial level or below. Those institutes include research and development institutes of specific subjects, universities, private enterprises and NGOs. For example, Southern Horticultural Research Institute (SOFRI) and Cuulong Rice Research Institute promote new technologies or varieties they developed in coordination with the extension centers at province and/or district level. Furthermore, private enterprises, such as fertilizer companies, do promotion of their products with a technical guidance of their products (i.e. effective use of fertilizer along with cropping calendar or type of soil). When doing promotion activities, such enterprises coordinate with provincial extension centers.

3.7.2 Extension in the Context of Sea Level Rise

To advance effects of saline water prevention for beneficially area with suitable and sustainable agricultural and aquacultural manner, there are four major points to be identified; 1) vulnerable areas where saline intrusion has already become apparent is the first one for adjustment of implementation schedule; 2) improved agricultural and aquacultural systems are the second one to be established for advancing effect of sluice construction, which are suited to each level of environmental features caused by sea level rise and its intervention ; 3) new agricultural and aquacultural systems are put in the agricultural and aquacultural land use plan in accordance with the progress of sea level rise for the third one to enhance further development; 4) the forth is that an entire process of the above is systematized as an improved extension system oriented to sea level rise and its intervention for coping with uncertain change of sea level rise in future.

Details of agriculture extension is described in Part V “Capacity Building on Cropping Pattern Improvement and Adjustment” in this report.

CHAPTER 4 IMPLEMENTATION ARRANGEMENT

This chapter describes necessary implementation arrangement for the project. As is mentioned in Chapter 1.3 Implementation Organizations, a responsible office for the project implementation depends on budget source whether it comes from national budget or foreign budget. This project deals with sluices proposed in Tra Vinh province and Vinh Long province; by which implementation arrangement is discussed hereunder:

4.1 Institutional Arrangement

4.1.1 Implementing Agency

For the project, there are three agencies which can implement for sluice construction under Ministry of Agriculture and Rural Development; one is Central Project Office Unit 10 for Mekong Delta regions (CPO (10)), the second is Permanent Representative Office under Department of Construction Management (PRO), and the third one is Department of Agriculture and Rural Development (DARD) in each Province.

CPO (10) deals with ODA project for large and regional scale. PRO can implement a project with medium and/or regional scale with Vietnamese government budget and also ODA budget. DARD is an implementation organization for a small and/or provincial scale project with Vietnamese government budget and also ODA budget. Implementing agencies for the project are summarized as follows. In fact, however, there is not clear demarcation among the scales of project; then, the minister of agriculture and rural development makes decision on the final section of the implementing agency.

Table 4.1.1 Implementation Agencies for Projects in Mekong Delta with different project scale

Project scale	Vietnamese Government's Budget	ODA Budget
Large and Regional	PRO	CPO (10)
Medium and Regional	PRO	PRO
Small and Provincial	DARD	DARD

4.1.2 Institutional Arrangement for Construction

There are two major procedures for construction works; one is budget disbursement procedure and the other is monitoring procedure. An implementation agency deals with procurement of engineers and contractors for sluice construction such as; tender, contract, construction inspection, budget disbursement. These activities must be reported to PRO, and DCM checks and approves them for the budget disbursement. DCM disburses budget for the project in case of Vietnamese government fund, and budget disbursement of ODA project is done by CPO.

There are some monitoring items for sluice construction in Mekong Delta such as technical aspects and governmental procedures. PRO is responsible to monitor these items to DCM in accordance with relevant laws and regulations of Vietnamese government. During this monitoring, if there is necessity to support and guide to DARD, PRO conducts appropriate and adequate guidance to DARD.

1) CPO (10)

Office of CPO (10) represents CPO for tasks and duties in Mekong Delta region. An office of it is located in Can Tho province and it is one of 10 regional branch offices under CPO. A dominant sector which CPO (10) deals with concerns water resource or drainage such as sluice construction, dike construction, and pump station construction. Since CPO was established for dealing with ODA budget project, CPO (10) represents MARD as a focal point for international donors; therefore, all projects whose budgets come from international donors in Mekong Delta are controlled by CPO (10).

Major tasks of CPO (10) for construction implementation are; to contact and communicate with donors as the representative of MARD in Mekong Delta region, to collaborate with PPCs in order to implement projects, to procure engineers and contractors, to disburse project payment to the contractors according to project progress, to disburse payment according request from PRO and/or DARD with endorsement of DCM, to manage large and regional projects on their own, and to prepare annual and/or semiannual monitoring and management report to MARD.

In year 2012, CPO (10) deals with total 12 ODA projects under their management and total projects' budget in this year is about US$ 24 million. Cost from donor shares about 30% of it, so that estimated disbursement in this year from ODA account is about US$ 7 million. Total staff in CPO (10) is 60 persons. Organization Chart of CPO with CPO (10) is shown in the following figure.

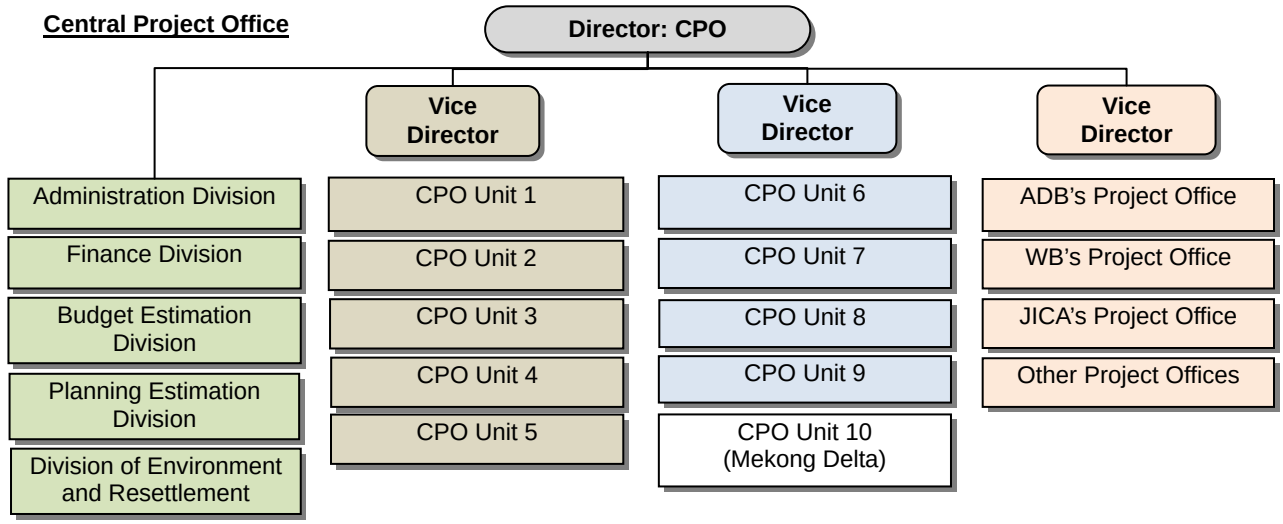

Figure 4.1.1 Organization Chart of Central Project Office with CPO (10)

2) PRO

Permanent Representative Office in Ho Chi Minh (PRO) represents Department of Construction Management and mainly deals with Vietnamese government budget project in Mekong Delta. PRO is basically a monitoring body for the government budget projects; PRO monitors construction implementation procedure whether DARD follows policy, laws, and regulations of the government or not. PRO also takes responsibility for construction implementation and technical assistant projects funded by ODA budget, then, PRO also monitors CPO (10)'s management for construction implementation procedures.

Major tasks of PRO for construction implementation are; to prepare monitoring reports on construction implementation procedures of DARD, to submit the reports to MARD for government approval on budget disbursement, to manage medium and regional scale projects on their own which the source of budget comes from Vietnamese government and/or ODA, to prepare and submit reports on international fund projects to MARD which implementing agencies are DARD, PRO, and CPO (10), to prepare annual evaluation report on the aforementioned projects.

In year 2012, PRO deals with total 25 regional projects with local budget and 3 regional projects with ODA budget; donors of these ODA projects are WB[1], ADB[2], and AFD[3], funded amount by donors are

[1] Mekong Delta Water Resource Management for Rural Development Project, funded by WB, 2011
[2] Phuoc Hoa Water Resource Supplementary Project, funded by ADB
[3] Flood prevention for Lower Saigon River Area

about 160 million US$, 220 million US$, and 110 million US$ respectively. There are total 8 staff in PRO. Organization Chart of DCM with PRO is shown in the following figure.

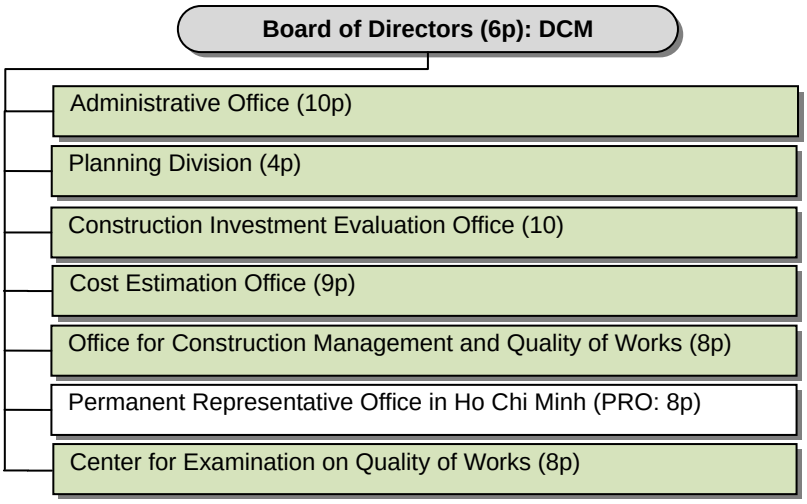

Figure 4.1.2 Organization Chart of Department of Construction Management with PRO

3) DARD

Department of Agriculture and Rural Development (DARD) is a regional branch office of Ministry of Agriculture and Rural Development in a province. DARD is responsible for the project implementation of hydraulic infrastructure construction in each province. Organization structure of DARD differs by province but there are usually several vice directors under the director. Under a vice director, there are usually a water resource department and an investment management department which concerns sluice construction.

The water resource department is a planning section of hydraulic infrastructure and this department assists an investment management department for implementation. The investment management department deals with all related works on hydraulic infrastructure construction implementation such as; land acquisition, resettlement, procurement of contractor and engineers, project management in association with the water resource department.

DARD obtains project budget for construction implementation from PRO and/or CPO (10) subject to obtaining approval from the Provincial Peoples Committee. Project scale which DARD deals with is normally small and/or provincial scale; implementing organization is decided by the Minister of Agriculture and Rural Development. DARD usually deals the local budget project while it can manage not only local budget project but also ODA budget project. A project with local budget is normally small and provincial scale but a project of such ODA project has large and regional scale, so that local budget project is dominant for DARD activities.

Number of staff in DARD is about 300 – 400 peoples; staff number of water resource department is 10 or more, and that of investment management department is about 10. In year 2011, DARD of Tra Vinh province deals with total 230 Billion VND, which is composed of 20% for ODA project, and 80% for Vietnamese government project in the water resource sector. The following figure shows an example of DARD organization chart.

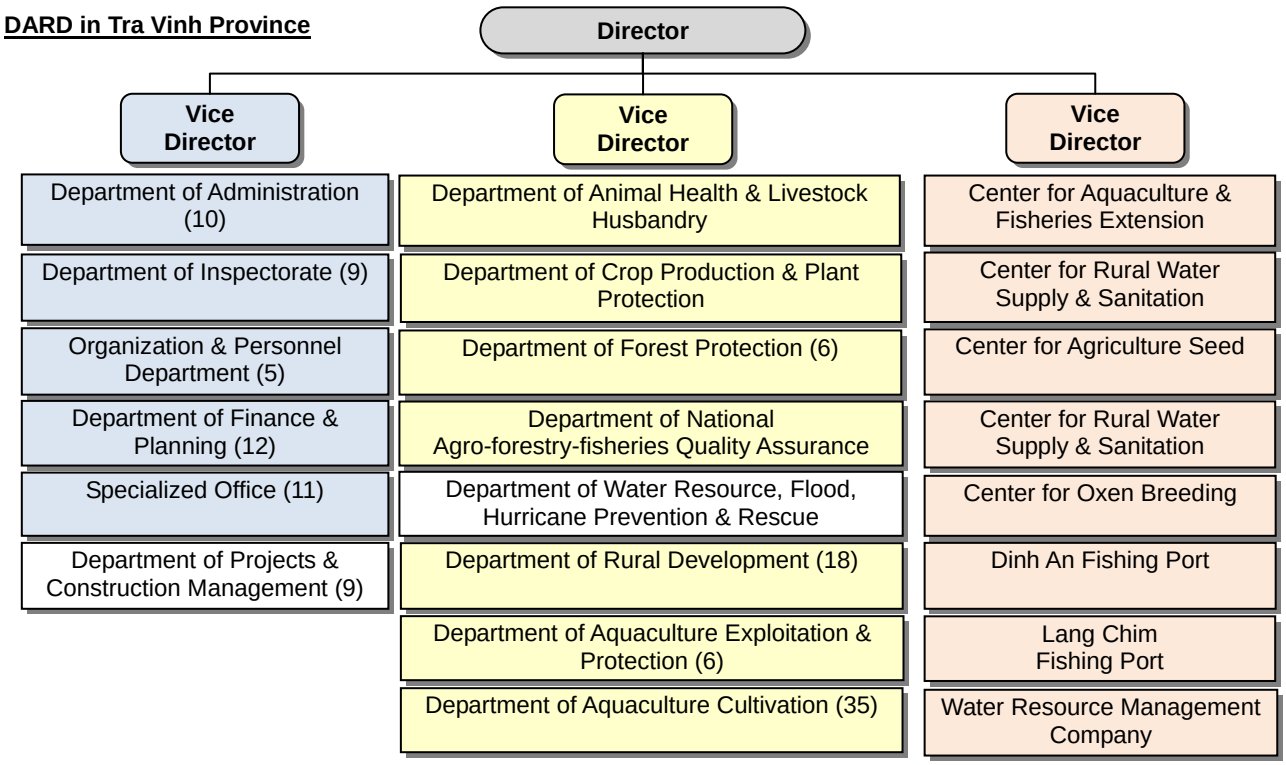

Figure 4.1.3 Organization Chart of DARD in Tra Vinh Province

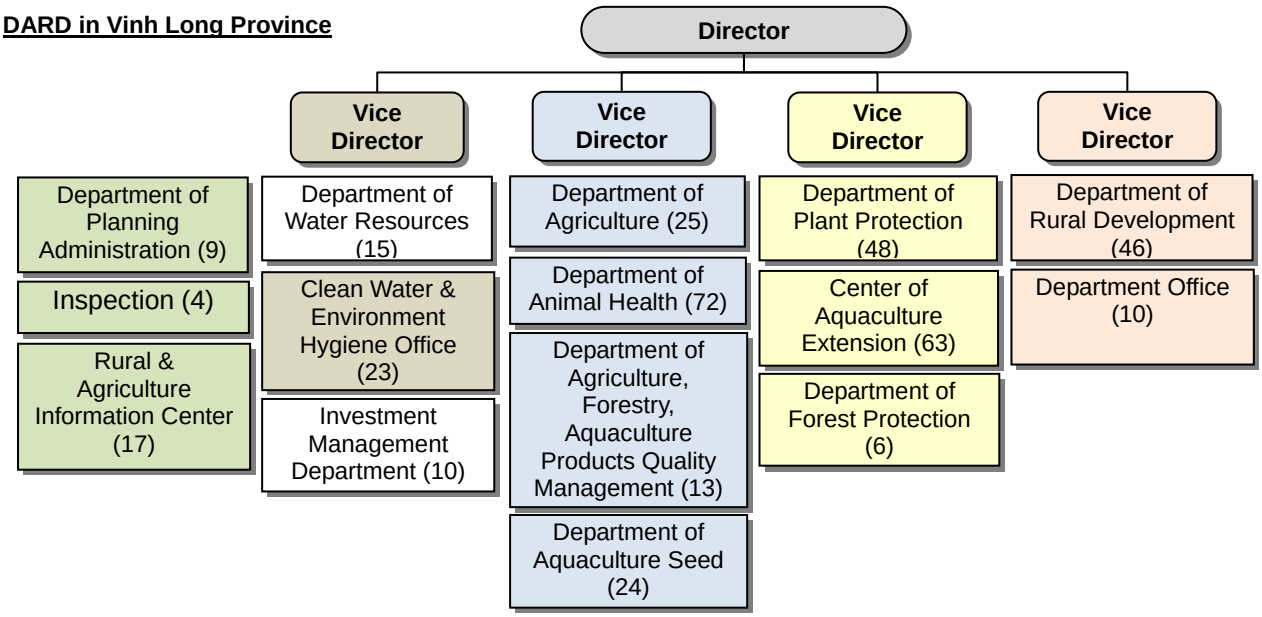

Figure 4.1.4 Organization Chart of DARD in Vinh Long Province

4.1.3 Institutional Arrangement for Operation and Maintenance

After completion of sluice construction, Water Resource Management Company (WRMC) is responsible for operation and maintenance of sluices. WRMC is an autonomous self-financing organization from DARD while it receives some works from DARD or PPC. WRMC in case of Tra Vinh province received budget from the central government (78% in share), provincial peoples committee (19% in share), and donation from people in the province (3%), total about 267 billion VND in 2007. Their tasks are; sluice management and operation including saline content monitoring,

canal dredging, small scale road construction, and small scale bridge construction. Total 39 staff is involved in these works.

4.2 Cost Sharing Arrangement

Total cost of this project is estimated as US$ 35.9 million which is composed of construction cost, compensation cost (for resettlement), and other cost. Since total cost of the project is quite huge, it is considered very difficult for the Vietnamese government to implement whole project on her own. Therefore, ODA assistance should be sought for the part of the construction cost. Construction cost shares about 73% of total cost, compensation cost is only 3%, and other cost is 24%. Other cost is composed of miscellaneous cost and contingency cost.

It is considered that project cost will be changed according to socio-economical situation and environmental condition; procedure of resettlement takes time and it takes more than 10 years in some cases. Therefore the costs including compensation shall be undertaken by Vietnamese government. Negotiation and discussion with peoples for resettlement should be done continuously and steadily, and then, implementation of the project will be commenced smoothly. Recommended cost share is summarized as follows.

Table 4.2.1 Proposed Cost Share for the Sluice Construction Project

Items	Cost (million US$)	Share (%)	Demarcation
Construction	26.06	73%	ODA
Compensation	1.23	3%	Vietnamese Government
Others	8.64	24%	Vietnamese Government
Total	35.93 (26.06: 9.87)	100% (73%: 27%)	-

Note: Others includes physical contingency, project management cost, consultation cost, and other miscellaneous cost.

Table 4.2.2 shows proposed allocation of cost between ODA and Vietnamese government; total cost of ODA for this project is 542.01 billlion VND which is equivalent to 26.1 million US$ while that of Vietnamese government is 205.2 billion VND which is equivalent to 9.87 million US$.

Table 4.2.2 Proposed Cost Share in detail for the Sluice Construction Project

No	Sluice Name	District / city	Schedule	Width (m)	ODA (Bil.VND)	Vietnam (Bil.VND)	Total Cost (Bil.VND)
1	Bong Bot	Cau Ke	2013-2020	60	141.50	54.46	195.96
2	Tan Dinh	Cau Ke	2013-2020	51	171.33	66.12	237.45
3	Vung Liem	Vung Liem	2013-2020	60	229.18	84.60	313.78
Total					542.01	205.18	747.19

4.3 Implementation Schedule in line with the Magnitude of Saline Intrusion

mplementation schedule of proposed sluice construction project is formulated based upon a series of saline water intrusion simulation and site survey. The simulations have indicated that saline intrusion will further increase an affected area coupled with going-up of saline intrusion front line along Mekong River; saline contents in such areas will become more and serious. The site survey has identified tangible saline intrusion phenomenon near the places for proposed sluices in this project. Based on the conditions and present situations aforementioned, priority is given to the suice at downstream as follows.

Table 4.3.1 Implementation Schedule of 3 Sluices and Say Don Canal

Sluice/Canal	Implementation	Remarks
Bong Bot	3 years	At most downstream location, the project is commenced in first; 2 years for construction
Tan Dinh	3 years	Construction is started after completion of Bong Bot construction; 2 years for construction
Vung Liem	3 years	Construction is started after completion of Tan Ding construction; 2 years for construction
Say Dong	7 years	Construction is started after completion of Vung Liem construction; 2 years for construction

CHAPTER 5 PROJECT COST

This chapter describes project cost for the proposed sluice construction project. Cost for the proposed sluices and waterway is made in this study as follows.

5.1 Standard Program Cost

Cost for construction is calculated in accordance with design of each sluice and canal; unit cost in 2012 is applied to this calculation; the estimated cost is summarized in the following table.

Table 5.1.1 Standard Project Cost for Proposed Major Sluices (Unit: Billion VND)

Items	BongBot	TanDinh	VungLiem	Canals
Construction	141.5	171.33	229.18	135.19
Compensation, Resettlement	7.41	9.19	8.95	198.01
Project management	1.99	2.36	3.05	1.77
Consultant (Engineering)	11.32	13.71	18.33	6.76
Other Cost	0.41	0.48	0.62	11.03
Tax	15.52	18.79	25.12	15.3
Physical contingency	17.81	21.59	28.53	36.81
Total	195.96	237.45	313.78	404.87

Source: DARD of Tra Vinh Province, SIWRP, and Project Team

Construction cost is calculated according to sluice construction cost implemented in recent years. Compensation and/or resettlement cost is based on information obtained from DARD of Tra Vinh and Vinh Long provinces. One % of construction cost is applied for project management; consultancy services' cost is set at 8% of construction cost, and physical contingency is applied to all items of listed costs.

5.2 Disbursement Schedule by Size of the Sluice Gate

Width of sluices is 60m for Bong Bot, 51m for Tan Dinh, 60m for Vung Liem. Estimated construction period is about two years; in advance of construction, design and land acquisition are necessary and it will be one year or more. Based on these viewpoints, disburse schedule is summarized as follows.

Table 5.2.1 Disbursement Schedule for Sluice and Waterway Construction

Project	Items for Construction Implementation	Implementation Year								
		1	2	3	4	5	6	7	8	9
Bong Bot	Construction									
	Compensation, Resettlement									
	Project management									
	Consultation (Engineering)									
	Other Cost									
	Physical contingency									
Tan Dinh	Construction									
	Compensation, Resettlement									
	Project management									
	Consultation (Engineering)									
	Other Cost									
	Physical contingency									
Vung Liem	Construction									
	Compensation, Resettlement									
	Project management									
	Consultation (Engineering)									
	Other Cost									
	Physical contingency									
Waterway (Say Don)	Construction									
	Compensation, Resettlement									
	Project management									
	Consultation (Engineering)									
	Other Cost									
	Physical contingency									

CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATION

Saline intrusion resulting from the climate change in the Mekong Delta is regarded as a critical threat, especially, in Tra Vinh Province, whereby it is an urgent matter to cope with the issue. Therefore, construction of three saline intrusion prevention sluice gates, namely, Vung Liem Sluice, Bong Bot Sluice and Tan Dinh Sluice is proposed. On the other hand, there is a possibility that the construction can cause some negative environmental impacts on surrounding environment. This chapter discusses expected impacts taking consideration into current natural and social conditions in the area and how to mitigate anticipated negative impacts.

6.1 Project Components which Cause Environmental Impacts

Construction of three sluice gates, namely, Vung Liem, Bong Bot and Tan Dinh to prevent saline intrusion is proposed in the project. Proposed structures and those scales are as shown below:

Table 6.1.1 Structures of Proposed Constructions

Sluice gate	Scale	Location	Notes
Vung Liem	4 sluice gates with 15m width and 8.5m height (in total 60m width)	In Vung Liem river, 2.5km away from connection point between Co Chien River and Vung Liem River	Open culvert, on-off valve gate
Bong Bot	2 sluice gates with 20m width and 8.0m height (in total 40m width)	In Bong Bot River and 500m away from connection point between Bong Bot River and Hau River	Open culvert, lift gate, 2 sheets
Tan Dinh	3 sluice gates with 17m width and 8.0m height (in total 51m width)	In Tan Dinh River and 400m away from connection point with Hau River	Open culvert, lift gate, 2 sheets

Source: JICA Project Team

The proposed three sluice gates are located on around provincial boundary between Vinh Long Province and Tra Vinh Province. The site of Vung Liem sluice gate is on Vung Liem River and it is located between Trung Thanh Dong Commune and Trung Thanh Tay Commune, Tra Vinh Province. Concerning Bong Bot Sluice, it is on Bong Bot River and falls totally in An Phu Tan Commune, Cau Ke District. Proposed construction site of Tan Dinh Sluice is on Tan Dinh River, it is also boundary between Vinh Long Province and Tra Vinh Province. Due to the constructions, resettlement and land recovery are needed. The planned construction sites are as follows:

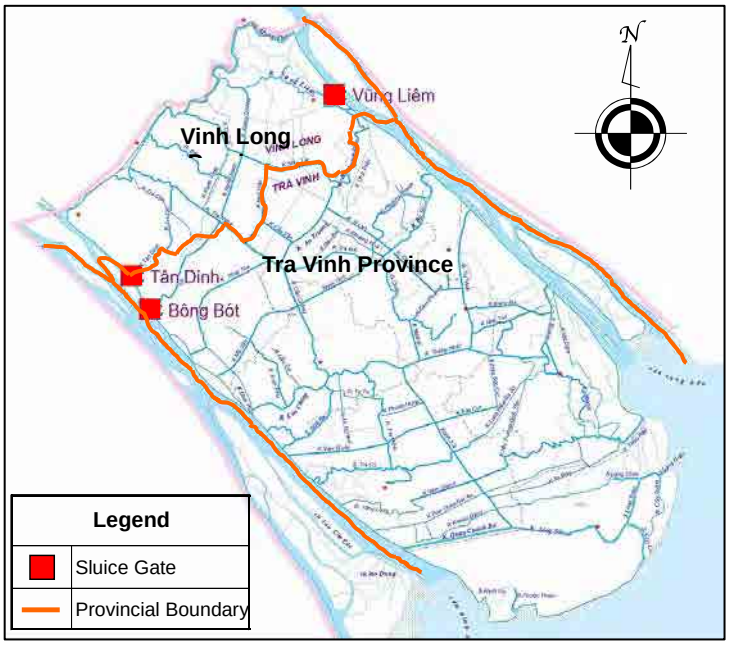

Figure 6.1.1 Location Map of Proposed Sluice Gates in Tra Vinh Province

6.2 Legislative and Institutional Framework of Environmental Consideration in Vietnam

In Vietnam, based on the Environment Protection Law enforced in January 1994, the government ordinance for the law practice (Government Decree No.175/CP) was enacted on October in the same year. Furthermore, many regulations regarding the penalty to violation, an environmental impact assessment, etc. were enacted. After 2008, QCVN which have a role of regulation accompanied by a penalty.and become a new standard was applied instead of TCVN. Some parts of TCVN were replaced for QCVN, and TCVN itself became invalid. The environmental standards of Vietnam have cleared the international level as a standard, and even if they compare with environmental standards of Japan, they are in an appropriate level (see Appendix VIII Chapter 1 for detail).

Current Environment Protection Law stipulates projects which need EIA and SEA, however, it does not mention neccecity of pubication of scoping and exmination of alternatives of proposed projects, while they are stiplulated in the JICA Environemtnal and Social Consideration Guideline. Following table illustlates differences between the JICA Guideline and Vietnamese law.

Table 6.2.1 Gap between JICA Guideline and Vietnamese Legal Frame

JICA Guideline	Vietnamese regulation	Remarks
▪ Alternatives of project shall be included in EIA report (JICA Guideline)	▪ No mention about examination of alternatives in EIA report contents preparation	
▪ After the disclosure of the scoping drafts, project proponents etc. conduct consultations with local stakeholders*. JICA incorporates the results of such consultations into its TOR. The consultations cover the needs of projects and the analysis of alternatives. (JICA Guideline)	▪ no mention	▪ There are description about consultation, however, the agenda does not cover scoping nor alternatives (Decree No.29-2011, Article 15).
▪ The socio-economic studies should be implemented in the early stages of project preparation and with the involvement of potentially displaced people (WB OP4.12, Para 6)	▪ no mention	
▪ Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets--provided that such claims are recognized under the laws of the country or become recognized through a	▪ Those who have a certificate of land use right or satisfying all of the conditions for issuance of a certificate of land use right are qualified as targets of compensation by the State	

JICA Guideline	Vietnamese regulation	Remarks
process identified in the resettlement plan are eligible for benefit (WB OP4.12, Para 15)		
▪ Compensation based on the full replacement cost must be provided as much as possible (JICA Guideline).	▪ The land prices stipulated by people's committees of provinces and cities under central authority shall be used as the basis for calculating compensation when the State recovers land. They must be close to actual market prices for assignment of land use right in normal conditions and, when there is a big difference compared with actual market prices, they must be adjusted for conformity. (Law on Land Article 56)	▪ Since compensation is based on the land price specified by Provincial People's Committee, there are some cases that there are differences between actual land price and compensated ones, they are not significant ones, though (interview result by the JICA Team, 2012).
▪ In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA Guideline) ▪ Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood (JICA Guideline)	▪ Agencies (organizations) that are assigned by the provincial-level People's Committees to arrange resettlement must inform every household that has land recovered and must be relocated of the tentative resettlement arrangement plans and publicly post up these plans at their headquarters, at the offices of the commune-level People's Committees of the localities where exists the recovered land and in the resettlement areas 20 days before such resettlement plans are approved by competent State bodies (Decree 197-2004, Article 34)	▪ Draft resettlement arrangement plan is informed to the affected people, however, people's participation in planning is limited.

6.3 Current Environmental and Social Conditions

Tra Vinh province is located at the most downstream part of the sandwiched area by two big Mekong tributaries of Co Chien River and Hau River. Farmland area accounts for around 60% of total land of the province. Main crop is paddy, and double and triple paddy cropping is dominant. Vinh Long Province is located at just upstream of Tra Vinh Province and also wedged between Co Chien River and Hau River. As well as in Tra Vinh Province, triple paddy production is dominant.

Annual rainfall in both provinces is in a range of 1,400-1,600 mm in general. Tra Vinh Province has been affected by sea water intrusion in these days and it is said that more than 70% of harvest was lost in about 8,000 ha of winter-spring paddy and about 30-70% loss in the areas of about 3,000ha (the total paddy area in Tra Vinh Province arrived at 92,000 ha in 2010, GSO) in 2011. It is rural area in and around the proposed construction sites where paddy production and coconut tree plantation are operated, and private and official structures are scattered.

The construction sites of sluice gates are located on rural area and paddy and orchard are dominant. Major income source in the area are farming and labor work. There is no cultural/historical monument and natural conservation area around the sites.

6.4 Examination of Alternatives

Taking consideration into geographic conditions, convenience/easiness of construction, necessity of resettlement, local people's request, budgetary issue and so on, proper location of each sluice gate is examined. For the three sluice gates, two options, namely, 1) construction on the shore and 2) construction across the river, are examined. In general, construction in water way is more difficult than that on the shore in terms of technical aspect, while adverse environmental impacts e.g. resettlement and land recovery or damage to transportation is smaller.

Based on the examination, construction on the shore is recommended for Vung Liem and Bong Bot sluice gates as shown in the following tables. Concerning Tan Dinh Sluice, there is no suitable point for construction on the shore, whereby no alternative of construction site is proposed. Therefore, only

comparison between option zero and option one is presented. Location maps of the options are also illustrated below:

Table 6.4.1 Examination of Proposed Construction Sites (1) Vung Liem Sluice

Environmental items	Option 0 (no project)	Option 1 Sluice construction on the shore	Option 2 Sluice construction in water
Construction site	-	2,500m away from connection point of Bung Liem River and Co Chien River	800m away from connection point of Bung Liem River and Co Chien River
Resettlement and land acquisition (land recovery)	-	XX	X
Transportation	-	XX	-
Protection of farmland from high tide	XX	+++	+++
Possibility to be regrettable project	None	None	None
Project cost	Zero	High	Medium
Selection	-	-	○

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact
+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

Table 6.4.2 Examination of Proposed Construction Sites (2) Bong Bot Sluice

Environmental items	Option 0 (no project)	Option 1 Sluice construction on the shore	Option 2 Sluice construction in water
Construction site	-	On the right bank of Bong Bot River and 400m away from the connection point of Bong Bot River and Hau River	In Bong Bot River 400m away from connection point of Bong Bot River and Hau River
Resettlement and land acquisition (land recovery)	-	XX	X
Transportation	-	XX	-
Protection of farmland from high tide	XX	+++	+++
Possibility to be regrettable project	None	None	None
Project cost	Zero	High	Medium
Selection	-	-	○

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact
+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

Table 6.4.3 Examination of Proposed Construction Sites (3) Tan Dinh Sluice

Environmental items	Option 0 (no project)	Option 1 Sluice construction on the shore
Construction site	-	In Tan Dinh River, 300m away from connection point of Tan Dinh River and Hau River
Resettlement and land acquisition (land recovery)	-	X
Transportation	-	-
Protection of farmland from high tide	XX	+++
Possibility to be regrettable project	None	None
Project cost	Zero	Medium
Selection	-	○

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact
+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

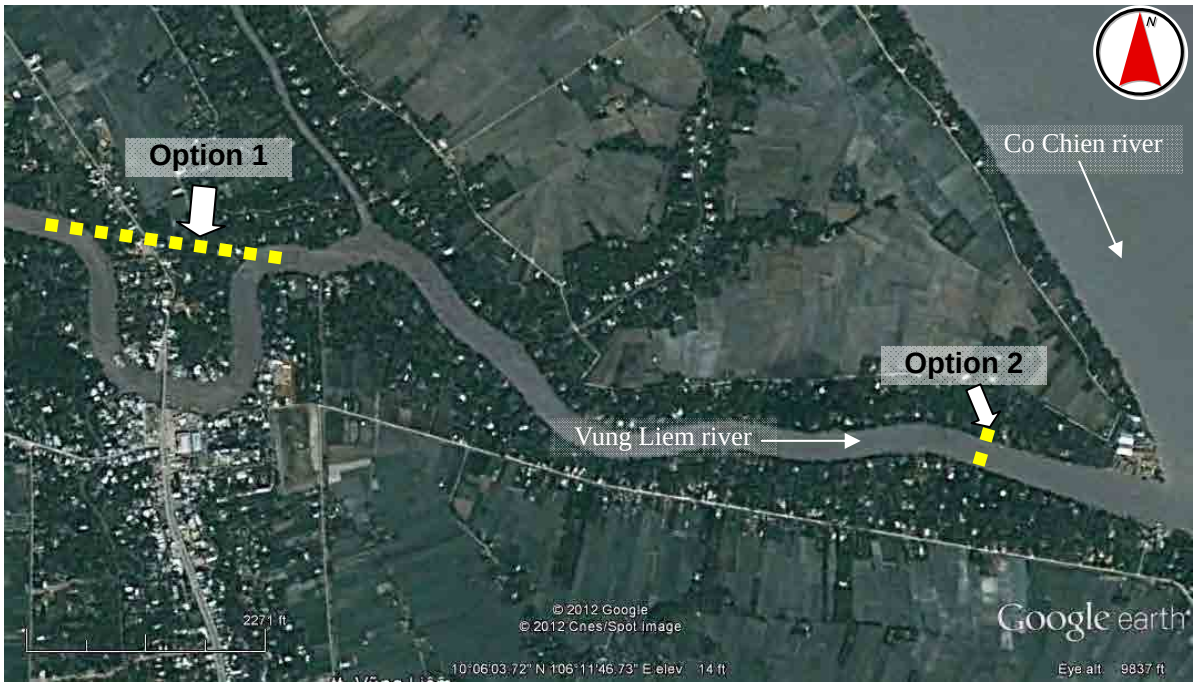

Figure 6.4.1 Location Map of Options of Vung Liem Sluice Construction Site

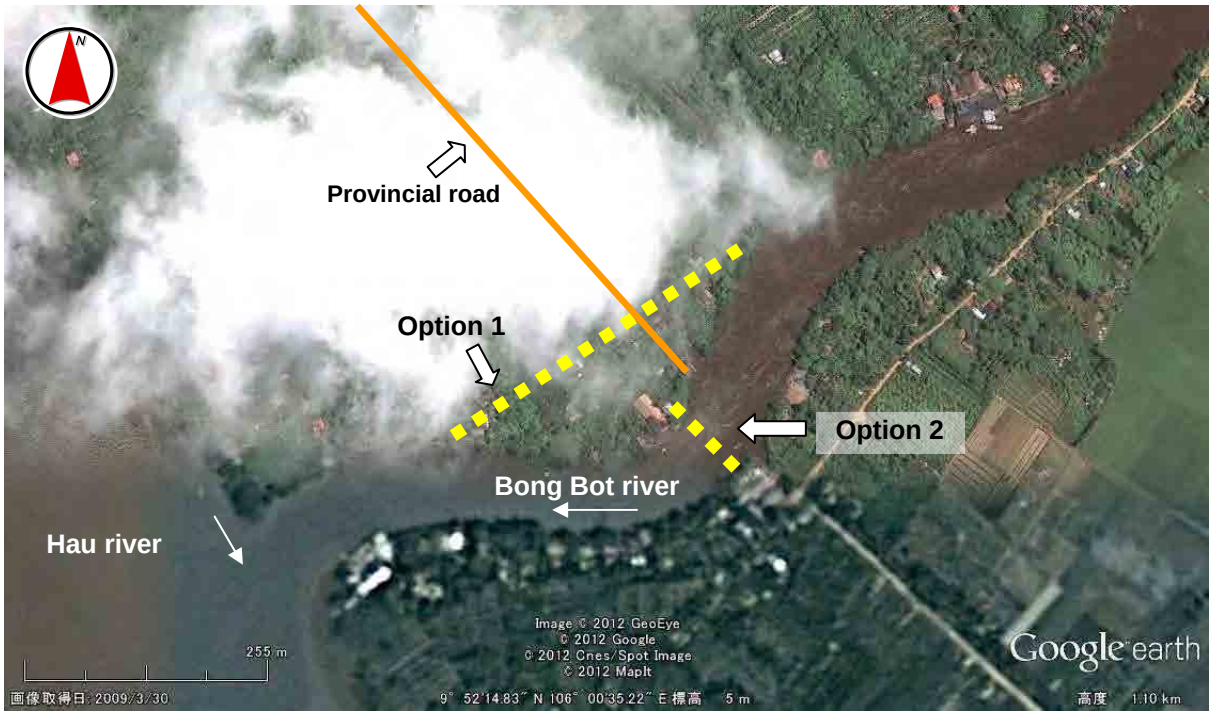

Figure 6.4.2 Location Map of Options for Bong Bot Sluice Construction Site

Figure 6.4.3 Location Map of Tan Dinh Sluice Construction Site

6.5 Scoping and Initial Environmental Examination

6.5.1 Scoping

Prior to IEE, examination of degree of environmental impacts by those constructions, so called as "Scoping" is done, and some environmental parameters, on which negative impacts are likely to be caused, are to be identified. For those parameters, terms of reference (TOR) to identify study method of IEE are prepared. Scoping of environmental impacts and TOR are presented as follows:

Table 6.5.1 Scoping

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operational phase	
1. Air Pollution	B^-	D	Due to the construction works, air quality deterioration such as dust generation and gas emission from construction vehicles is expected, however it will be temporally. After the completion of works, no air pollution is anticipated.
2. Water Pollution	B^-	D	Drainage from construction sites, heavy industrial machines, vehicles and so on is expected. However, the period water is polluted is limited.
3. Waste	B^-	D	Construction waste will be dumped during construction phase.
4. Soil Contamination/ salinization	B^-	D	Oil leakage from construction vehicles can be caused, however, its scale is limited to construction phase.
5. Noise and Vibration	B^-	D	Noise due to construction works and transportation of construction vehicles is anticipated. However, it is tentative.
6. Ground Subsidence	D	D	Ground subsidence is not expected both during and after works.
7. Offensive Odor	D	D	Offensive odor is not expected both during and after works.
8. Bottom sediment	D	D	Bottom sediment is not expected both during and after works.
9. Protected area/endangered species	D	B^-	If there is rare species around the sites, it can be affected.
10. Ground water	D	D	The works does not give any impacts on ground water.
11. Hydrological Situation	D	B+	Due to construction works to prevent from saline water intrusion, hydrological situations will be changed, however, it will be positive. In addition, the project will not prevent flow of main Mekong subsidiaries.
12. Topography and Geographical features	D	D	No topographical and geographical impacts by the works will be caused.
13. Involuntary Resettlement	B^-	D	Some households are requested to resettle for the works.
14. Land Acquisition	B^-	D	Some lands are recovered for construction works.
15. Cultural heritage	D	D	There is no cultural heritage in and around sites.
16. Landscape	D	D	No adverse effect on landscape is anticipated.
17. The indigenous and ethnic people	D	D	There is no ethnic minority in and around construction sites.
18. Livelihood	D	B^+/B^-	Since some households are requested to resettle have to restart their livelihood in new area, others will not be affected negatively. On the other hand, due to increase of fresh irrigation water, the project will be beneficial fro the livelihood.
19. Local economy	D	B^+/B^-	Resettlement and land recovery can cause negative impact, on the other hand, prevention of saline water intrusion will give positive impacts on local economy in general.
20. Existing social infrastructures and services	B^-	B^-	During construction works, traffic jam can be caused by the increase of traffic volume. Shipping will be disturbed in and after construction.

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operational phase	
21. Misdistribution of benefit and damage	D	D	Except those who to be resettled, the people can enjoy decrease of damage by saline water intrusion.
22. Social institutions	D	B^-	Since the number of resettlement is not very big, negative impact on social institution will be negligible.
23. Water Usage or Water Rights and Rights of Common	D	B^+	Due to the prevention of saline water intrusion, the local people can access to fresh water more than present.
24. Gender	D	D	No negative impact in terms of gender is expected.
25. Children rights	D	D	Damage to children rights is not anticipated.
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	D	D	No hazard or infectious disease is expected both during and after works.
27. Accidents	B^-	D	During construction, there is a possibility that number of accident will be increased due to increase of traffic increase for construction works.
28. Global Warming	D	D	No global warming by the works is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 6.5.2 Terms of Reference

Environmental Parameters	Study Contents	Study Method
Air Pollution	• General situations in the adjacent area of construction sites	• Confirmation of construction period, construction site
Water Pollution	• Information collection of other similar cases	• Examination of drainage from construction sites
Waste	• Waste disposal method	• Data collection in other similar projects
Soil Contamination/ salinization	• Oil leakage from construction vehicles	• Confirmation of situations in other similar projects
Noise and Vibration	• General situations in the adjacent area of construction sites	• Confirmation of location of hospital, school, residential areas and so on
Endangered species	• Existence of rare species	• Data collection of rare species in the area
Involuntary Resettlement	• Number of households to be relocated • Extent of affected area	• Interview to local people • Confirmation of general conditions in and around the construction sites • Cost estimation for resettlement
Land Recovery	• Area to be recovered	• Confirmation of land recovery area • Cost estimation of compensation for land recovery
Existing social infrastructures and services	• Traffic jam due to the project • Impacts on shipment	• Confirmation of shipment • Confirmation of situations in other similar projects
Accidents	• Possibility of accident	• Confirmation of situations in other similar plans

Source: JICA Project Team

6.5.2 Results of Initial Environmental Examination

Following the TOR mentioned above, IEE based on the existing data and households survey to all the

affected households were organized. The sites are located on rural area, there is no school or hospital near the sites, while 35 households have to be relocated and 8.3 ha of land will be recovered. Transportation by water during construction phase will be affected to some extent. However, it is possible to mitigate the impact by application of modified construction method, which closes water way half-and-half for the construction. In operation phase, if the sluices are equipped with navigation lock gate, the adverse effect on shipping will not be significant. There is no habitat of rare flora and fauna such as protected area in and around the sites. The results based on the IEE are as follow:

- Air pollution: Considering construction period is relatively limited and population density around the construction sites is relative low, significant negative impact is not expected. Any large scale air pollution by other similar project haves not been reported
- Noise/Vibration: Locations of hospital or schools have yet to be identified, however, the area around construction sites are located on rural area and it is common that such structures are not constructed along the water canal. Therefore, the scale of impact on surrounding environment is limited.
- Water pollution: It is stipulated that waste water from the construction sites shall be treated before drainage into the surrounding environment based on the national regulations/standards in Vietnam, therefore, water pollution can be negligible. Any big impacts on water around construction sites by other similar project have not been reported
- Soil contamination: Oil leakage from construction vehicles, however, it will be negligible.
- Waste: Garbage from construction lodging houses and construction works will be produced, the impact will be avoidable, as far as waste is disposed properly. Excavated soil can be reused for embankment. As a whole, severe impact will not be expected.
- Accident: Construction site will be surrounded by the fence not to allow the residents and accident by the construction works will not give damage to the people. Still, there is a possibility that traffic accident can be caused due to increase of transportation.
- Transportation by water: Half-and-half construction method in the water canals is to be applied to minimize impacts on shipment. If the sluices are equipped with lock gate, shipment will not be affected after the construction works very much.
- Impacts on eco-system: There is no natural reserve to be protected around the construction sites. There are some migratory fish between sea and Mekong River and it is though that Hau River is one of path for the migratory fish. However, considering that the fish are rarely observed in the Mekong Delta and proposed sluice gates will constructed in the water canal instead of subsidiary of Mekong River, the possibility that the project give damage to the fish. It is needed to collect data of eco-system continuously.
- Resettlement: It is expected that resettlement of 35 household (39 houses) and 8.3ha of land recovery are needed due to the construction works.
- Impact on livelihood: Major income of the affected persons is farming. Their livelihood can be changed by the resettlement and land recovery. On the other hand, improvement of agricultural productivity due to prevention from high tide is expected.

- Impacts on local economy: As mentioned before, change to livelihood is expected and some impacts on the local economy can be caused. On the other hand, due to prevention from high tide, local agriculture can be improved and activated.

- Impacts on social institutions: In general, Vietnamese people like to stay their familiar areas continuously instead of going to strange area, even though they have to relocate for the project. They prefer compensation by cash to new land provision by the government and they like to purchase other lands within their familiar areas. Therefore, the possibility that existing social institutions will be disrupted significantly even if there would be some change to the institutions is low.

6.5.3 Evaluation

Based on the results mentioned above, evaluation regarding environmental impacts is shown. After the study, evaluation of No.9, namely, "protected area/endangered species" was changed.

Table 6.5.3 Environmental Evaluation

Environmental parameters	Evaluation at Scoping		Evaluation based on IEE		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
1. Air Pollution	B-	D	B-	D	Due to the construction works, air quality deterioration such as dust generation and gas emission from construction vehicles is expected, however it will be temporally. After the completion of works, no air pollution is anticipated.
2. Water Pollution	B-	D	B-	D	Drainage from construction sites, heavy industrial machines, vehicles and so on is expected. However, the period of water pollution is limited to construction phase.
3. Waste	B-	D	B-	D	Construction waste will be dumped during construction phase.
4. Soil Contamination/ salinization	B-	D	B-	D	Oil leakage from construction vehicles can be caused, however, its scale is small and limited to construction phase.
5. Noise and Vibration	B-	D	B-	D	Noise due to construction works and transportation of construction vehicles is anticipated. However, it is temporary during only construction.
6. Ground Subsidence	D	D	N/A	N/A	No negative impact is expected.
7. Offensive Odor	D	D	N/A	N/A	No negative impact is expected.
8. Bottom sediment	D	D	N/A	N/A	No negative impact is expected.
9. Protected area/endangered species	D	B-	D	C-	There is a possibility that migratory fish can be affected, but the scale will not be significant, since they are rarely observed in the Mekong Delta.
10. Ground water	D	D	N/A	N/A	No negative impact is expected.
11. Hydrological	D	B+	N/A	N/A	No negative impact is expected.

Environmental parameters	Evaluation at Scoping		Evaluation based on IEE		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
Situation					
12. Topography and Geographical features	D	D	N/A	N/A	No negative impact is expected.
13. Involuntary Resettlement	A^-	D	A^-	D	35 households are requested to resettle for the works.
14. Land Acquisition	B^-	D	B^-	D	8.3 ha land is recovered for construction works.
15. Cultural heritage	D	D	N/A	N/A	No negative impact is expected.
16. Landscape	D	D	N/A	N/A	No negative impact is expected.
17. The indigenous and ethnic people	D	D	N/A	N/A	No negative impact is expected.
18. Livelihood	D	$B+/B^-$	D	$B+/B^-$	While some households are requested to resettle have to restart their livelihood in new area, others will not be affected negatively and can enjoy increase of available fresh water.
19. Local economy	D	$B+/B^-$	D	$B+/B^-$	Change of livelihood can cause negative impacts on local economy while prevention of saline water intrusion will give positive impacts on local economy.
20. Existing social infrastructures and services	B^-	B^-	B^-	B^-	During construction works, traffic jam can be caused by the increase of traffic volume and transportation by water can be affected. Half-and-half construction method is to be applied to minimize impacts on shipment. If the sluices are equipped with lock gate, shipment will not be affected after the construction works.
21. Misdistribution of benefit and damage	D	D	N/A	N/A	No negative impact is expected.
22. Social institutions	B^-	B^-	B^-	B^-	Since the number of resettlement is not very big, negative impact on social institution will be negligible.
23. Water Usage or Water Rights and Rights of Common	B+	B+	N/A	N/A	No negative impact is expected.
24. Gender	D	D	N/A	N/A	No negative impact is expected.
25. Children rights	D	D	N/A	N/A	No negative impact is expected.
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	D	D	N/A	N/A	No negative impact is expected.
27. Accidents	B^-	D	B^-	D	During construction, there is a possibility that number of accident will be increased due to increase of traffic increase for construction works.
28. Global Warming	D	D	N/A	N/A	No negative impact is expected.

Source: JICA Project Team

6.6 Mitigation Measure

Some adverse effects by the project are anticipated, and in general they are limited to construction phase only, the damages are tentative and recoverable, e.g. air pollution, water pollution and noise. Those mitigation measures are to be covered by construction companies. It is possible to minimize such impacts by some mitigation measures as shown in the following table. DARD and DONRE are to monitor whether those mitigation measures are taken as planned. For operation phase, internal and external monitoring will be implemented to check the resettled households and their living conditions, and the monitoring cost is included in the management cost for resettlement.

Table 6.6.1 Mitigation Measures

Environmental Parameters	Proposed Environment Management Plan		Implementing organization	Monitoring /responsible organization
	Construction phase	Operation phase		
Air Pollution	• Setting of temporary enclosure • Utilization of construction machines equipped with reduction of gas emission reduction system • Regular check and full maintenance of construction vehicles • Water spray in and around entrances of construction sites	-	Construction contractor	DARD and DONRE
Water Pollution	• Waste water treatment before discharge into rivers	-	Construction contractor	DARD and DONRE
Waste	• Classification waste dumping, recycle, reduction of waste • Entrustment of Proper disposal of waste which can not be reused to dismantling operator	-	Construction contractor	DARD and DONRE
Soil Contamination/ salinization	• Proper management of construction vehicles	-	Construction contractor	DARD and DONRE
Noise and Vibration	• Setting of temporary enclosure • Utilization of construction machines with less noise and vibration • Not to work during nighttime and to use detour in the residential area	-	Construction contractor	DARD and DONRE
Existing social infrastructures and services	• Half-and-half construction method is to be applied to minimize impacts on shipment for construction phase. • To set lock gate for no disturb of shipment after construction works • To ensure enough width of road and to prepare turnout according to necessity • Decentralization of construction vehicles by disperse traveling route	-	Construction contractor	DARD and DONRE
Involuntary Resettlement	• To keep residential area from construction roads and material storage sites	Monitoring	DARD and Board for Compensation, Support and Resettlement	PMU
Land Recovery	• Ditto	Monitoring	DARD and Board for Compensation, Support and Resettlement	PMU
Protected area/endangered species	• To ensure enough distance from the construction sites to the protected area	Monitoring	Construction contractor	Natural Resources Conservation Department* and DARD
Safety	• Working environment	-	Construction contractor	DARD and DONRE
Accidents	• Proper management of construction vehicle operation to minimize centralization • Instruction on compliance with prescribed routes, speed, to drivers of construction vehicles	-	Construction contractor	DARD and DONRE

Source: JICA Project Team

6.7 Monitoring Plan

Anticipated environmental impacts are limited to construction phase, and related monitoring will be implemented during the period. Since the environmental parameters which can be affected by the construction works are air pollution, water pollution, waste and noise, those items shall be monitored. Although there is no standard of water quality of effluent from sites of construction for water resource in Vietnam, according to MONRE, it is possible to apply QCVN 08/2008 National Technical Regulation on Surface Water Quality, Class 2B[1] for water quality monitoring. Regarding monitoring of resettlement, details are discussed in next sub-chapter. The proposed monitoring plan is shown below:

Table 6.7.1 Recommended Monitoring Plan (Construction Phase)

Environmental Parameter	Monitoring Item	Survey point	Standard	Frequency	Responsible Organization
Air pollution	NOx SOx Ozone CO TSP	Construction site	200μg/m^3/hour 350μg/m^3/hour 180μg/m^3/hour 30,000μg/m^3/hour 300μg/m^3/hour	Once per month	DARD and DONRE
Water pollution	pH TSS Total oil and grease	Drainage outlet	6.5-8.5 <100mg/l <0.3mg/l (QCVN-38/2011)	Once per month	DARD and DONRE
Noise and vibration	Noise (dB)		70 dB	Once per month	DARD and DONRE
Waste	Volume of waste		-	Once per month	DARD and DONRE
Safety	Working environment	-	-	Once per month	DARD and DONRE

Source: JICA Project Team

Monitoring formats for construction period and operation period, respectively, are to be prepared. Comments obtained from the people through the monitoring and response by the government also are needed to be recorded. Monitoring method of resettlement and land recovery is shown in next sub-chapter.

Table 6.7.2 Draft Monitoring Form (Construction Period)

(1)Response and actions by the government

Comments and response	Monitoring results
Number and contents of comments from the people	
Number and response to the comments from the people	

(2) Pollution

Environmental Parameter	Monitoring Item	Measured value (min)	Measured value (max)	Standard	Survey point	Frequency
Air pollution	NOx SOx Ozone CO TSP			200μg/m^3/hour 350μg/m^3/hour 180μg/m^3/hour 30,000μg/m^3/hour 300μg/m^3/hour		Once per month
Water pollution	pH TSS Total oil and grease			6.5-8.5 <100mg/l <0.3mg/l (QCVN-38/2011)		Once per month
Noise and vibration	Noise (dB)			70 dB		Once per month

[1] Class 2B: water quality limitation for traffic by water and other purposes with requirements of low water quality

(3) Natural Environment

Environmental Parameter	Monitoring results	Measures taken
Waste		
Soil contamination		
Protected area		

(4)Social Environment

Environmental Parameter	Monitoring results	Measures taken
Existing social infrastructures and services		
Accident	Incidence per 1000 residents	

Table 6.7.3 Draft Monitoring Form (Operation Period)

(1)Response and actions by the government

Comments and response	Monitoring results	Measures taken	Frequency
Number and contents of comments from the people			
Number and response to the comments from the people			

(2) Natural Environment

Environmental Parameter	Monitoring results	Measures taken	Frequency
Endangered fish			

6.8 Resettlement

6.8.1 Necessity of Resettlement

At the stage of alternative examination, minimization of land recovery and resettlement were made taking consideration into the physical conditions, budget and people's opinions. Still, however, proposed three sluice gate constructions will have to accompany involuntary resettlement and land recovery. The affected areas are illustrated as follows:

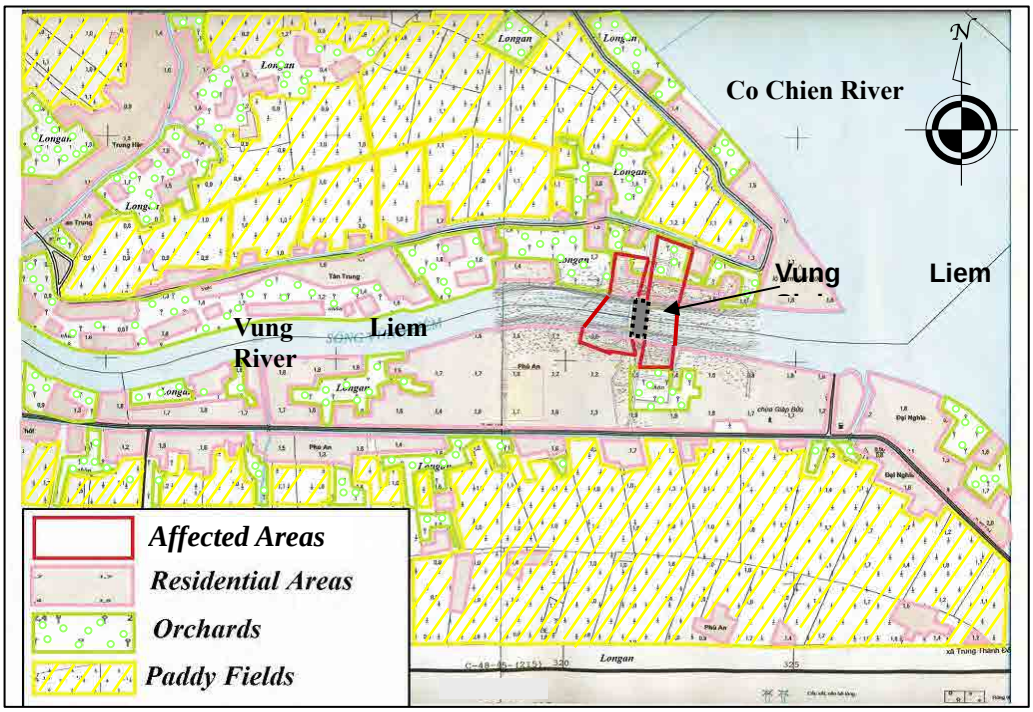

Figure 6.8.1 Affected Area and Land Use around Construction Site (1) Vung Lien Sluice

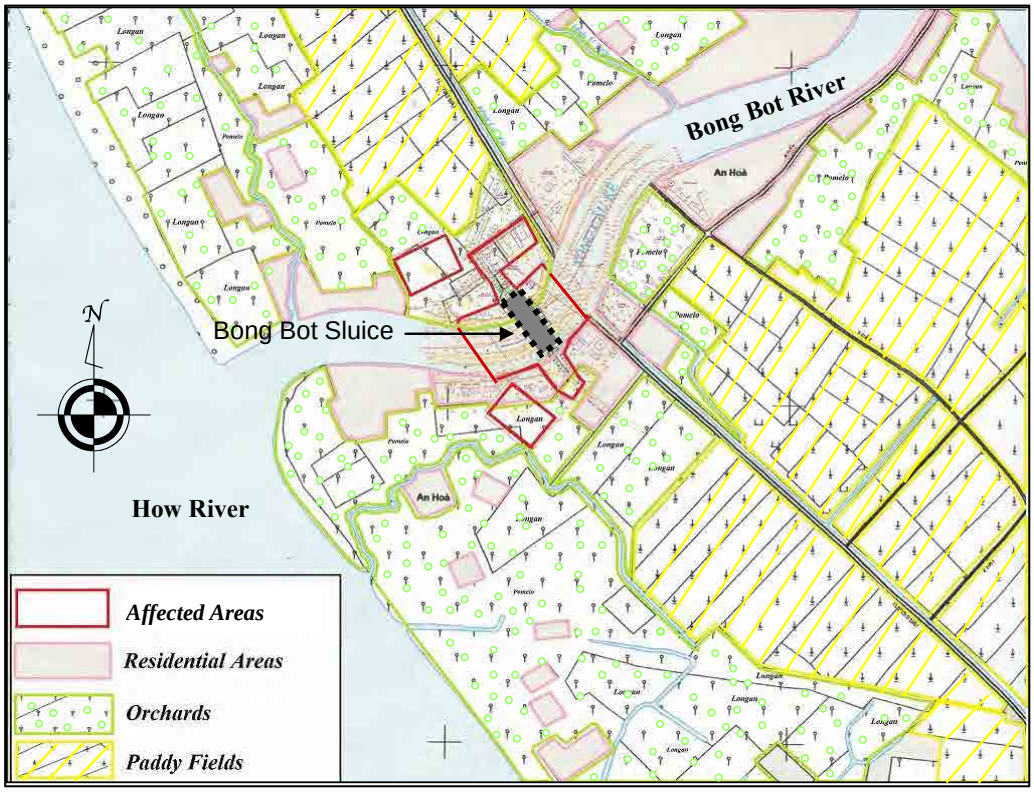

Figure 6.8.2 Affected Area and Land Use around Construction Site (2) Bong Bot Sluice

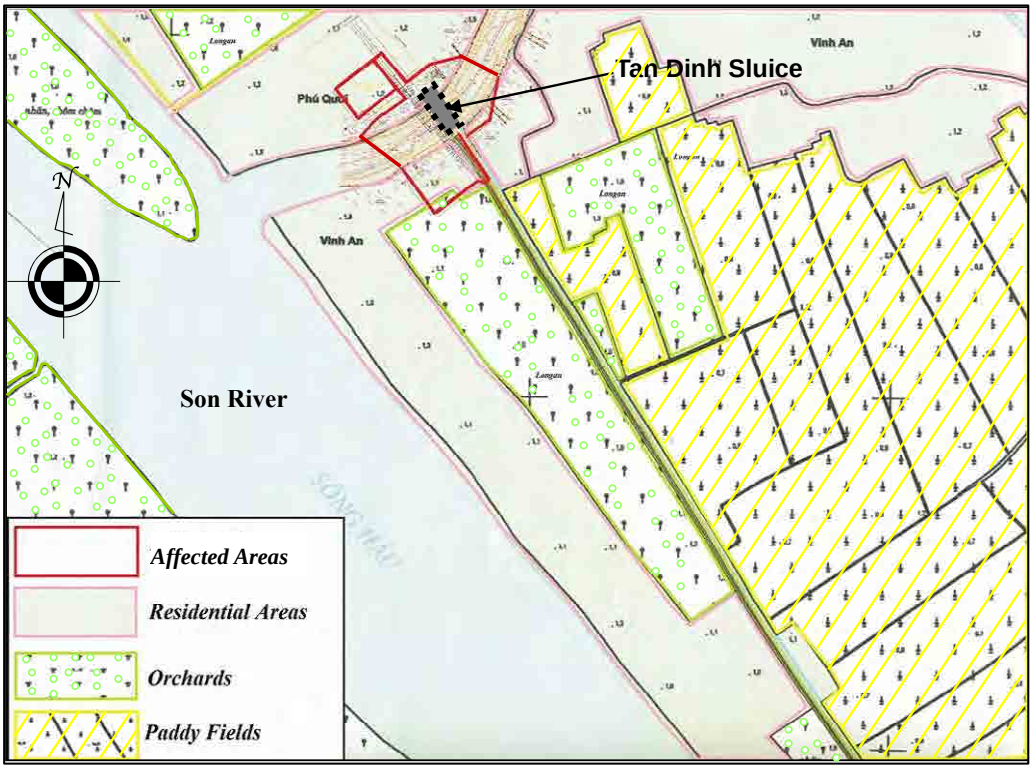

Figure 6.8.3 Affected Area and Land Use around Construction Site (3) Tan Dinh Sluice

6.8.2 Scope of Resettlement

1) Project Affected Households

The affected areas cut across two provinces, namely, Vinh Long Province and Tra Vinh Province. Proposed Tan Dinh Sluice crosses over Tan Dinh River, which is provincial boarder of those provinces. Communes to be affected by the project are Trung Thanh Tay, Trung Thanh Dong, An Phu Tan and Tich Thien. Total number of affected households and affected houses are 35 and 39, respectively, since four households own two house structures as follows (see Table 6.3.1). The breakdown of the households affected by each sluice and house structure is also shown in Table 6.2.2.

Table 6.8.1 Distribution of Affected Households

Sluice's Name	Province	Communes which affected houses are located	No. of households	No. of house
Vung Liem	Vinh Long	Trung Thanh Tay	7	8
	Vinh Long	Trung Thanh Dong	4	4
Tan Dinh	Tra Vinh	An Phu Tan	7	7
	Vinh Long	Tich Thien	9	11
Bong Bot	Tra Vinh	An Phu Tan	8	9
Total			35	39

Source: JICA Project Team

Table 6.8.2 Number of Project Affected Units and Affected Persons

Type of loss	No. of Project Affected Units			No. of Project Affected Persons		
	Legal	Illegal	Total	Legal	Illegal	Total
Household	35	0	35	132	0	132*1
House structure	39	0	39	-	-	-
Temple	1	0	1	0	0	0
Shop	0	0	0	0	0	0

Source: JICA Team, 2012

*1: It does not include number of three household which were not interviewed out of 35 households due to their absence. Given that the average family number of other 32 households interviewed is 4.125/HH, total affected persons number can be estimated at 144.

*2: Four households own two structures, therefore, total number of households and house structures are different.

2) Land and Structures to be Recovered

Thirty nine (39) house structures (35 households), one temple and 14 electric poles are to be relocated in total. Furthermore, there are orchards gardens, residential area and some ponds for aquaculture around the construction sites, which will be affected while there is no temporary land loss or house relocation. The detail affected lands and structures are as follows:

Table 6.8.3 Properties and Lands to be Affected

Item	Vung Liem Sluice	Bong Bot Sluice	Tan Dinh Sluice	Total
Leaf Houses (private)	60m^2	120 m^2	360 m^2	540m^2
Brick Houses (private)	360m^2	360 m^2	480 m^2	1,200m^2
Steel roof Houses (private)	240m^2	60 m^2	240 m^2	540m^2
Temple	1 unit	-	-	1 unit
Electric pole	3 poles	2 poles	9 poles	14 poles
Water coconut (nippa palm)	200m^2	200m^2	120m^2	520m^2
Pond	3,000m^2	0m^2	0m^2	3,000m^2
Coconut tree	1,000 trees	500 trees	100 trees	1,600 trees
Other tree	1,000 trees	200 trees	1,000 trees	2,200 trees
Permanent garden land loss	29,500 m^2	24,550 m^2	23,400 m^2	77,450 m^2

Item	Vung Liem Sluice	Bong Bot Sluice	Tan Dinh Sluice	Total
Permanent residential area loss	1,500 m^2	1,350 m^2	2,700 m^2	5,550 m^2

Source: JICA Project Team

3) Income Source

According to the households survey (JICA, 2012), the affected area is characterized by diverse income sources such as labor, farming, grocery, aquaculture, shipping and so on. The majority is engaged in agriculture, 14 households (orchard garden: 8 and paddy: 6). However, even if they have farmland as a main income source, they tend to depend on labor work as the second main income source since their farmland is only 0.65 ha at average. Following the agriculture composed of orchard garden and paddy cultivation, labor comes next including those who do not have farmland to cultivate. The main income source of the affected households is shown as below:

Table 6.8.4 Main Income Source of Affected Households

Main income source	Vung Liem Sluice	Bong Bot Sluice	Tan Dinh Sluice	Total
Orchard garden	2	3	3	8
Paddy	2	0	4	6
Labor	5	2	4	11
Business/Grocery	0	1	2	3
Shipping	1	1	0	2
Aquaculture	1	0	0	1
Others	0	0	1 (support by children)	1
Unknown	0	1 (absence)	2 (absence)	3
Total	11	8	16	35

Source: Household survey by the JICA Team, 2012

* Occupations of three households are unknown since they were absent for work in Ho Chi Minh city when the household survey was organized. Probably, they make living by work away home.

The interviewees were reluctant to tell their expenditures and incomes. There is a possibility that the estimated mean annual incomes are not so correct. Generally, if agricultural households and non-agricultural households are compared, latter get more income than former, 44.2 million and 90.6 million VND, respectively. Income from shipping is high, 300 to 500 million VND annually. When breakdown of annual income of agricultural household is focused, other income and farm income are 32.4 million VND and 11.8 million VND, respectively, which means that farm income accounts for small percentage even for agricultural households. Given that monthly wage is estimated at 3.0 million VND for one male in this area (about 1.5 million VND for female), agriculture is not profitable compared with other works.

Table 6.8.5 Annual Income of the Affected Households (Unit: million VND/year)

Item	Agricultural household	Non agricultural household	Average
Farm income	11.8	0.6	5.2
Other income	32.4	90.0	65.9
Total	44.2	90.6	71.1

Source: Household survey by the JICA Team, 2012

Concerning educational level of the residents, the highest has finished grade 9, and in general, the level ranges from grade 3 to 7, and more than half of them did not remember their own educational level. Therefore, it can be estimated that their levels are not very high. Most of them can access to electrical power, however, the number of households who can access to piped water supply is limited. The house structures are brick, thatch and wooden.

4) Consideration for Marginalized people

One household does not have land use certificate for their housing land; however, following the Law on Land (revised in 2003), it is qualified as land user and eligible for full compensation of land recovery since the family has been staying there even before October 1993, which is the eligible year specified by law (Law on Land, revised in 2003). In addition, there is no minority around the sites. Therefore, there are no marginalized people to be paid special consideration.

6.8.3 Compensation Measures

1) Resettlement Policy of the Project

The Government of Vietnam will use the Resettlement Policy for a series of projects to cope with the climate change. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Those are summarized as follows:

1) Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

2) Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.

3) Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which are on account of project implementation would have his, her or their:

   - ✓ Standard of living adversely affected;
   - ✓ Right, title or interest in any house, interest in, or right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
   - ✓ Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
   - ✓ Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

4) Compensation will be paid to current users of land recovered by the State who fully satisfy the conditions specified in Clauses 1, 2, 3, 4, 5, 7, 9, 10 and 11, Article 8 of the Government's Decree No. 197/2004/ND-CP. For land users who are ineligible for compensation, PPC shall consider these cases in order to provide support. Support for life and production stabilization, and support for job-change training and job creation in case of recovery of agricultural land.

5) PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.

6) People temporarily affected are to be considered PAPs and resettlement plans address the issue of temporary acquisition.

7) Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

8) The resettlement plans will be designed in accordance with the Land Law (2003), Decrees No.84/2007,/ND-CP, Decree No. 69/2009/ND-CP and other decrees or circulars concerned.

9) The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups such as communes.

10) Payment for land and/or non-land assets will be based equal to the value of land use rights and non-land assets as at the time when the decision on recovery is made by PPC where no land is available for compensation or PAPs prefer the monetary compensation to land-based compensation.

11) Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training and skill development.

12) Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and new land for the same purpose as the type of land which was recovered. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

13) Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support includes implementation of vocational training and payment of cash equivalent to 30 kg of rice to each affected person per month.

14) The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement such as without legal title to land.

15) Representatives of PAPs will be involved in the process of developing and implementing resettlement plans

16) PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

17) Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

18) Displacement does not occur before provision of compensation and of other assistance required for relocation. Sufficient civic infrastructure must be provided in resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities).

19) Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

20) Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

In terms of principle of replacement cost, a compensation for land and non-land assets owned by households/shop owners will be based on the principle of replacement cost. Replacement cost is the amount calculated before displacement which is needed to replace an affected asset without depreciation and without deduction for taxes and/or costs of transaction as follows:

- ✓ Existing local government regulations for compensation calculations for building, crops and trees will be used where ever available.
- ✓ For perennial crops, cash compensation at replacement cost that should be in line with local government regulations.
- ✓ For timber trees, cash compensation at replacement cost that should be in line with local government regulations.

Based on the discussion above, following Entitlement Matrix is proposed:

Table 6.8.6 Entitlement Matrix

Type of loss	Definition of entitlement person	Entitlement
Loss of land	Land user who satisfy the conditions of the compensation according to the law	1) Cash compensation for acquired land, or 2) Land provision Based on JICA Guideline for qualified persons for compensation and national regulation of Vietnam for compensation price, respectively
Loss of house/structure	User of the house/structure	1) Compensation for affected constructions with 100% of replacement price, or 2) Compensation price being calculated on real affected area
Loss of income and business	Aquaculture	There is no regulation of compensation for pond loss, therefore, based on actual conditions (construction cost, maintenance cost, profit and so on), compensation will be estimated.
Loss of standing crops and trees	Lost crop	Compensation for lost crop based on regulation
Assistance for restoration (1)	Households to be resettled	Support for transportation to the resettled area (4 million VND/household based on 20/2009/QD-UBND of Vinh Long province on 5/11/2009 and 3 million VND/household based on Decree No. 22/1998/ND-Cp 24/4/1998
Assistance for restoration (2)	Households to be resettled	Support for life and production stabilization, and support for job-change training and job creation in case of recovery of agricultural land (Cash support equal to 1.5-5 times the agricultural land, Decree No.69/2009/ND-CP 12/2/2009
Assistance for restoration (3)	Households to be resettled	Monetary support to affected person to stabilize their livelihood (12month*30Kg rice *11000 VND per person) based on Article 20, Decree No.69/2009/ND-CP 12/2/2009
Assistance for restoration (4)	Vulnerable persons	Not specified in the laws, People's Committee at commune level will decide depending on the situations of affected persons.

Source: JICA Project Team

2) Compensation for Loss and Support

Depending on the type of loss and entitlement, supports to the affected persons will have to be provided. Details of support for resettlement such as duration of job training are, however, not specified in the relevant decree and therefore those matters will be directed by PPC (refer to Decree 69/2009-ND-CP). According to JICA Guideline, all affected persons are qualified for compensation for land losses while only those who are satisfied with national regulation in Vietnam. In this case, affected households are qualified for compensation based on the Vietnamese regulation. Cut-off date is

set as the day which the socio-economic survey done by JICA Team was started.

There is a gap of land unit price between official ones and market price, especially, for residential area. It is needed to take countermeasure to recover the gap according to the Law on Land (2003)[2]. The comparison of unit price of land in the affected area is as shown below:

Table 6.8.7 Comparison of Official Prices and Market Prices of Land

Sluice's Name	Commune	Province	Governmental Price (1,000 VND/m^2)*1		Market Price (1,000 VND/m^2)*2	
			Residential area	Paddy and Farmland	Residential area	Paddy and Farmland
Vung Liem	Trung Thanh Tay	Vinh Long	260-400	60-105	500-1,000	200-300
	Trung Thanh Dong	Vinh Long	200-300	60-105	300	200-300
Tan Dinh	An Phu Tan	Tra Vinh	100-200	42-65	200-300	200-300
	Tich Thien	Vinh Long	150-240	60-105	250-350	250-350
Bong Bot	An Phu Tan	Tra Vinh	100-200	42-65	200-300	200-300

Source *1: No. 27/2011/QĐ-UBND, Decision on Price of Land in Vinh Long and 20/2011 /QĐ-UBND, Decision on Price of Land in Tra Vinh

*2: Land management official who manages land in each commune, 2012.

For the purpose of set-off of the big difference between official price and market price, it is very important to provide any supports such as job training in case the affected people prefer change their job due to the resettlement. It is important to include the cost for job training based on the national and provincial regulations such as Decree No.69/2009/ND-CP 12/2/2009.

Since unit prices are determined depending on the conditions of provinces, each PPC has original unit prices for compensation. The project covers two provinces; therefore, compensation is calculated by province. Regarding Tan Dinh Sluice, which is located on between Vinh Long Province and Tra Vinh Province, unit price of Vinh Long is applied for estimation of the compensation. Estimated cost compensation including job change support is as follows:

Table 6.8.8 Compensation for Loss (1) Vung Liem Sluice

No.	ITEMS	No.	Quantity	Unit	Unit price	Amount (million VND)	Source of unit price
I	House (60m^2 times one house)						
1	Leaf house	1	60	m^2	484,000	29	*1
2	Brick house	7	420	m^2	2,482,000	1,042	*1
4	Steel roof house	4	240	m^2	655,000	157	*1
II	Standing crops and other structures						
1	Grave		-	Unit	-	0	-
2	Temple		1	Unit	20,000,000	20	-
3	Movement of electric pole		3	Unit	15,000,000	45	*2
4	Paddy		-	m^2	-	0	-
5	Coconut		1,000	Trees	290,000	290	*3
6	Nipa palm		200	m^2	3,000	1	*3
7	Other trees		1,000	Trees	150,000	150	*3

[2] The land prices stipulated by people's committees of provinces and cities under central authority shall be used as the basis for calculating compensation when the State recovers land. They must be close to actual market prices for assignment of land use right in normal conditions and, when there is a big difference compared with actual market prices, they must be adjusted for conformity. (Law on Land, Article 56)

III	Land loss						
1	Temporary land loss		0	m^2	-	0	-
2	Permanent land loss		31,000	m^2	-	0	-
*	Land for paddy cultivation		0	m^2	-	0	-
*	Garden land		29,500	m^2	70,000	2,065	*4
*	Rural residential land		1,500	m^2	195,000	293	*4
IV	Support						
1	Support for movement of house		11	Household	4,000,000	44	*5
2	Grant for life stabilization (11HH* 6 persons/HH)		66	Individual	3,960,000	261	*6
3	Support for changing job and creating job		29,500	m^2	140,000	4,130	*7
	Total: (I+II+III+IV)					8,527	-
IV	Cost for activities of compensation, site clearance and resettlement (5%)					426	-
	Grand Total					8,953	

*1: Decision No. 16-2011dated on 21 Jul 2011, Vinh Long PPC
*2: The figure is tentatively set, no source.
*3: Decision No.28-2009 Dated on 25 Dec 2009, Vinh Long PPC
*4: Decision No.27/2011 QÑ-UBND dated on 20 Dec 2011 of Vinh Long PPC
*5: Decision No.20-2009 Dated on 5 Nov., 2009, Vinh Long PPC
*6: No. 69/2009/ND-CP (Cash payment which is equal to 30kg rice to each affected person: 12 months*30kg*11,000 VNG =3,960,000VND)
*7: According to the Decision No.20-2009 Dated on 5 Nov., 2009, Vinh Long PPC, twice of unit price of agricultural land is applicable for job change, therefore, twice of unit price of garden land is applied.

There is no regulation of compensation for pond loss in Vietnam; therefore, based on actual conditions (construction cost, maintenance cost, profit and so on), compensation will have to be estimated. Therefore, the compensation cost for pond loss is not included in the table above for Vung Liem Sluice. According to the interview to the person who operates aquaculture (JICA Team, 2012), the construction cost was reported at around 6 million VND per square meter and annual maintenance cost is 1.5 million VND.

Table 6.8.9 Compensation for Loss (2) Bong Bot

No.	ITEMS	No.	Quantity	Unit	Unit price	Amount (million VND)	Source
I	House ($60m^2$ times one house)						
1	Leaf house	3	180	m^2	724,400	130	*1
2	Brick house	6	360	m^2	3,142,000	1,131	*1
3	Steel roof house	0	0	m^2	790,150	0	*1
II	Standing crops and other structures						
1	Grave		-	Unit	-	0	-
2	Temple		-	Unit	-	0	-
3	Movement of electric pole		2	Unit	15,000,000	30	*2
4	Paddy		-	m^2	-	0	-
5	Coconut		500	Trees	200,000	100	*3
6	Nipa palm		200	m^2	3,000	1	*3
7	Other trees		200	Trees	120,000	24	*3

III	Land loss						
1	Temporary land loss		-	m^2	-	0	-
2	Permanent land loss		25,900	m^2	-	0	-
*	Land for paddy cultivation		0	m^2	60,000	0	-
*	Garden land		24,550	m^2	70,000	1,719	*4
*	Rural residential land		1,350	m^2	200,000	270	*4
IV	Support						
1	Support for movement of house		8	Household	3,000,000	24	*5
2	Grant for life stabilization (8HH* 6 persons/HH)		48	Individual	3,960,000	190	*6
3	Support for changing job and creating job		24,550	m^2	140,000	3,437	*7
	Total: (I+II+III+IV)					7,056	-
IV	Cost for activities of compensation, site clearance and resettlement (5%)					353	-
	Grand Total					7,408	

*1: Decision No.08/2011/QĐ-UBND, Tra Vinh Province -
*2: It is tentatively fixed at this moment.
*3: Decision No.06/2008/QĐ-UBND dated on 26 Feb 2008 of Tra Vinh PPC
*4: Decision 20/2011 QÑ-UBND dated on 21 Dec 2011 of Tra Vinh PPC
*5: Decree No.22/1998ND-CP, generally, 1-3 million is paid to the affected persons within Tra Ving Province.
*6: No. 69/2009/ND-CP (Cash payment which is equal to 30kg rice to each affected person: 12 months*30kg*11,000 VNG =3,960,000VND)
*7: According to Decree No.22/1998ND-CP, 1.5 times to 5 times of unit price of agricultural land is applied for support of job change. Considering twice is applied in Vinh Long Province, twice of garden land unit price is applied.

Table 6.8.10 Compensation for Loss (3) Tan Dinh

No.	ITEMS	No.	Quantity	Unit	Unit price	Amount (million VND)	Source
I	House ($60m^2$ times one house)						
1	Leaf house	8	480	m^2	484,000	232	*1
2	Brick house	8	480	m^2	2,482,000	1,191	*1
3	Steel roof house	2	120	m^2	655,000	79	*1
II	Standing crops and other structures						
1	Grave		-	Unit	-	0	-
2	Temple		-	Unit	-	0	-
3	Movement of electric pole		9	Unit	15,000,000	0	*2
4	Paddy		-	m^2	-	135	-
5	Coconut		100	Trees	290,000	29	*3
6	Nipa palm		120	m^2	3,000	0	*3
7	Other trees		1,000	Trees	150,000	150	*3
III	Land loss						
1	Temporary land loss		-	m^2	-	0	-
2	Permanent land loss		26,100	m^2	-	0	-
*	Land for paddy cultivation		-	m^2	-	0	-
*	Garden land		23,400	m^2	85,000	1,989	*4
*	Rural residential land		2,700	m^2	195,000	527	*4

IV	Support						
1	Support for movement of house		16	household	4,000,000	64	*5
2	Grant for life stabilization (16HH*6 persons)		96	individual	3,960,000	380	*6
3	Support for changing job and creating job		23,400	m^2	170,000	2,293	*7
	Total: (I+II+III+IV)					7,070	-
IV	Cost for activities of compensation, site clearance and resettlement (5%)					353	-
	Grand Total					7,423	

*1: Decision No. 16-2011dated on 21 Jul 2011, Vinh Long PPC
*2: The figure is tentatively set, no source.
*3: Decision No.28-2009 Dated on 25 Dec 2009, Vinh Long PPC
*4: Decision No.27/2011 QÑ-UBND dated on 20 Dec 2011 of Vinh Long PPC
*5: Decision No.20-2009 Dated on 5 Nov., 2009, Vinh Long PPC
*6: No. 69/2009/ND-CP (Cash payment which is equal to 30kg rice to each affected person: 12 months*30kg*11,000 VNG =3,960,000VND)
*7: According to the Decision No.20-2009 Dated on 5 Nov., 2009, Vinh Long PPC, twice of unit price of agricultural land is applicable for job change, therefore, twice of garden land is applied.

The total amount of compensation cost for resettlement and land recovery by three sluice constructions is as follows:

Table 6.8.11 Total Compensation Cost (Unit: million VND)

Particulars	Vung Liem	Bong Bot	Tan Dinh	Total
I. House structure	1,229	1,262	1,502	3,992
II. Standing crops and other structures	506	155	314	975
III. Land loss	2,358	1,989	2,516	6,862
IV. Support	4,435	3,651	4,422	12,509
V. Sub-total	8,527	7,056	8,754	24,337
VI. Cost for resettlement activities (5% of sub-total)	426	353	438	1,217
VII. Grand total	8,953	7,408	9,192	25,554

6.8.4 Restoration of Livelihood

The affected households shall have right to choose either of new land or cash payment as compensation for the land loss. However, according to the household survey, most of them do not have clear ideas which new land preparation or cash payment is preferable, since they think the project will be implemented in far future. Given that Vietnamese people are reluctant to go to unknown lands and they prefer staying within the same area, it may be recommended that that cash payment for land loss as compensation is better at this moment. After the consultation meeting, it is expected that they will understand clearly. It is therefore recommended to hear their opinions at the meeting as much as possible to prepare a preferable resettlement plan.

6.8.5 Handling of Complaints

According to No.181/2004, ND-CP/2004, Decree No.69/2009/NĐ-CP and Article 61 of Chapter VII Decision No. 20/2009QD-UBND (Vinh Long Province), “Board of Compensation, Support and Resettlement or Land Fund Development” are responsible for receiving complaints, denunciations and consider to submit to the President of DPC to decide to settle the complaint of individuals and organizations under a Law on complaints and denunciations within thirty (30) working days after receiving the application. If those who are recovered their land do not agree with the decision by

District PC (peoples' committee), it is possible to initiate lawsuit at people's court or complain to the Provincial PC. Apart from the PCs, there is no organization which handles such disputes in Vietnamese system.

6.8.6 Implementation Structure

In Vietnam, implementation structure for resettlement is stipulated by a governmental regulation. There is no big difference among projects depending on scale or category. At first, Project Management Unit (PMU)[3], which is responsible for overall project management, namely, project design, implementation and monitoring is established, and this PMU plays an important role in resettlement, too. Moreover, "Board of Compensation, Support and Resettlement" shall be established prior to resettlement. It is directly responsible organization for a series of resettlement activities. In addition to them, various organizations are concerned to the resettlement; namely, PPC, DPC, Provincial Department of Natural Resources and Environment, Department of Finance, Project Management Unit and so on. Those organizations' tasks are summarized in the following table based on the 197/2004/ND-CP:

Table 6.8.12 Major Tasks of Organizations Concerned

No.	Organization	Task
1	Project Management Unit (PMU)	To design the detailed project to determine the exact boundaries of land acquisition To train staffs joined in the resettlement activities To survey and investigate the population in detail To Present the draft plan for compensation and resettlement to the authorities. After approved, this plan will be reported at the public meeting To relocate the affected people To monitor project progress, the performance analysis, synthesis, evaluation and reporting performance results and propose solutions to solve difficult problems during project implementation to ensure project implementation schedule, proper technical requirements, economic.
2	Board of Compensation and Resettlement Support	To make, submit for approval and organize the implementation of, the compensation, support and resettlement plan; To check accuracy and rationality of inventory statistics, the legality of land and property eligible or ineligible for compensation, supports in the compensation, support and resettlement plans. To receive complaints from affected persons and submit it to DPC
3	PPC	To direct, organize, propagate and mobilize all organizations and individuals concerning compensation, support and resettlement policies and ground clearance according to the land recovery decisions of competent state bodies; To direct the provincial/municipal services, departments, branches and district-level People's Committees: To approve or assign the district-level People's Committees to approve compensation, support and resettlement plans; To approve land prices; promulgate the property price tables for compensation calculation; prescribe support levels and supporting measures according to their competence; resettlement arrangement plans, job change training plans according to their assigned competence; To direct the concerned agencies to settle citizens' complaints, denunciations related to compensation, support and resettlement according to their law-prescribed competence; To guarantee impartiality and equity when considering and deciding on the compensation, support and resettlement when land is recovered by the State according to their competence prescribed in this Decree; To decide or assign the district-level People's Committees to apply coercion to cases of deliberately failing to abide by the State's land recovery decisions according to their competence;

[3] PMU is an organization which has responsibilities for management and implementation of projects including resettlement activities. It can be formed from personnel of the investor or as an organization hired by the investors.

No.	Organization	Task
		To direct the examination and handling of violations in the compensation, support and resettlement domain.
4	DPC	To direct, organize, communicate and mobilize all organizations and individuals on policies of compensation, support, resettlement and site clearance that are done in accordance with the land revoking decision of State competent agencies. To direct board of compensation and resettlement support for setting up and organizing methods for compensation, support and resettlement, implement approved plan of compensation, support and resettlement. To settle complaints and denunciation for compensation To coordinate with provincial Departments, institutions and Investor in implementation of project construction, plans for creating a resettlement area locally as assigned by PPC
5	People's Committees of communes	To coordinate with the compensation, support and resettlement boards in certifying land and property of persons who have land recovered; To join in, and create conditions for, the payment of compensation and support money to, and arrange resettlement for, persons who have land recovered, and create conditions for the ground clearance.
6	Department of Natural Resources and Environment	To guide the determination of land area, soil type, land position, land area and conditions for compensation, land without compensation when the State revokes land. To guide the determination of the size of land that is eligible for compensation or no compensation, the amount of compensation or support for each of revoked land users as the basis for the calculation of compensation and support for each object. To guide for uniform inventory forms, using price for compensation and resettlement, support for Board of Compensation, support and resettlement of districts, cities in the province.
7	Department of Planning and Investment	To guide and supervise the establishment and implementation of resettlement projects.
8	Construction Department	To guide the determination of the size, area, legitimacy, illegality of the construction works associated with the revoked land as the basis for the calculation of compensation and support for each object. To make price list for housing, new construction projects and submit to PPC for issuing decision as a basis for calculating the value of compensation.
9	Department of Finance and Provincial Inspector	To check the payment of compensation, support and costs for works of organizing compensation payment and resettlement support locally.
10	Working group*	To advise and assist PC of Districts to inspect and supervise the implementation of regulation on compensation, support and resettlement

*Working group is established if a project covers plural districts.

The resettlement system in Vietnam is very complicated; however, an organization which plays a central role is the Board of Compensation, Resettlement and Support, which is chaired by official personnel from DPC. Basic implementation structure of resettlement in the country can be illustrated as follows:

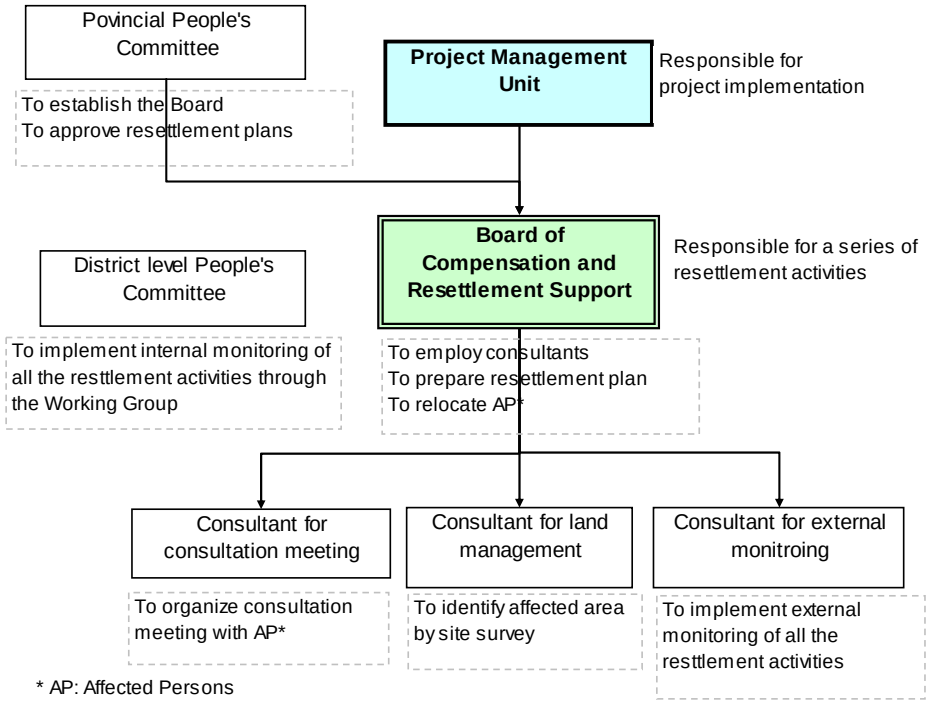

Figure 6.8.4 Basic Implementation Structure[4]

The Project covers two provinces; in such case, Board of Compensation, Support and Resettlement shall be established in each province by initiative of the People's Committee and consultants and experts for site survey will be hired under the Board. In case of the project, the implementation structure can be as below:

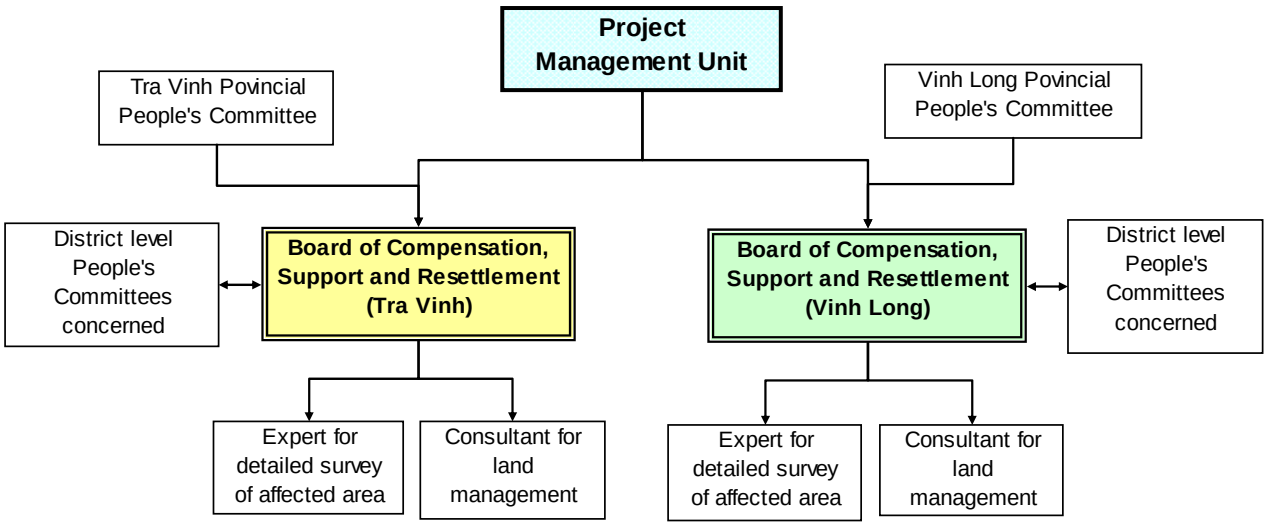

Figure 6.8.5 Implementation Structure

6.8.7 Implementation Schedule

After the approval of project implement, a series of resettlement will be organized based on the following procedure.

1) Establish of Board of Compensation, Support and Resettlement

Board of Compensation, Support and Resettlement will be established by means of initiative of PPC

[4] This figure is prepared by JICA Team based on interview to SIWRP.

and the board shall include 1) a DPC leader as its chairman; 2) a finance agency's representative as its vice chairman; 3) the investor as a standing member; 4) a natural resources and environment agency's representative as member; 5) a representative of the commune-level People's Committee of the place where land is recovered as member; 6) one or two representatives of households having land recovered. Staff who join in the resettlement planning and implementation will be trained by the PMU.

2) Announcement

The approved plan shall be informed to the public by PMU before detailed design of the projects. A meeting for announcement will be held in affected wards in order to hear opinions from the people: (i) scope of the project, (ii) impacts, (iii) inherited rights for types of losses and damages, (iv) operation schedule staring with study of detailed design, (iv) responsibilities of organization, and (v) mechanism of complaint and grievance.

3) Resettlement Plan Preparation

Board of Compensation, Support and Resettlement prepares a draft resettlement plan in collaboration with other organization concerned to resettlement. The draft version shall be approved by PPC.

4) Consultation Meeting

A consultation meeting, which the affected persons, the board, PPC, DPC, PMU and so on participate, is organized. At the meeting, the draft resettlement plan is presented to the attendants and the affected persons can lodge complaints against the drafted document.

5) Site Investigation and Cost Estimation for Resettlement

The board implements a household survey covering all of displaced persons to identify their houses, farmlands and so on to estimate of resettlement cost with the support of representatives of affected persons. Based on the result and the resettlement policy mentioned above, the latest unit price for resettlement and land recovery including transportation, vocational support and monitoring will be estimated by the board. The revised resettlement plan and cost estimation will be approved by the PPC.

6) Publication of the Proposed Resettlement Plan

Revised resettlement plan will be publicized at headquarter of Commune People's Committee for 20 days and the affected persons have a chance to complain the revised once again.

7) Finalization of the Resettlement Plan

Based on the opinions acquired through the publication, the draft resettlement plan is finalized. The board sends the final resettlement plan and the decision, which mentions level of compensation, support, locations of house/land to be relocated, and timing of compensation and resettlement, to each affected person in collaboration with Commune People's Committee.

8) Compensation

Prior to resettlement and land recovery, compensation shall be implemented following the resettlement plan.

9) Resettlement

Resettlement is implemented, according to need, vocational support or monetary support to stabilize livelihood of affected persons will be organized under the supervision of the PMU and Board.

10) Social Support

Handover of land or property in resettlement area, income restoration and social supports for the affected people is to be completed by the PMU and Board.

11) Monitoring

There are two kinds of monitoring system, namely, internal and external ones. The Board is responsible for internal monitoring in collaboration with Working Group of District while PMU employs consultants for external monitoring. Regarding duration of monitoring, even after the completion of monitoring of resettlement activities, it is recommended to continue motioning quarterly during construction period and annually during operation period for 2 years. The overall implementation schedule regarding resettlement is shown as below:

Table 6.8.13 Implementation Schedule

Work	Work schedule (month)										
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Construction period	Operation period until 2 years later of start
Approval of project implementation	▲										
1. Establish of Board of compensation, support and resettlement	↔										
2. Announcement to the affected people	↔										
3. Review of draft resettlement plan preparation	↔	↔	↔								
4.Detail design level site investigation/ Cost estimation for resettlement			↔	↔							
5 Consultation meeting of detailed design level of resettlement plan and revise				↔							
6. Publication of the resettlement plan at the Commune People's Committee (for 20 days)				↔	↔						
7. Finalization of the resettlement plan					↔						
8. Compensation					↔	↔					
9. Resettlement						↔	↔	↔			
10. Social supports such as job training							↔	↔	↔		
11. Monitoring	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔

Source: JICA Project Team

6.8.8 Cost and Fund

The total estimated cost for resettlement is 25,554 million VND as shown in the following table. This cost is for compensation for project affected persons, transportation, support for restoration, external monitoring, administrative costs and contingency. The cost shall be covered by the implementation agency, namely, MARD and/or DARD.

Table 6.8.14 Cost for Resettlement

No	Items of Compensation	Cost (million VND)	Notes

1	Houses	3,992	
2	Standing crops and other structures	975	
3	Land loss	6,862	
4	Support	12,509	
5	Sub-total	24,337	
6	Cost for management related to resettlement (5%)*	1,217	It includes cost of monitoring. According to 69/2009 ND-CP, it is specified at 2%, however, in these days, 5% is applied in many projects (SIWRP), this figure is applied in this program, too.
7	Grand total	25,554	

Source: JICA Project Team

6.8.9 Monitoring Structure and Monitoring Form

The monitoring of resettlement is to be organized during and after the construction in order to ensure that resettlement and land recovery shall be conducted in accordance with the rules and specific resettlement plan. These activities will provide feedbacks for the implementation to all the stakeholders. It is expected that likelihood of success and risks could be timely detected and solved during the operational phase of the project. A series of resettlement monitoring is categorized into two systems, namely, internal and external ones.

1) Internal monitoring

Board of Compensation, Resettlement and Support, and working group are entirely responsible for internal monitoring, as well as for the resettlement plan with the assistance of the project consultants. The monitoring will be based on the monitoring format as shown below. The monitoring indicators include; 1) Information dissemination and community consultation, 2) The complaint procedures, especially the involved problems in management, 3) payment for affected households in accordance with the compensation plan, 4) support for stabilizing their lives; 5) restoration for income, and 6) progress of land acquisition. PMU shall acquire the information from the Board. The database collected in the resettlement plan will be kept and updated monthly.

2) External monitoring

External monitoring is an activity of a research organization or consultant to ensure the monitoring. This organization or consultant must have the experience for monitoring the resettlement, and is normally appointed by PMU. The external monitoring should be started when the Board of Compensation, Support and Resettlement is established. Same monitoring format can be used for both internal and external monitoring for cross-check. The proposed monitoring format is as shown below:

Table 6.8.15 Recommended Monitoring Format

Responsible organization: PMU

Work	Planned in total	Progress in quantity	Progress in percentage	Responsible organization
Announcement to the affected people				
Draft resettlement plan preparation and site investigation (socio-economic survey)				
Cost estimation for resettlement				
Consultation meeting				
Revise of the resettlement plan and signing based on the feedback at the consultation meeting				
Compensation in cash				
Compensation by land				
Resettlement				
Social supports such as job training				

Announcement to the affected people

Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Consultation meeting with the affected people		
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune
Date:	Province/District:	Commune

6.8.10 Consultation Meeting

A series of consultation meeting to explain the project objectives, project components, compensation policy and so on for the affected persons was organized by DARD in October 2012. The date, venue and number of participants of the consultation meeting are shown in following table:

Table 6.8.16 Consultation Meeting

Sluice gates	Date	Venue of consultation meeting	Number of participants from affected households	Number of participants from the government
Vung Liem	October 17, 2012	Hall of Trung Thanh Tay Commune, Vung Liem District, Vinh Long Province	11	9
Bong Bot	October 18, 2012	Hall of An Phu Tan Commune, Cau Ke District, Tra Vinh Province	8	6
Tan Dienh	October 19, 2012	Meeting Room of Dinh An Village, An Phu Tan Commune, Cau Ke District, Tra Vinh Province	16	8
Total			35	23

The presented opinions about the project by the affected persons are as shown below:

- Government needs to help farmers' life have to be stabilized as soon as possible after sluice construction;
- Waterways have to be operated continuously during sluice construction; and
- Compensation should be done based on the policy fully.

As a whole, all the participants agreed the project since it can prevent from saline water intrusion and high tide damage.

DARD officer explained the Vung Liem sluice construction to the affected persons.

The consultation meeting for Vung Liem sluice construction was closed with consensus.

DARD official personnel answered to a question by the affected persons due to Tan Dinh sluice construction

The affected person put his signatures on the Minutes of Meetings of the consultation meeting for Bong Bot.

Detail information of the consultation meetings is attached to the Annex VIII, Attachment-A.

6.9 Conclusion and Recommendations

It can be said that the proposed project does not give severe adverse effects on surrounding environment except for resettlement and land recovery. Even though temporary impacts such as air pollution are to be caused, it is temporary and possible to mitigate them by some measures mentioned above. On the resettlement and land recovery, it is needed to pay enough attention to the affected persons.

The legal frame of resettlement is well developed in Vietnam. Especially, the system, where each PPC has its original unit price of compensation considering local conditions and national level regulation, functions very well. It is, however, further recommended to apply WB policy 4.12 more in the resettlement frame. For instance, opportunity for the affected persons to participate in the preparation of resettlement plan is limited at present. Furthermore, minimization of gap between market price and prescribed price of land compensation shall be promoted according to the Law on Land (2003). Therefore, it is recommended to involve the affected persons at earlier stage and to fill the gap mentioned above based on the actual conditions.

6.10 Checklist

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	1) Have EIA reports been officially completed? 2)Have EIA reports been approved by authorities of the host country's government? 3) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? 4) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	1) N 2) N 3) N 4) N	Project components have been just proposed in 2012, EIA report has yet to be prepared. At this moment, Initial Environmental Examination (IEE) level study was implemented.
	(2) Explanation to the Public	1) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? 2) Are proper responses made to comments from the public and regulatory authorities?	1) Y 2) Y	Affected persons have been already informed of the project. Based on people's request, an alternative to minimize resettlement (construction across the water way instead of on-shore) was selected.

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
	(3) Examination of alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	At Strategic Environment Assessment (SEA) focusing on adaptation of climate change in the Mekong Delta, structural measure, non-structural measure and zero-option are examined. At the project level, alternatives of construction sites are examined.
2 Pollution control	(1) Water Quality	(a) Do effluents or leachates from various facilities, such as infrastructure facilities and the ancillary facilities comply with the country's effluent standards and ambient water quality standards?	(a) N	There is no effluent from sluice gate.
	(2) Waste	(a) In the case of that large volume of excavated/dredged materials are generated, are the excavated/dredged materials properly treated and disposed of in accordance with the country's standards?	(a) -	The generated waste by the construction will be reused for other purposes, it is not a big issue to dispose the waste.
	(3) Subsidence	(a) Is there a possibility that the excavation of waterways will cause groundwater level drawdown or subsidence? Are adequate measures taken, if necessary?	(a) N	Water level of groundwater will not be caused
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(1) N	Even though there are 5 protected areas in the Target Area, however, there is enough distance from the construction sites and the protected area. The possibility of damage to the area is low.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that hydrologic changes, such as reduction of the river flow, and seawater intrusion up the river will adversely affect downstream aquatic organisms, animals, vegetation, and ecosystems? (e) Is there a possibility that the changes in water flows due to the project will adversely affect aquatic environments in the river? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) – (d) N (e)Y and N	(d) Positive impact is expected due to prevention saline water intrusion. (e) Some endangered fish species, which migrate within Mekong river, or fresh water and sea, range in the Mekong Delta. However, the frequency of observation of those fish is very limited in the area.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the project will adversely affect surface water and groundwater flows?	(a) N	Due to sluice construction, saline water intrusion can be prevented, which bring about a positive impact.
	(4) Topography and Geology	(a) Is there a possibility that excavation of rivers and channels will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas?	(a) N	The proposed sluice will be constructed across the water way, no topographic nor geological change is expected.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and	(a) Y (b) Y (c) Y (d) Y	(a) Proposed construction sites are determined considering minimization of resettlement. (b) Consultation meeting was

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
		resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socio-economic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(e) Y (f) N/Y (g) Y (h) Y (i) Y (j) N	done. (c) Replacement cost is estimated following governmental regulations. In addition, considering JICA Guideline, support for livelihood recovery (cash for job training) is included in the cost estimation. (d) Prior to resettlement, compensation shall be paid following the regulations. (e) It is included in the report. (f) There is a case that a PPC supported those who do not have official certificate considering their conditions. However, it is case-by-case, not regulated (g) At the consultation meeting, minute was formulated, and both governmental side and the affected persons put their signatures on the minute of meeting. (h) Board for Compensation, Support and Resettlement, which is responsible for resettlement, will be established based on the regulations. (i) A proposed monitoring plan is documented in the report. (j) Board for Compensation, Support and Resettlement, will handle complaints.
5. Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) - (c) -	(a) Some mitigation measures such as temporary enclosure are proposed. (b) Severe negative impact on the natural environment is not expected. (c) Due to resettlement, some damage to social institution are expected, however, the scale will not be significant.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) Are the items, methods and frequencies of the monitoring program adequate? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) Monitoring parameters are proposed. (c) Department of Natural Resource and Environment (DONRE) and DARD will monitor the environmental impacts in construction phase. DARD, which cover water resource, is the center of monitoring, since DONRE covers all sectors. For resettlement, internal and external monitoring will be organized. PMU is the final

Category	Environmental Item	Main Check Items	Yes (Y) No (N)	Confirmation of Environmental Considerations
				responsible organization for all impacts. (d) Draft monitoring format is attached in the report.
6. Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems,such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)N	(a) The construction sites are located on the downstream of the Mekong River, no trans-boundary environmental impact is anticipated.

CHAPTER 7 PROJECT EVALUATION

7.1 Condition of Economic Evaluation of the Project

Tra Vinh Province is located in the area between tributaries of Co Chien River and Hau River. Saline intrusion has affected winter-spring (WS) paddy production in this Province. It is reported that more than 70% of harvest lost in about 8,000 ha of paddy field in 2011 because of saline intrusion. Protecting paddy field from saline intrusion is one of the highest priorities in this province.

The proposed Project is to construct 3 sluice gates to prevent paddy field from saline intrusion and recruit fresh water from Vinh Long Province. Sluice gates will play an important role of preventing salinity water from coming into paddy field. Also, fresh water can be withdrawn with canal extension in Tra Vinh Province towards an upstream in Vinh Long Province.

The Project components are; two sluice gate constructions at the Hau River side called Tan Dinh and Bong Bot sluice gates, one sluice gate construction at the Co Chien side called Vung Liem sluice gate, and the canal extension towards an upstream in Vinh Long Province. Vung Liem sluice gate will be constructed at the downstream area of Vung Lien River in Vinh Long Province, so that this will play a role of recruiting fresh water from Vinh Long Province.

Economic benefit from the Project is estimated as the value of preventing damage cost caused by saline intrusion. Also, damage recovery from saline intrusion will be counted as a major benefit. This is because yield of paddy and fruit has already been damaged by saline intrusion, and the productivity of these crops will recover after installing sluice gates.

The economic evaluation of the Project is conducted to estimate of the Economic Internal Rate of Return (EIRR), the B/C, and the Net Present Value (NPV). Also, as a financial analysis of the Project, a farm budget analysis is carried out to estimate the Project impact on farm income. The following are the basic assumptions of the economic evaluation:

1) Referring to other similar projects in the sector, the economic life of the Project designed at 30 years.

2) Prices employed in the evaluation refer to the prevalent market ones in year 2011.

3) The opportunity cost of capital in Vietnam is considered at 12% based on National Standard for Project evaluation in Vietnam. It is judged that the Project is economically feasible when the EIRR of the Project exceeds it.

4) A Standard Conversion Factor (SCF) of 0.9 is applied for converting the financial price to the economic price. Conversion factors for specific items are shown in Table 7.1.1.

5) Transfer cost such as tax is eliminated from the economic cost. Also, price contingency (inflation) cost is not counted in the economic evaluation.

6) Regarding climate change impact, sea level rise estimated under B2 scenario (mid greenhouse gas emission scenario) is applied for the calculation of saline intrusion impact on yield as a base case. This is because B2 scenario is one of the most frequently referred by other climate change relate projects in Vietnam.

7) Average discharge of Mekong River between 1991 and 2000 is applied with the above-mentioned sea level rise for the calculation of saline intrusion impact. Mekong River Commission has predicted an increase of Mekong River flow at some years; however, the future discharge is predicted under uncertain situation. Hence, the Project evaluation will be carried out under conservative assumptions with average discharge between 1991 and 2000.

Table 7.1.1 Applied Conversion Factors[1]

Standard Conversion Factor	0.9
Rice	1.128
Fertilizer	0.95
Skilled Labor	1.0
Unskilled Labor	0.8
Agricultural Inputs	0.9
Fruit	1.057
Land acquisition and Compensation	0.265

Source: the World Bank and others. Refer to the footnote

7.2 Project Cost

The Project has proposed to construct 3 sluice gates and the canal extension towards Vinh Long Province. Total Project cost is estimated at VND 1,117 billion at financial price (US$54 million) and VND 938 billion at economic price (US$45 million). Target area of Tan Dinh Sluice Gate is 2,600ha; Bong Bot is 3,200ha; Vung Liem is 4,800ha, and total target area including the canal extension is 32,000ha. Project cost of Say Don Canal Extension is the largest with VND 370 billion (US$ 18 million) followed by Vung Liem Sluice Gate with VND 313 billion (US$15 million), Tan Dinh with VND 237 billion (US$11 million), and Bong Bot with VND 195 billion (US$9 million).

Table 7.2.1 Total Project Cost

	FINANCIAL PRICE			ECONOMIC PRICE		
	F/C ('000VND)	L/C ('000VND)	Total ('000VND)	F/C ('000VND)	L/C ('000VND)	Total ('000VND)
1) Bong Bot Sluice Gate	84,069,722	111,889,085	195,958,807	84,069,722	80,604,391	164,674,113
(18%)			18%			18%
2) TanDinh Sluice Gate	101,768,470	135,668,388	237,436,859	101,768,470	97,634,450	199,402,921
(21%)			21%			21%
3) Vung Liem Sluice Gate	135,907,715	177,879,561	313,787,276	135,907,715	129,495,869	265,403,583
(28%)			28%			28%
4)Say Don Canal Extension	90,765,098	279,626,603	370,391,700	90,765,098	127,146,403	217,911,500
(33%)			33%	42%	58%	26%
Total	412,511,005	705,063,637	1,117,574,641	412,511,005	434,881,112	847,392,117
(100%)	37%	63%	100%	49%	51%	100%
US$			$54,489,920			$45,742,594
O&M Cost			6,772,009			6,367,043

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

Operation and Maintenance (O&M) cost is estimated at 1% of the construction cost of each sluice gate and the canal extension. This cost is calculated based on the O&M cost estimated by other similar projects in Mekong Delta. Considering simplicity of the proposed gates, 1% of the construction cost is applied for O&M cost. Annual O&M cost at financial price is estimated at VND 2.2 billion for Vung Liem, VND 1.4 billion for Bong Bot, and VND 1.7 billion for Tan Dinh.

Table 7.2.2 Project Cost of Sluice Gates

	Bong Bot	TanDinh	Vung Liem	Bong Bot	TanDinh	Vung Liem
Item	Total ('000VND)	Total ('000VND)	Total ('000VND)	Total ('000VND)	Total ('000VND)	Total ('000VND)
Construction Cost	141,502,825	171,329,405	229,181,638	133,040,956	161,083,906	215,476,576
	72%	72%	73%	81%	81%	81%
Compensation and Resettlement Cost	7,408,477	9,191,637	8,953,497	1,963,246	2,435,784	2,372,677
	4%	4%	3%	1%	-1%	1%
Project	1,985,243	2,357,900	3,051,973	1,885,981	2,240,005	2,899,375

[1] Note: Major conversion factors refer to appraisal documents prepared by the World Bank "Mekong Delta Water Resource Management for Rural Development Project".
Conversion factor for Fruit is estimated based on the Project "Restore, Upgrading North Nghe An Irrigation System"

	Bong Bot	TanDinh	Vung Liem	Bong Bot	TanDinh	Vung Liem
Management Cost	1%	1%	1%	-1%	1%	1%
Consulting Service	11,320,226	13,706,352	18,334,531	10,527,810	12,746,907	17,051,114
	6%	6%	6%	6%	6%	6%
Other Cost	406,155	479,119	620,642	385,848	455,163	589,610
	0.2%	0.2%	0.2%	0%	0%	0%
Tax	15,521,444	18,787,277	25,118,878	0	0	0
	8%	8%	8%	0%	0%	0%
Contingency Cost	17,814,437	21,585,169	28,526,116	16,870,272	20,441,155	27,014,232
	9%	9%	9%	10%	10%	10%
Total	195,958,807	237,436,859	313,787,276	164,674,113	199,402,921	265,403,583
	100%	100%	100%	100%	100%	100%
US$ (thousand)	9,554,422	11,576,779	15,299,419	8,029,064	9,722,347	12,940,361
O&M Cost	2,291,816	1,415,028	1,713,294	2,154,766	1,330,410	1,610,839

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

Table 7.2.3 Project Cost of Say Don Canal Extension

	FINANCIAL PRICE			ECONOMIC PRICE		
	F/C ('000VND)	L/C ('000VND)	Total ('000VND)	F/C ('000VND)	L/C ('000VND)	Total ('000VND)
Construction Cost	67,931,468	67,255,533	135,187,000	67,931,468	59,171,350	127,102,817
	50%	50%	100%	53%	47%	100%
Compensation and Resettlement Cost	0	7,408,477	7,408,477	0	1,963,246	1,963,246
Project Management Cost	992,622	992,622	1,985,243	992,622	893,359	1,885,981
	50%	50%	100%	53%	47%	100%
Consulting Service	3,396,068	7,924,158	11,320,226	3,396,068	7,131,742	10,527,810
	30%	70%	100%	32%	68%	100%
Other Cost	203,078	203,078	406,155	203,078	182,770	385,848
	50%	50%	100%	53%	47%	100%
Contingency Cost	8,818,850	8,818,850	17,637,700	8,818,850	7,936,965	16,755,815
	50%	50%	100%	53%	47%	100%
Total	157,025,718	213,365,983	370,391,700	157,025,718	151,662,832	308,688,549
	42%	58%	100%	51%	49%	100%
US$			18,059,299			15,050,820
O&M Cost			1,351,870			1,271,028

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

Disbursement of the Project cost is divided over 9 years in total. Each sluice gate will take one year to implement land acquisition and compensation and two years to complete the construction. The first year of each gate for land acquisition, compensation, and a part of consultancy services, and following two years are spent on construction work. Land acquisition and compensation is expected to start in 2014 and the whole investment will be finished by 2022.

The construction is expected to start by Bong Bot sluice gate followed by Tan Dinh, Vung Liem, and finally Say Don Canal since Bong Bot sluice gate is located in upstream of the Province. Land acquisition and compensation for Say Don Canal is divided over 5 years since the cost is relatively large so that it is assumed to take a longer time than land acquisition and compensation of the gates.

Table 7.2.4 Disbursement of the Project Cost at Financial Price

Total Project	2014	2015	2016	2017	2018	2019	2020	2021	2022
(1) Bong Bot									
Land acquisition & Compensation	11,937								
Construction		110,413	73,609						
(2) TanDinh									
Land acquisition & Compensation			14,674						
Construction				133,658	89,105				
(3) Vung Liem									
Land acquisition & Compensation					16,287				
Construction						178,500	119,000		
(4) Say Don Canal									
Land acquisition & Compensation			39,655	39,655	39,655	39,655	39,655		
Construction								103,269	68,846
Total	11,937	110,413	127,938	173,313	145,048	218,155	158,655	103,269	68,846

Source: JICA Study Team
Note: Unit VND million

7.3 Project Benefit

7.3.1 Basic Concept of the Project Benefit

As a Climate Change Adaptation Project, the proposed project has two main aspects considering as monetary value for the Project benefit; 1) damage recovery and 2) damage prevention from saline intrusion.

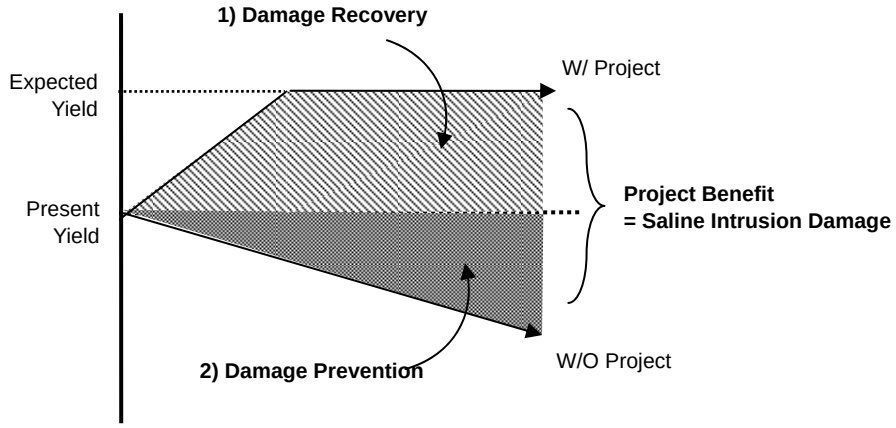

Figure 7.3.1 Basic Concept of the Project Benefit

1) Damage Recovery

Yield of paddy and fruit is expected to recover after implementation of the Project. This is because crop yield in Tra Vinh Province has already been affected by saline intrusion in dry season. It is found that present crop yield is lower than the expected yield under less salinity water environment. Salinity level will decrease in the Project area upon the installation of the gates, so that yield of paddy and fruit is expected to recover. Thus, the value of damage recovery is counted as a major economic benefit of the Project

Yield of paddy is assumed to recover by 12% from the present yield. This 12% is calculated by the difference between average yield of all the eight targeted districts and the highest yield among these districts. According to the statistical yearbook, average paddy yield in these eight districts is 5,827kg/ha. The highest yield is 6,526kg/ha in Huyen Cang Long district.

Constructing sluice gates and canal extension are expected to narrow this gap because average yield of the targeted area has already been damaged by saline intrusion at some degree, whereas it is thought

that the district with the highest yield has not seriously been affected by saline intrusion yet. From this point of view, installing sluice gates will contribute to increasing the area average (5,827kg/ha) to the area highest yield (6,526kg/ha). The difference between average yield and the highest yield is 12.0%. Therefore, yield of paddy is expected to recover by 12%.

Fruit yield is assumed to recover by 16% from the present yield. Basically, the calculation of fruit yield recovery is the same as paddy. Average yield of coconuts, orange, mango, longan, and pomelo in the whole province is 10,834kg/ha. The highest yield of these crops is 12,564kg/ha in Huyen Chau Thanh district. The reason for focusing on these five fruits is that these five crops are produced in all the districts, so that the average yield of these crops is counted to be comparable.

The present yield, 10,834kg/ha, is expected to recover at least 12,564kg/ha; namely, 15.97% increase. In addition, the vulnerability assessment carried out under a JICA funded Master Plan Study, 'Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta in Vietnam', revealed that fruit is more susceptible to salinity water than paddy. Considering these facts, yield of fruit is assumed to recover by 16%. Table 7.3.1 shows the expected yield recovery for both paddy and fruit:

Table 7.3.1 Expected Yield Recovery with Project

	Yield (kg/ha)		Increase
	Present	With Project	%
Winter- Spring Paddy	5,827	6,526	12%
Fruit	10,834	12,567	16%

Source: Household Economic Survey, JICA Study Team (2011)

2) Damage Prevention from Saline Intrusion

Preventing damage by saline intrusion is one of the main roles of constructing sluice gates. Saline intrusion damage is estimated based on the predicted trend of paddy and fruit yield examined under the Vulnerability Assessment carried out by the Master Plan. Based on this data, expected yield during the project life period (2014-2043) is calculated. Yield of paddy and fruit is expected to drop to 5,301 kg/ha and 9,355 kg/ha respectively in year 2050. Paddy yield is predicted to decrease by 9% and fruit yield is predicted to decrease by 13.7%. Expected yield without the Project is shown in Table 7.3.2.

Table 7.3.2 Expected Yield in Representative Years (kg/ha)

	Yield Trend Without Project (kg/ha)			Decrease (%)		
	Paddy	Vegetable	Fruit	Paddy	Vegetable	Fruit
2012 (Present)	5,827	4,450	10,834	-	-	-
2020	5,725	4,365	10,538	1.8%	1.9%	2.7%
2030	5,597	4,259	10,169	3.9%	4.3%	6.1%
2040	5,449	4,138	9,762	6.5%	7.0%	9.9%
2050	5,301	4,016	9,355	9.0%	9.8%	13.7%

Source: JICA Study Team.

7.3.2 Economic Value of the Project Benefit

1) Damage Recovery from Saline Intrusion

As mentioned, yield of paddy and fruit is assumed to recover by 12% and 16% respectively. Production cost and agricultural gate price are assumed the same in "With" and "Without" cases. Annual net income of paddy will increase approximately 12% of the present situation with VND 100 billion in the whole Project area. Fruit will also increase by 12% with VND 214 billion.

Table 7.3.3 Value of Damage Recovery in Financial Price

Place	Crop	Area (ha)	Without Project Net Income ('000VND)	With Project Net Income ('000VND)	Damage Recovery ('000VND)	Increase %
Whole Project (three gates + canal extension)	Paddy	22,400	409,538,080	509,749,800	100,211,720	24.5%
	Fruit	9,600	898,618,042	1,113,287,251	214,669,210	23.9%
	Total	32,000	1,308,156,122	1,623,037,052	314,880,930	24.1%
1. Bong Bot Sluice Gate	Paddy	2,240	40,953,808	50,974,980	10,021,172	24.5%
	Fruit	960	89,861,804	111,328,725	21,466,921	23.9%
	Total	3,200	130,815,612	162,303,705	31,488,093	24.1%
2. Tan Dinh Sluice Gate	Paddy	1,820	33,274,969	41,417,171	8,142,202	24.5%
	Fruit	780	73,012,716	90,454,589	17,441,873	23.9%
	Total	2,600	106,287,685	131,871,760	25,584,076	24.1%
3. Vung Liem Sluice Gate	Paddy	3,360	61,430,712	76,462,470	15,031,758	24.5%
	Fruit	1,440	134,792,706	166,993,088	32,200,381	23.9%
	Total	4,800	196,223,418	243,455,558	47,232,140	24.1%

Source: JICA Study Team

2) Damage Prevention from Saline Intrusion

Expected saline intrusion damage will reach VND 3,364 billion (US$ 164 million) during the project life period. The largest amount of saline intrusion damage is estimated in the target area of Vung Liem Sluice Gate with VND 504 billion at financial price (US$ 24 million) followed by Bong Bot with VND 336 billion (US$ 16 million) and Tan Dinh with VND 273 billion (US$ 13 million).

Table 7.3.4 Expected Saline Intrusion Damage

Year	Whole Project (3 gates & canal extension)	1. Bong Bot Sluice Gate	2. Tan Dinh Sluice Gate	3. Vung Liem Sluice Gate
2020	51,228,922	5,122,892	4,162,350	7,684,338
2030	115,265,076	11,526,508	9,365,287	17,289,761
2040	186,895,610	18,689,561	18,689,561	28,034,341
Total: 2014-2043	3,364,795,653	336,479,565	273,389,647	504,719,348
US$	$164,058,346	$16,405,835	$13,329,741	$24,608,752

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

3) Total Project Benefit

Total accrued benefit from the 30-year Project period will be VND 9,912 billion (US$ 483 million) at financial price. Project benefit accrued from damage recovery accounts for 70% with VND 6,954 billion, and damage prevention shares 30% with VND 2,957 billion at financial price.

Table 7.3.5 Total Project Benefit between 2014 and 2043 (30 years)

	(1)Damage Recovery '000VND	(2) Damage Prevention '000VND	Total Benefit '000VND
Whole Project (three gates + canal extension)	6,954,864,925	2,957,859,777	9,912,724,703
(US$)	$339,100,424	$144,217,252	$483,317,676
1. Bong Bot	881,666,604	339,681,373	1,221,347,977
2. Tan Dinh	716,354,116	275,991,116	992,345,231
3. Vung Liem	1,322,499,906	509,522,059	1,832,021,966
Share in total	70%	30%	100%

Source: JICA Study Team
Note: US$= VND 20,509.75 (Exchange rate: World Bank Official Exchange rate in 2011 (LCU per US$, period average)

7.4 Project Economic and Financial Evaluation

The Economic Internal Rate of Return (EIRR) is calculated based on the above economic cost and benefit. B/C and Net Present Value (NPV) are also calculated using the opportunity cost of capital in Vietnam, namely 12% as a discount rate. As shown in table 7.4.1, The EIRR of total Project, three sluice gates plus Say Don Canal extension, is estimated at 27.7%. In addition, other economic indicators show positive results; B/C is calculated at 2.95 and NPV is approximately VND 972 billion. Therefore, it is concluded that the proposed Project is economically feasible.

The EIRR is also calculated two cases; the Project benefit considered only future damage prevention and the Project benefit considered only damage recovery from saline intrusion. If the Project considered only future damage prevention as a project benefit, the EIRR would drop to 8.0%. If the Project counted only damage recovery from the saline intrusion as the project benefit, the EIRR would decrease to 23.6%.

This result indicates that even if the Project counts only present damage recovery, the whole Project still be feasible from the economic point of view. On the other hand, it is difficult to find economical efficiency if the Project focuses on future damage prevention further to be caused by future climate change. Table 7.4.1 shows the results of economic indicators.

Table 7.4.1 Results of the Economic Indicators

Particulars	EIRR	B/C	NPV '000VND	(FIRR)
Whole Project (3 gates + canal extension)	**27.7%**	**2.95**	**972,379,714**	**21.5%**
Benefit: only Damage Prevention	8.0%	0.64	-179,750,474	6.1%
Benefit: only Damage Recovery	23.6%	2.23	614,727,184	17.4%
1. Tan Dinh Sluice Gate	**14.4%**	**1.20**	**32,295,161**	**11.2%**
2. Bong Bot Sluice Gate	**20.9%**	**1.79**	**105,447,747**	**16.6%**
3. Vung Liem Sluice Gate	**19.6%**	**1.66**	**143,246,831**	**15.6%**

Source: JICA Study Team

The EIRRs of each gate is also calculated; as a result, all of them exceed 12%. Bong Bot Sluice Gate shows the highest EIRR with 20.9% followed by Vung Liem Sluice Gate with 19.6%, and Tan Dinh Sluice Gate with 14.4%. Therefore, if the sluice gates constructed individually one by one, it would still be economically feasible.

7.5 Sensibility Analysis

As a result of sensibility analysis, 1) if the investment cost would increase by 10%, the whole Project of EIRR would be reduced to 25.9%. 2) If the Project benefit would decrease by 10%, the total EIRR would be decreased to 25.8%. 3) The effect of both 10% increase cost and 10% decrease benefit events would result in an EIRR 24.1%. 4) In case of 20% increase of estimated cost, the EIRR would drop to 24.4%. 5) If the Project would reduce by 20% of the expected benefit, the EIRR would be decreased to 23.7%. These results indicate that the proposed Project would be strong enough to overcome adverse circumstances.

Exploring the sensibility of each sluice gate, the proposed sluice gates show high economic efficiency with all the cases except Tna Dinh sluice gate. There are only two cases which the EIRRs are below 12%. In case of 10% increase of project cost nad 10% decrease of project benefit, the EIRR of Tan Dinh sluice gate would reduce to 11.8%. Also, if the project cost decreased 20%, the EIRR of Tan Dinh sluice gate would drop to 11.5%. However, the EIRRs of all the other cases show the positive result. Therefore, these results also support the strong economical feasibility of the Project.

Table 7.5.1 Results of Sensibility Analysis

	Whole Project(including Canal Extension)	1. Tan Dinh Sluice Gate	2. Bong Bot Sluice Gate	3. Vung Liem Sluice Gate
Base Case	27.7%	14.4%	20.9%	19.6%
1) 10% increase of Cost	25.9%	13.1%	19.2%	18.0%
2) 10% decrease of benefit	25.8%	13.0%	19.0%	17.8%
3) 1+2	24.1%	11.8%	17.4%	16.3%
4) 20% increase of cost	24.4%	12.0%	17.7%	16.6%
5) 20% decrease of benefit	23.7%	11.5%	17.0%	15.9%

Source: JICA Study Team

7.6 Farm Budget Analysis

A farm budget representing typical rural household in Project area is modeled as shown in Table 7.6.1. Total net income with the Project will increase by 16.7% compared to the present net income. An increase of fruit production will be a big part of total net income increase that is about 11.4%. This is because fruit production gives higher economic return than that of paddy. Contrary, net income increase of paddy shares only 5.3% of the total increment. The proposed project would allow not only damage prevention from saline intrusion, but also contribute to nearly 17% increases in household income.

Table 7.6.1 Farm Budget Analysis

			Present (Without)		With Project		Net Income Increase
	Area (ha)	Unit Price (VND/kg)	Yield (kg/ha)	Total Value (VND)	Yield (kg/ha)	Total Value (VND)	
SA Paddy	0.65	6,365	4,670		4,670		
(A) Gross Income				19,320,958		19,320,958	
(B) Production Cost				11,567,365		11,567,365	
(C) Net Income				7,753,593		7,753,593	0.0%
AW Paddy	0.71	6,591	4,687		4,687		
(A) Gross Income				21,933,332		21,933,332	
(B) Production Cost				11,644,000		11,644,000	
(C) Net Income				10,289,332		10,289,332	0.0%
WS Paddy	0.69	6,398	5,827		6,526		
(A) Gross Income				25,723,991		28,810,870	
(B) Production Cost				13,108,755		13,108,755	
(C) Net Income				12,615,236		15,702,114	5.3%
Fruit	0.3	12,900	10,834		12,567		
(A) Gross Income				41,927,580		48,635,993	
(B) Production Cost				13,845,766		13,845,766	
(C) Net Income				28,081,814		34,790,227	11.4%
Total	2.05			58,739,974		68,535,266	16.7%

Source: Household Economic Survey, JICA Study Team (2011) and Statistical Yearbook 2010, Tra Vinh Province.

7.7 Project Indirect Benefit

1) Enhancement of Mobility

Enhancing mobility is also expected as another indirect benefit from the Project. Most of the sluice gates have a function as a bridge besides saline intrusion prevention. People who usually take a long way around will be able to save time by using the bridge attached to the gate. Thus, the Project will

contribute to enhancing the mobility of people's daily life.

2) Narrowing Disparities between Urban and Rural

The Project will contribute to narrowing disparities between urban and rural areas. This is because the Project is expected to increase farm income as a result of recovering crop productivity. This makes farm income level in rural area higher; hence, the Project will contribute to narrowing income disparities between urban and rural people.

3) Promoting High Value Added Crops

The Project will encourage farmers to cultivate high value added crops such as fruit. This is because the Project is to protect agricultural production from saline intrusion damage. Constructing sluice gates will play a role of promoting value added crops by preventing one of the major farming risks. Therefore, farmers will be able to cultivate more high value added crops.

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Necessity of sluice gate construction, together with the extension of fresh water recruitment canal under the project, has been urged by a series of simulation and studies. Saline intrusion has already affected the project area and also is considered to expand its affected area in future, so that the implementation of this project is essential for Tra Vinh province in order to sustain the agriculture therein. This project is now considered feasible from the following view points, whereby it is concluded that the project should be implemented at an early period of time with higher priority:

1) On the economic evaluation, overall EIRR showed 26.7%, higher than the opportunity cost of 12% in Vietnam, in case of the project composed of three sluices construction plus canal extension. If only the sluices are taken up as an individual project separating from the canal extension, estimated EIRR came to; 20.9% for Bong Bot sluice gate, 14.4% for Tan Dinh sluice gate, and 19.6% for Vung Liem sluice gate, all of which are higher than that of opportunity cost of Vietnam.

2) On the environmental issue, except for resettlement, the proposed project does not give severe adverse impact on the surrounding environment. Some impacts such as noise and air pollution may take place during construction period; however, these impacts are limited and temporary, and still possible to mitigate by available measures to be taken by contractor(s).

3) On the resettlement, numbers of households to be relocated are estimated at; 8 for Bong Bot sluice gate, 16 for Tan Dinh sluice gate, 11 for Vung Liem sluice gate, and approximately 260 for the canal extension. The legal frame of resettlement in Vietnam is well developed where each PPC has its original unit price of compensation considering local conditions together with the national level regulation. The system has been functioning, so that the resettlement required under the project could be managed.

4) On the technical issue, there are no specific difficulties for implementing the project and in addition materials to be used under this project are common and available in Vietnam. Therefore, the project is technically feasible to implement, and in addition the construction schedule is not tight taking into account actual similar practices in Mekong delta. Further, each responsible office to implement and manage this project has enough human resources with similar experiences, whereby construction and management thereafter could well be done.

8.2 Recommendations

Toward and during the implementation, following measures are recommended for the Vietnamese government to undertake:

1) As for resettlement and land recovery, it is recommended to pay further attention to the people to be affected; e.g. application of WB policy 4.12 is recommended in addition to the existing resettlement frame to increase opportunity for the affected persons to participate in the preparation of the resettlement plan, and to minimize a gap between market price and prescribed price of land compensation. In sum, it is recommended to involve the persons to be affected at an earlier stage and also to fill the gaps between the prices.

2) It is recommended to implement the sluice construction by ODA assistance while the canal extension by the Vietnamese government budget. This is because; impact of climate change, especially saline intrusion coupled with sea level rise, is an argent issue in Tra Vinh province. To prevent the saline intrusion at an early stage of time, it is thought to be better to seek assistance from donor(s) taking into account budgetary constraint for the Vietnamese government. On the other hand, canal extension work may take longer time than planned due mainly to the many

households to be relocated. Therefore it is needed for the government to proceed step by step, utilizing the government own budget.

3) Of the 3 sluices, priority should be given to the Bong Bot and Tan Dinh sluices which are planned on the Tien river side while Vung Liem planned on Co Chien river side can be implemented later than those 2 gates taking into account the current level of saline intrusion. Vung Liem should also be constructed in parallel with the canal extension, so that the water recruitment starting at an upstream point from the Vung Liem sluice gate can be achieved to the maximum expected level.