PART IV

CROPPING SYSTEM IMPROVEMENT PROGRAM TOWARD CLIMATE CHANGE

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 Cropping System Improvement Program toward Climate Change, which centers on capacity development for the relevant government officers as well as farmers in adapting to and coping with climate change for their cropping system.

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 Paddy production in the Project area is in an increasing trend, notwithstanding some stagnation in area planted. In particular, summer-autumn production and winter-spring production have been increasing in the past two decades, while the production of autumn-winter paddy is on a little decreasing trend. In fact, yield has been increasing for all the seasons' paddies including autumn-winter paddy. Of them, winter-spring paddy has kept the highest yield; 6.4 ton/ha in 2010 as an average of 7 coastal provinces, followed by 4.7 tons/ha for summer – autumn paddy and 4.12 tons/ha for autumn – winter paddy.

2.8 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.

2.9 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.

2.10 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.

2.11 Extensive shrimp cultivation system is sometimes combined with paddy production. In this kind of system, shrimp is cultivated only in the dry season when saline intrusion takes place. In this system, as the period available for shrimp culture is limited, larvas are released only one time at the beginning of the dry season in most cases. After farmers have harvested the shrimp at the end of dry season, they usually leave the farm land for two to two and half months during the early rainy season. The farm plots where salt has been accumulated with shrimp culture are therefore washed by rainfall, getting ready for paddy cultivation for the rainy season.

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 by about 3.0% by year 2050 in the case of A2 scenario (high green house gas emission). Monthly rainfall in October is projected to increase by 15%, more than 20%, and more than 30% by year 2100 for the scenarios B1, B2, and A2 respectively. 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:

- ✓ *Yield loss by temperature rise*: Extremely high temperature during vegetative stage of paddy reduces tiller number and plant height and negatively affects panicle and pollen development. It was estimated that approximately 0.57 ton/ha of yield loss is caused per 1.0 degree Celsius of temperature increase at a range between 31-33 degree Celsius. As a result, present yield of winter-spring paddy at around 4.5-4.9 tons/ha would decrease to 3.8-4.2 tons/ha by 2050, accounting for about 12-18% of yield loss.

- ✓ *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.

- ✓ *Combined loss by saline intrusion and inundation*: Combined loss of saline intrusion in dry season and inundation in rainy season in year 2050 is estimated on average 30% of the annual production of paddy, vegetable, fruits, tree and shrimp, ranging from 20% to 50% by province. In monetary value, it accounts for about 3.6 trillion to 12 trillion VND.

4. DESIGN OF THE PROJECT

4.1 To pursue the national targets in agricultural and rural development, the project is proposed with an aim to avoid any losses conceivable by the negative effect of climate change in the future. It is expected that general trend of climate change entails significant impacts to the rural life as forms of saline intrusion, temperature increase, and a lack of freshwater, and skewed weather pattern for example. As a result, there will be such areas where agro-ecological condition may no longer be suitable to the existing commodities.

4.2 Generally, those issues can be addressed through structural measures such as construction of sea dykes, sluice gate, and irrigation/drainage canals effectively and thoroughly. Yet, precise timing and consequences of climate change are still in uncertainty and thus it is difficult to put the highest priority to such a large investment projects. To complement structural measures, therefore, this project proposal focuses on non-structural measure, namely adapting cropping systems in accordance with the occurrence of climate change issues on the ground. Here, the term "cropping systems" is used in a broader sense –including aquaculture or sometimes represented by "agricultural system."

4.3 The overall goal is that based on agricultural land use plan, suitable cropping systems are adapted in the coastal Mekong delta where climate change issues become apparent. By achieving the overall goal of the project, farmers in the coastal area can reduce avoidable losses of agricultural production to be affected by climate change and then productions of agricultural and aquacultural commodities are secured along with the government policy. The objectives is therefore that through the project, cropping systems suitable to such an environment being affected by climate change issues are developed and adapted in the target areas of the coastal Mekong delta.

4.4 To achieve the project objective, there are five major outputs expected: 1) vulnerable areas where climate change issues, such as saline intrusion, have already become apparent are identified; 2) improved agricultural and aquacultural systems are established, which are suited to each level of environmental features caused by climate change; 3) new agricultural and aquacultural systems are put in the agricultural and aquacultural land use plan in accordance with the progress of climate change; 4) new systems are promoted through the existing government extension system, using field trials, on-farm demonstration, lectures, etc.; and 5) an entire process of the above is systematized as an improved extension system oriented to climate change adaptation.

4.5 Activities are planned as listed below corresponding to the aforementioned each output:

<u>Output (1): Vulnerable areas where CC issues have already become apparent are identified</u>

1-1: Review existing documents concerning climate change issues such as saline intrusion
1-2: Select pilot provinces where climate change issues are urgent
1-3: Study needs of farmer households to clarify the significance of CC issues and their impacts to the livelihood of target areas
1-4: Confirm existing policy of target provinces
1-5: Confirm the issues with related agencies including DARD
1-6: Select target districts

<u>Output (2): Improved agricultural systems are established, which are suited to features caused by CC</u>

2-1: In coordination with research and development institutes, universities, and government agencies concerned, identify useful technologies for agricultural and aquacultural production (i.e., varieties, cropping system, farming portfolio).
2-2: Validate applicability of new technologies based on coordination with target farmers

<u>Output (3): New systems are put in the land use plan in accordance with the progress of CC</u>

3-1: Modify agricultural and aquacultural land use plan according to the progress of climate change issues
3-2: Make agreement with agencies concerned and target farmer groups for the land use plan
3-3: Make a strategic plan of technology dissemination in accordance with the land use plan

<u>Output (4): New systems are promoted through the existing extension system</u>

4-1: Survey existing extension system for agriculture and aquaculture technologies
4-2: Produce extension materials related to new agricultural and aquacultural system
4-3: Train extension officers at provincial extension centers in coordination with provincial extension entities, research and development institute and the implementing agency
4-4: Supervise provincial extension officers carry out further extension to district extension officers and clientele farmers
4-5: Monitor the improvement of agricultural and aquacultural system at sites
4-6: Provide technical guidance to participating farmer households
4-7: Evaluate effectiveness and applicability of introduced technologies

<u>Output (5): An entire process is systematized as an improved extension system oriented to CC</u>

5-1: Extension materials are prepared and tested, and finalized based on feedback from participants
5-2: An extension model is prepared as a guideline for agricultural and aquacultural production under changing environment associated with climate change

4.6 As the project requires highly technical conduct, technical assistance and related inputs may be required from donor country(ies) along with the self-support of Vietnamese government toward the same end. In principle, deployment of experienced experts are required for both long term and short term position from the donor(s); those who are responsible in designing of the entire project framework, provision of technical guidance, and coordinating with agencies concerned, through which technical transfer is to be made to counterpart personnel involved in the implementing process of the project.

4.7 Here, the Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP) is proposed as the main implementing agency. Sub-NIAPP is responsible for consulting works in southern provinces of Vietnam, which includes general research in agricultural planning, land use planning, and design and implementation of agricultural and rural development projects. As a part of its duty, Sub-NIAPP carries out survey and assessment of agricultural resources such as soil property, biological species, and human resources. Particularly, for land use planning and associated cropping-pattern planning, Sub-NIAPP plays a pivotal role in coordination with provinces and the central government.

4.8 As for the proposed institutional arrangement, Joint Coordinating Committee (JCC) should be established at central level in Hanoi, which is composed of MARD, MoNRE, and JICA. As general land use plan is subject to the approval from MoNRE, MoNRE should also be a part of the JCC. The JCC is responsible to authorize the direction of the project and coordinate the project activities to be in line with the government policy. For example, proposed change of land use plan should be submitted to the JCC, at which the plan should be approved.

4.9 At regional level, Project Implementing Committee (PIC) is established in participation with responsible institutes in agriculture and aquaculture development. The PIC is responsible in monitoring and improvement of project activities. Sub-NIAPP is the primary institute that administrates the entire process of the Project in coordination with donor experts.

4.10 Those two parties, Sub-NIAPP and donor experts, coordinate with and get support from other agencies: provincial peoples' committee, provincial extension center that represents agricultural division of DARD, Aquaculture Research Institute No.2, Cuu Long Delta Rice Research Institute, and SOFRI. The institutes provide technical guidance and help establish a set of improved agricultural and aquacultural systems oriented to climate change adaptation, e.g. adaptation to saline intrusion.

4.11 Then, improved systems are to be disseminated through existing government extension system. Here, provincial extension centers supported by the experts and Sub-NIAPP carry out provincial level project activities, and supervise the frontline activities to be pursued by district extension stations. The district extension stations take a lead as an interface of extension entities to clientele farmers. Those participating officers from district extension stations are targeted to be functional and strengthened their extension capacities oriented to climate change adaptation through the project activities.

4.3 Target Groups

4.12 The main objective of the project is to adapt agricultural and aquacultural systems to ever-changing climatic conditions. To this end, it is required to secure such a system wherein improved technologies be disseminated to farmer households through an extension mechanism. Under such circumstances, direct target groups of the project are set as provincial extension centers. Provincial extension center maintains a pool of technical staff (on average 60 officers/ province) and, as a part of DARD, holds an enough authority in planning and implementation of agricultural and rural development activities in the province.

4.13 To be sure, involvement of district extension station is crucial. District extension stations are the tail-end entity of the government's extension system in agricultural and aquacultural technology dissemination. As an interface to farmer households, district extension stations maintain, on average, six officers per office and sometimes they are attached to the peoples' committees' office at commune level for short-term or activity-basis. Upon technical guidance from provincial extension center, those technical officers train a group of advanced farmers from communes, through which technologies are to be disseminated. To ensure an effective technology-dissemination, thus, it is necessary to activate the extension activities of those officials on the ground.

4.4 Project Implementation Schedule and Cost

4.14 This Project is carried out in a five-year period, which is divided into three phases. In phase I, precise agricultural land use plan is established based fully on the latest status of climate change issues especially saline intrusion. As a part of it, improved cropping systems are proposed as technical packages. Example includes introduction of new rice varieties (saline tolerant, morning pollination type, early maturing, etc.), rotation between paddy cultivation and shrimp culture, and introduction of transplanting, all of which are suitable to avoid potential loss incurred by climate change issues.

4.15 In phase II, those technical packages are introduced, promoted, and adapted in areas where climate change issues have already become apparent. For the promotion of the technologies, the existing government extension system is fully used, through which capacity of extension officers at provincial and district levels are to be strengthened. In phase III, activities of promoting new agricultural and aquacultural systems are expanded toward wider range of areas where climate change issues are in place. Through monitoring extension activities and application of the new technologies, entire process is reviewed and finalized.

4.16 Project costs is categorized into donor side and Vietnamese side, and further divided into expert, materials/equipment, training, and others. As a summary, total project cost for the 5 year project duration comes to US$ 5,178,000 composed of US$ 4,913,000 by donor and US$ 265,000 for counterpart fund.

CONTENTS (CROPPING SYSTEM IMPROVEMENT)

EXECUTIVE SUMMARY
CONTENTS
ABBREVIATIONS
LIST OF TABLES
LIST OF FIGURES

CHAPTER 1 INTRODUCTION IV-1-1

1.1 Rationale of the Project IV-1-1
1.1.1 National Plans IV-1-1
1.1.2 National Target Program to Respond to Climate Change (Ntp-Rcc) IV-1-2
1.1.3 Action Plan Framework of Rural and Agriculture Sector (2008-2020) IV-1-2
1.1.4 Development Direction in Mekong Delta IV-1-3
1.1.5 Constraints and Difficulties IV-1-3
1.2 Outline of the Project IV-1-6
1.2.1 Overall Goal, Objective, Outputs, Activities, and Input IV-1-6
1.2.2 Implementing Agency IV-1-8
1.2.3 Target Groups IV-1-10

CHAPTER 2 THE PROJECT AREA AND CLIMATE CHANGE IV-2-1

2.1 Salient Features of Project Area IV-2-1
2.1.1 Location and Demography IV-2-1
2.1.2 Meteorology and Hydrology IV-2-3
2.1.3 Major Features of Agriculture (Diversified Agriculture) IV-2-5
2.1.4 Agricultural and Aquacultural Land Use IV-2-5
2.2 Agriculture in the Project Area IV-2-10
2.2.1 Farmland per Household IV-2-10
2.2.2 Agriculture Production IV-2-11
2.3 Aquaculture (Shrimp Culture) in the Project Area IV-2-13
2.3.1 Aquaculture Production IV-2-13
2.3.2 Shrimp Culture by Category IV-2-14
2.4 Extension System for Agriculture and Aquaculture IV-2-17
2.4.1 Extension Systems IV-2-17
2.4.2 Authorization of Agricultural Land Use Plan IV-2-18
2.5 Expected Climate Change Based on Simulation Analysis IV-2-18
2.5.1 Temperature IV-2-19
2.5.2 Rainfall IV-2-21
2.5.3 Sea Level Rise IV-2-23
2.5.4 Mekong River Flow Regime Prediction (Mrc) IV-2-23
2.6 Expected Impact by and Adaptation to Climate Change IV-2-26
2.6.1 Impact on Crop Production by Temperature Rise under Climate Change IV-2-26
2.6.2 Impact on Crop Production by Saline Intrusion Under CC IV-2-28

CHAPTER 3 DESIGN OF THE PROJECT IV-3-1

3.1 Current and Up-Coming Issues Identified IV-3-1
3.1.1 Government Officers' Perception on Climate Change IV-3-1
3.1.2 Villagers' Perception on Climate Change IV-3-2

3.1.3 Saline Intrusion as Main Issue Considered in this Project IV-3-6
3.2 Project Components..IV-3-8
3.2.1 Cropping Calendar Adjustment/Improvement Programme.............................IV-3-10
3.2.2 Development of New Rice Varieties IV-3-11
3.2.3 Crop Diversification and Extension Program...IV-3-12
3.3 Proposed Technical Assistances and Inputs for the Project IV-3-13
3.3.1 Technical Assistances Required IV-3-13
3.3.2 Inputs Required IV-3-14
3.3.3 Proposed Project Sites..IV-3-15
3.4 Preparatory Project Evaluation IV-3-15
3.4.1 Evaluation by Five Criteria IV-3-15
3.4.2 Consideration on Poverty, Gender, and Environmental Issues........................IV-3-17
3.5 Institutional Arrangement for Project Implementation IV-3-18
3.5.1 Implementing Agency IV-3-18
3.5.2 Proposed Project Steering Committee..IV-3-20
3.6 Project Implementation Schedule and Cost IV-3-21
3.6.1 Project Implementation Schedule and Cost...IV-3-21
3.6.2 Project Implementation Schedule and Cost...IV-3-22
3.7 Project Design Matrix (PDM) and Plan of Operation (PO)...IV-3-27

CHAPTER 4 RECOMMENDATIONS IV-4-1

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
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) Company
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
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
NCB	National Competitive Bidding
NPK	Nitrogen, Phosphate, Potassium
NPV	Net Present Value
O&M	Operation and Maintenance
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
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 21,054 (TTB)
US$ 1.00	=	82.11 Japanese Yen (TTB)
VND 1.00	=	0.0039Yen

VIETNAM FISCAL YEAR

January 1 to December 31

LIST OF TABLES

Table 1.1.1 Past Trend in Climate and Water Level in Mekong Delta IV-1-4
Table 1.1.2 Simulated Trend in Climate and Water Level in Mekong Delta IV-1-5
Table 2.1.1 Land and Demography of the Project Area as compared with Other Areas IV-2-2
Table 2.1.2 Agricultural Land Use in the Project Area IV-2-8
Table 2.1.3 Major Cropping Calendar in Project Area IV-2-9
Table 2.2.1 Yield of Paddy from 2000 to 2010 .... IV-2-13
Table 2.3.1 Aquaculture Production in the Mekong Delta and Other Regions (2010) IV-2-13
Table 2.3.2 Typical Profile of Semi-Intensive and Intensive Systems IV-2-17
Table 2.5.1 Monthly Average Discharges at Kratie Simulated under Different Scenarios IV-2-24
Table 2.6.1 Damage Index for Saline Water Intrusion IV-2-28
Table 3.1.1 Issues with Priority Order related to Climate Change identified by 7 Provinces IV-3-1
Table 3.1.2 Priority Order of the Issues related to or caused by Climate Change IV-3-1
Table 3.1.3 Climate Change Issues Identified in the Problem Trees of Each Commune IV-3-3
Table 3.1.4 Climate Change Respondents Observed IV-3-4
Table 3.1.5 Major Damages or Losses Caused by Climate Change IV-3-5
Table 3.1.6 Countermeasures Taken by the Households IV-3-5
Table 3.1.7 Saline Intrusion at Farmers' Field or Canals Nearby IV-3-6
Table 3.1.8 Typical Cropping Pattern in Saline-Prone Areas IV-3-7
Table 3.1.9 Saline Prone Area of Currently Paddy Area to be Expected in 2050 (ha) IV-3-8
Table 3.6.1 Summary of Project Cost, US$ IV-3-22
Table 3.7.1 Project Design Matrix (PDM) for the Proposed Project IV-3-24
Table 3.7.2 Plan of Operation (PO) for the Proposed Project IV-3-28

LIST OF FIGURES

Figure 1.2.1 Overall Goal, Objective, and Outputs of the Project IV-1-7
Figure 1.2.2 Government Agencies related to the Proposed Project IV-1-9
Figure 1.2.3 Implementing Agency and Target Group IV-1-10
Figure 2.1.1 Population and Land Area by Province in the Mekong Delta IV-2-2
Figure 2.1.2 Population Density (Left) and Population Growth Ratio (Right) by Province in the Mekong Delta and by Region in Vietnam IV-2-3
Figure 2.1.3 Average Monthly Air Temperature at Major Locations in Mekong Delta IV-2-3
Figure 2.1.4 Annual Average Rainfall Counters IV-2-4
Figure 2.1.5 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month IV-2-4
Figure 2.1.6 Land Use Map of the Mekong Delta as of 2008 .... IV-2-6
Figure 2.1.7 Agricultural Land Use per Total Land Area (%)) IV-2-7
Figure 2.1.8 Agricultural Land Use per Total Agricultural Area (%) IV-2-8
Figure 2.2.1 Average Farm Production Area as Compared with Other Regions IV-2-10
Figure 2.2.2 Share of Farm Land Holdings by Scale as Compared with Other Regions IV-2-10
Figure 2.2.3 Paddy Production by Province in the Mekong Delta IV-2-11
Figure 2.2.4 Production of Paddy per Capita by Province IV-2-11
Figure 2.2.5 Paddy Production in Coastal Seven Provinces IV-2-12
Figure 2.2.6 Yield of Paddy in the Project Area IV-2-12
Figure 2.3.1 Per-capita Production of Aquaculture Fish (Left) and Shrimp (right) (2010) IV-2-14
Figure 2.3.2 Trend of Shrimp Production in Vietnam and Thailand IV-2-15
Figure 2.3.3 Shares in Area Cultivated and Production of Shrimp by Category IV-2-15
Figure 2.4.1 Agricultural Extension System IV-2-17

Figure 2.5.1 Mean Annul Temperature Rise at Year 2050 in Percentage under Scenario B2 .... IV-2-17
Figure 2.5.2 Mean Annual Temperature Change in Mekong Delta With 3 Scenarios, Source; PRECIS Simulation IV-2-19
Figure 2.5.3 Mean Annual Max. Temperature Change In Mekong Delta with 3 Scenarios, Source; PRECIS IV-2-19
Figure 2.5.4 Mean Annual Min. Temperature Change In Mekong Delta With 3 Scenarios, Source; PRECIS IV-2-19
Figure 2.5.5 Mean Annual Temperature Change Under Scenario B2 By Province, Source; PRECIS Simulation IV-2-20
Figure 2.5.6 Mean Annual Temperature Change Under Scenario A2 By Province, Source; PRECIS Simulation IV-2-20
Figure 2.5.7 Mean Monthly Temperature Change in Mekong Delta under B1, Source; PRECIS simulation IV-2-20
Figure 2.5.8 Mean Monthly Temperature Change in Mekong Delta under B2, Source; Precis SIMULATION IV-2-20
Figure 2.5.9 Mean Monthly Temperature Change in Mekong Delta under A2, Source; PRECIS simulation IV-2-20
Figure 2.5.10 Annual Rainfall Change at Year 2050 in Percentage under Scenario B2 .... IV-2-21
Figure 2.5.11 Annual Rainfall Change in Mekong Delta under 3 scenarios, Source; PRECIS simulation IV-2-21
Figure 2.5.12 Annual Rainfall Change by Province under Scenario B1, Source; PRECIS simulation IV-2-21
Figure 2.5.13 Annual Rainfall Change by Province under Scenario B2, Source; PRECIS simulation IV-2-22
Figure 2.5.14 Annual Rainfall Change by Province under Scenario A2, Source; PRECIS simulation IV-2-22
Figure 2.5.15 Monthly Rainfall Change in Mekong Delta under Scenario B1, Source; PRECIS simulation IV-2-22
Figure 2.5.16 Monthly Rainfall Change in Mekong Delta under Scenario B2, Source; PRECIS simulation IV-2-22
Figure 2.5.17 Monthly Rainfall Change in Mekong Delta under Scenario A2, Source; PRECIS simulation IV-2-22
Figure 2.5.18 Sea Level Rise of Mekong Coastal Area under 3 Scenarios, Source; PRECIS simulation IV-2-23
Figure 2.5.19 Sea Level Rise by Province Under Scenario B1, Source; PRECIS simulation IV-2-23
Figure 2.5.20 Sea Level Rise by Province Under Scenario B2, Source; PRECIS simulation IV-2-23
Figure 2.5.21 Sea Level Rise by Province Under Scenario A2, Source; PRECIS simulation IV-2-23
Figure 2.5.22 Mekong River Discharge at Kratie during Dry Season (A1 and B2) IV-2-25
Figure 2.5.23 Mekong River Discharge at Kratie during Rainy Season (A1 and B2) IV-2-25
Figure 2.5.24 Mekong River Discharge at Kratie during Dry Season with Basin Development Projects IV-2-25
Figure 2.5.25 Mekong River Discharge at Kratie during Rainy Season with Basin Development Projects IV-2-25
Figure 2.6.1 Correlation between the Paddy Yield and Maximum Monthly Temperature ... IV-2-26

Figure 2.6.2 Four Potential Development Options based on Structural and Non-structural Interventions IV-2-27
Figure 2.6.2 Yield Reduction under B2 Scenario IV-2-27
Figure 2.6.3 Yield Reduction in % under B2 Scenario IV-2-27
Figure 2.6.4 Yield Reduction under A2 Scenario IV-2-27
Figure 2.6.5 Yield Reduction in % under A2 Scenario IV-2-27
Figure 2.6.6 Production Reduction under B2 Scenario IV-2-28
Figure 2.6.7 Production Reduction under A2 Scenario IV-2-28
Figure 2.6.8 Salinity Isolines of March for DY 1998 MR Discharge with 30 cm SRL (2050) IV-2-29
Figure 2.6.9 Salinity Isolines of April for DY 1998 MR Discharge with 30 cm SRL (2050) IV-2-29
Figure 2.6.10 Salinity Isolines of May for DY 1998 MR Discharge with 30 cm SRL (2050) IV-2-29
Figure 2.6.11 Salinity Isolines of June for DY 1998 MR Discharge with 30 cm SRL (2050) IV-2-29
Figure 2.6.12 Production Loss(%) by Province (DY1998 MR Discharge with Different SLR) IV-2-30
Figure 2.6.13 Production Loss(%) by Province (Scenario B2 MR Discharge with Different SLR) IV-2-30
Figure 2.6.14 Production Loss(VND) by Province (DY1998 MR Discharge with Different SLR) IV-2-30
Figure 2.6.15 Production Loss(VND) by Province (Scenario B2 MR Discharge with Different SLR) IV-2-30
Figure 3.1.1 Trend of Drought (Fresh Water Shortage) IV-3-3
Figure 3.1.2 Trend of Inundation IV-3-3
Figure 3.1.3 Trend of Saline Intrusion IV-3-3
Figure 3.1.4 Saline Intrusion in 1998 and 2020 based on Simulation IV-3-7
Figure 3.2.1 Recommended Adjustment for Cropping Patterns IV-3-9
Figure 3.5.1 Organizational Structure of Sub-NIAPP IV-3-18
Figure 3.5.2 Institutional Arrangement IV-3-20
Figure 3.6.1 Phasing of the Project IV-3-22

MAIN
REPORT

CHAPTER 1 INTRODUCTION

This report is to propose an agricultural and rural development project as one of the necessary activities for climate change adaptation in the coastal Mekong Delta. First, a comprehensive project proposal is presented from Chapter 1 to Chapter 3 and then from section 3.3, a specific technical assistance project is proposed aiming to be funded by donors as technical cooperation project.

1.1 Rationale of the Project

1.1.1 National Plans

1) National Development Plan (Agricultural and Rural Development 2011 – 2015)

Overarching national development plan in Vietnam is the Five Year Socio-Economic Development Plan 2011 – 2015, composed of all the development sectors corresponding primarily to the ministerial set-up. Of the plan, the section of Agriculture and Rural Development 2011 – 2015 is the relevant part to the proposed project. The main objective of the agricultural and rural development sector is to achieve sustainable development, improve living conditions of rural population, especially poor people, and properly protect and exploit natural resource and the environment.

The sector elaborates relevant activities in such areas of agriculture, aquaculture, livestock, horticulture, etc. Of them, the agriculture sector development aims at ensuring food security for the nation and exploitation of advantageous commodities for domestic and export demand. Some proposed priority projects include: 1) national food security program, 2) farming pattern shift program, 3) disease control for farming program. Of them, the first 2 programs are quoted below;

National food security program, one of the priority programs, aims at maintaining planned paddy area at 3.8 million ha, investing on water resources development to meet irrigation requirements, conducting research and study to develop improved seeds, enhancing promotion activities to encourage farmers apply advanced technologies into production, and developing post-harvest technology. Also, the program plans to enhance paddy production in the two deltas, form large production area in East-southern region, Central Highland, Northern Midlands and Mountainous region, Mekong Delta, and apply suitable cropping pattern to achieve high output. The paddy production target in 2015 is set at 40 million tons, including export of 4 – 4.5 million tons.

Farming pattern shift program is to promote the production of advantageous crops in the country such as paddy, coffee, cashew, pepper, tea, rubber, tropical fruits and vegetable; enhance value of those crops to improve competitiveness in domestic and international market. The targets under this program are; cereals crop area reaches 8.23 million ha with output 46.3 million tons, in which paddy is 7.0 million ha with the output 40 million tons. Beans and vegetable area is set at 1.09 million ha with output 15 million tons, and on average production per capita is targeted at 161 kg/person/year. Fruit is targeted to increase by 50,000 ha to reach 850,000 ha in year 2015.

In the aquaculture development sector, such development indicators are set; total aquaculture farming area is set to increase from 1,110,000 ha in 2010 to 1,120,000 ha (101%) in 2015, total aquaculture output from 4,800,000 tons to 6,000,000 tons (125%), total catching production from 2,200,000 tons to 2,350,000 tons (107%), and export from US$ 5,000 million to US$ 7,000 million (140%). It is known that the export is targeted to increase by as much as 40% in monetary value by year 2015. In fact, 60% of the aquaculture products are planned to be processed in meeting safety and hygiene standard, for which export is to be facilitated to 200 countries.

The aquaculture development sector aims at upgrading technology, and developing offshore catching. In addition, the sector is to continue development of aquaculture farming in fresh, brackish and saline area, and ensure enough seeds (50 billion shrimp seed, 25 billion fish seeds). Farming area is to be maintained at 1.12 million ha while the total aquaculture farming output is targeted to increase to 3.65 million tons in 2015 from 2.60 million ton in 2010. Focus is placed on such 3 main raising commodities as tiger shrimp, white-leg shrimp, and catfish.

Though the above Agricultural and Rural Development 2011 – 2015 does not specifically mention about climate change, it is obvious unless otherwise measures are undertaken, such target as 40 million tons production of paddy can hardly be achieved. In addition, aquaculture e.g. brackish shrimp culture is emphasized in the above plan especially from export point of view aside from fresh water catfish. Therefore, the proposed Project to adjust cropping pattern and improve the pattern as well the agricultural system is highly in line with the national development plan.

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

National Target Program to Respond to Climate Change (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 to ensure sustainable development of Vietnam. The standing agency for the NTP-RCC 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.

1.1.3 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) conduct the communication and information program to disseminate knowledge and experiences to enhance people’s awareness on climate change impacts, 2) develop human resources and conduct studies to develop and consolidate scientific foundation for providing solutions for climate mitigation and adaptation, 3) develop policy system, integrating climate change in sectoral development program, 4) promote international cooperation in mitigation and adaptation, and 5) carry out priority activities for implementing mitigation and adaptation.

In connection with above 5) priority projects, there are some concrete project 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 measures is to improve cropping pattern/system and adjust the pattern to the climate change environment, e.g. to cope with and/or adapt to saline intrusion, one of the severest impact from climate change. Therefore, the proposed Project is highly in line with the above 2 national plans.

1.1.4 Development Direction in Mekong Delta

One of the most important policy settings can be seen in the master plan to agriculture product development up to 2020 and vision to 2030 (Decision No. 124/QD-TTg, as of February 2, 2012). In this decision, area for aquaculture production is targeted to be 790,000 ha in the nation, which is 99,700 ha or 14.4% of increment from the current land use. To this end, the Mekong Delta is expected to contribute 70% of this increment, that is, by 2020, approximately 70,000 ha of shrimp culture area need to be newly developed in the Mekong Delta. Considering the fact that brackish shrimp culture is mainly practiced in the coastal areas, this projection should be focused on the Project area.

Additionally, it was decided to maintain 3,812,000 ha of paddy field in the Country, of which 3,200,000 ha is to be cultivated under the two-cropping system, producing 41-43 million tons in 2020 and 44 million tons in 2030 both for self-consumption and exportation. This clause of the decision can be interpreted to a general direction that current paddy area should be kept as it is. In fact, a small-scale pilot project on fruits production in Tien Giang province was rejected as it was in a "paddy" area of the land use plan—policy of land use, especially for paddy production, is strictly enforced by the Government.

Regarding Mekong Delta area, there are two important development directions: 1) current paddy cultivation area should be maintained, and 2) area of shrimp culture should be increased for 70,000 ha. Yet, as it is discussed hereafter, climate change would make it difficult to keep the paddy cultivation area as it is today, especially in the coastal Mekong Delta. Thus, the recommended strategy is to change the cropping pattern from paddy-paddy cultivation to shrimp-paddy cultivation where paddy production during dry season can hardly be done, and then, increase the yield of paddy production where paddy cultivation is still possible. In this regard, the proposed Project is highly expected to contribute to the above development direction of the Mekong Delta.

1.1.5 Constraints and Difficulties

1) Current Issues related to Climate and Sea Level

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 three places: 15 cm over the past three decades—meaning 5 cm of increase per decade. The table below summarizes past trend in climate and water level.

Table 1.1.1 Past Trend in Climate and Water Level in Mekong Delta

Indicator	Trend	Measuring Stations	Period
Temperature	Annual mean: Increased by 0.7 degree Celsius Mean maximum: Increased by 1.0 degree Celsius Mean minimum: Increased by1.0 degree Celsius	Vung Tau, Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Annual Sunshine hours	Decreased by about 500 hours, accounting for 20% of original hours	Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Evaporation	Increased in Vung Tau and Can Tho Decreased in Ca Mau and Rach Gia (Annual value ranges 800-1,400mm)	Vung Tau, Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Rainfall	Increased in Ca Mau, Rach Gia and My Tho Little decreased in Ca Mau, Vun Tao (Can Tho alone increased during 1910-2010)	Can Tho, Ca Mau, Rach Gia , My Tho, Vun Tao	1978-2010
Water level	Increased by 15 cm over 30 years (5 cm per decade)	Vung Tau, Rach Gia, Can Tho	1982-2009/2011

Source: JICA Project Team (2012)

As a result of all those climate changes, there are a number of issues claimed on the ground, although concrete quantitative evidences are not always available. For example, it was pointed out that occurrence of diseases has increased both for crop and aquaculture products, size of fruits has decreased, and paddy received damage by saline water, etc. Typically observed is an issue of saline intrusion along coastal areas. Many farmer households have already shifted from paddy cultivation to shrimp cultivation in such areas where saline contents is considerably high.

On the other hand, in such a delicate area where saline intrusion occurs once in a while, paddy is often damaged by high salinity in canal water. Risk of saline intrusion is also associated with human factors: a delay of gate operation had caused loss of paddy approximately 70% of harvest in 8,000ha and 30-70% in about 3,000ha in Tra Vinh province in 2010. So, climate change issues are already urgent issues.

2) Climate Change Prediction

With reference to a climate change simulation by Global Circulation Model (GCM) and the Providing Regional Climates for Impacts Studies (PRECIS)—a regional climate model system, it is expected that the mean annual temperature (1980-1999) would increase by 1.0 degree Celsius by year 2050, of which significance of temperature increase is greater in rainy season when paddy is mainly cultivated. Monthly rainfall in October is now projected to increase by 15%, more than 20%, and more than 30% by year 2100 for the scenarios B1, B2, and A2.

On the other hand, annual rainfall is expected to increase by about 3.0% by year 2050 in the case of A2 scenario (high green house gas emission). 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 31cm by year 2050 and as much as 103 cm by 2100. The trend is quite exponential up until year 2100 for all the scenarios.

Table 1.1.2 Simulated Trend in Climate and Water Level in Mekong Delta

Indicator	Simulation Result
Annual temperature	- Increase by 1.0 degree Celsius by 2050 (A2, B1, B2) - Increase by 1.4 to 2.7 degree Celsius by 2100(A2, B1, B2)
Monthly temperature	- Increase 1.2 (B1), 1.3 (B2) and 1.4 (A2) degree Celsius by 2050 during rainy season - Increase 0.6 (B1), 0.7 (B2) and 0.8 (A2) degree Celsius by 2050 during dry season
Annual rainfall	- Increase the biggest at A2 scenario at 3.0% by 2050 and 7.0% by 2100
Monthly rainfall	- Decrease during dry season - Increase during rainy season (July and October) - As mean rainfall in October, increase by 15% (B1), 20% (B2), and 30% (A2) by year 2100
Sea level	- Increase by 31 cm by 2050 and 103 cm by 2100 (A2: biggest) - Increase by 28 cm by 2050 and 79 cm by 2100 (B2: medium) - Increase by 27 cm by 2050 and 70 cm by 2100 (B1: least) - Trend of all scenario is exponential until around year 2100
Mekong River Discharge	(Given no development project upstream) - In dry season, remain the same by 2050 as the average discharge during 1991-2000 (B2 and A2), having stronger tendency to increase from beginning to the end of the season. - In rain season, no clear tendency observed, having bigger discharge after September, as compared to the average discharge during 1991-2000
	(Given development project in catchment areas) - In dry season (March to April), increase by 70% from 2,300-2,400 m^3/s during 1991-2000 to 4,000 m^3/s by 2050 due to the effect of hydropower dams that release water during dry season.

Source: JICA Project Team (2012)

3) Constraints and Difficulties in Agriculture and Aquaculture

By the climate change so far having taken place and expected to occur, a range of damages are caused or to be caused. In this section, typical problematic issues are discussed as constraints and difficulties to farmer households on the ground:

a) *Yield loss by temperature rise*: Extremely high temperature during vegetative stage of paddy reduces tiller number and plant height and negatively affects panicle and pollen development. It was estimated that approximately 0.57 ton/ha of yield loss is caused per 1.0 degree Celsius of temperature increase at a range between 31-33 degree Celsius. As a result, present yield of winter-spring paddy at around 4.5-4.9 tons/ha would decrease to 3.8-4.2 tons/ha by 2050, accounting for about 12-18% of yield loss.

b) *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. As mentioned earlier, in addition, loss of paddy by saline intrusion is already a central issue in coastal provinces.

c) *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.

d) *Combined loss by saline intrusion and inundation*: Combined loss of saline intrusion in dry season and inundation in rainy season in year 2050 is estimated on average 30% of the annual production of paddy, vegetable, fruits, tree and shrimp, ranging from 20% to 50% by province. In monetary value, it accounts for about 3.6 trillion to 12 trillion VND.

After all, agricultural and aquacultural production in the coastal Mekong delta is at stake due to climate change so far having happened and expected to occur.

1.2 Outline of the Project

To pursue political targets in agricultural and rural development, this project is proposed with an aim to avoid any losses conceivable by the negative effect of climate change in the future. It is expected that general trend of climate change entails significant impacts to the rural life as forms of saline intrusion, temperature increase, and a lack of freshwater, and skewed weather pattern for example. As a result, there will be such areas where agro-ecological condition may no longer be suitable to the existing commodities.

Generally, those issues can be addressed through structural measures such as construction of sea dykes, sluice gate, and irrigation/drainage canals effectively and thoroughly. Yet, precise timing and consequences of climate change are still in uncertainty and thus it is difficult to put the highest priority to such a large investment projects. To complement structural measures, therefore, this project proposal focuses on non-structural measure, namely adapting cropping systems in accordance with the occurrence of climate change issues on the ground. Here, the term "cropping systems" is used in a broader sense –including aquaculture or sometimes represented by "agricultural system."

1.2.1 Overall Goal, Objective, Outputs, Activities, and Input

1) Overall Goal

Based on agricultural land use plan, which is to be periodically updated according to the latest circumstances of climate change, suitable cropping systems are adapted in the coastal Mekong delta where climate change issues become apparent. By achieving the overall goal of the project, farmers in the coastal area can reduce avoidable losses of agricultural production to be affected by climate change and then productions of agricultural and aquacultural commodities are secured along with the government policy.

2) Objective

Through the project, cropping systems suitable to such an environment being affected by climate change issues are developed and adapted in the target areas of the coastal Mekong delta.

3) Outputs

To achieve the project objective, there are five major outputs expected: 1) vulnerable areas where climate change issues, such as saline intrusion, have already become apparent are identified; 2) improved agricultural and aquacultural systems are established, which are suited to each level of environmental features caused by climate change; 3) new agricultural and aquacultural systems are put in the agricultural and aquacultural land use plan in accordance with the progress of climate change; 4) new systems are promoted through the existing government extension system, using field trials, on-farm demonstration, lectures, etc.; and 5) an entire process of the above is systematized as an improved extension system oriented to climate change adaptation.

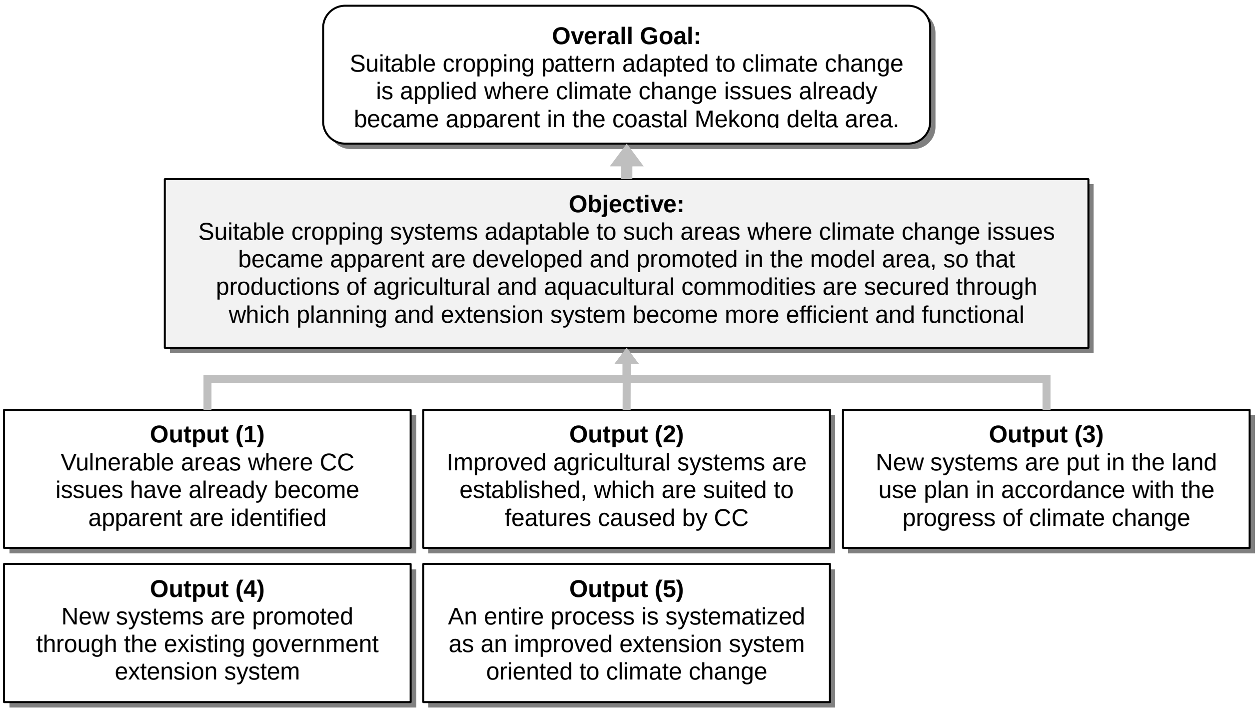


Figure 1.2.1 Overall Goal, Objective, and Outputs of the Project

4) Activities

Activities are planned as listed below corresponding to the aforementioned each output:

Output (1): Vulnerable areas where CC issues have already become apparent are identified

1-1: Review existing documents concerning climate change issues such as saline intrusion
1-2: Select pilot provinces where climate change issues are urgent
1-3: Study needs of farmer households to clarify the significance of CC issues and their impacts to the livelihood of target areas
1-4: Confirm existing policy of target provinces
1-5: Confirm the issues with related agencies including DARD
1-6: Select target districts

Output (2): Improved agricultural systems are established, which are suited to features caused by CC

2-1: In coordination with research and development institutes, universities, and government agencies concerned, identify useful technologies for agricultural and aquacultural production (i.e., varieties, cropping system, farming portfolio).
2-2: Validate applicability of new technologies based on coordination with target farmers

Output (3): New systems are put in the land use plan in accordance with the progress of CC

3-1: Modify agricultural and aquacultural land use plan according to the progress of climate change issues
3-2: Make agreement with agencies concerned and target farmer groups for the land use plan
3-3: Make a strategic plan of technology dissemination in accordance with the land use plan

Output (4): New systems are promoted through the existing extension system

4-1: Survey existing extension system for agriculture and aquaculture technologies
4-2: Produce extension materials related to new agricultural and aquacultural system

4-3: Train extension officers at provincial extension centers in coordination with provincial extension entities, research and development institute and the implementing agency

4-4: Supervise provincial extension officers carry out further extension to district extension officers and clientele farmers

4-5: Monitor the improvement of agricultural and aquacultural system at sites

4-6: Provide technical guidance to participating farmer households

4-7: Evaluate effectiveness and applicability of introduced technologies

Output (5): An entire process is systematized as an improved extension system oriented to CC

5-1: Extension materials are prepared and tested, and finalized based on feedback from participants

5-2: An extension model is prepared as a guideline for agricultural and aquacultural production under changing environment associated with climate change

5) Inputs

As the project requires highly technical conduct, technical assistance and related inputs may be required from donor country(ies) along with the self-support of Vietnamese government toward the same end. In principle, deployment of experienced experts are required for both long term and short term position from the donor(s); those who are responsible in designing of the entire project framework, provision of technical guidance, and coordinating with agencies concerned, through which technical transfer is to be made to counterpart personnel involved in the implementing process of the project.

1.2.2 Implementing Agency

Institutional setting related to agricultural and rural development in Mekong delta area is shown in Figure 1.2.2. In principle, Ministry of Agriculture and Rural Development (MARD) is the primary institute that governs the entire sector of agriculture, fishery, forestry, livestock and aquaculture. At national and regional level, there are a number of research and development institutions that are focused on specific subjects, for example, Cuu Long Delta Rice Research Institute that is a responsible agency in research and development on rice.

The Institute of Agricultural Science for Vietnam and its branch, the Institute of Agricultural Science for Southern Vietnam, covers wider area of expertise in agricultural sciences including various commodities. Others may include the Southern Horticultural Research Institute (SOFRI) that is a leading institute for research and development on horticulture (fruits). Similar institute is the Research Institute for Aquaculture No.2 that leads the aquaculture sector in southern provinces. Those independent institutions (colored by olive green) are all under MARD.

In addition, the National Center for Agricultural Extension (NAEC) functions as an apex institute in extension of agricultural technologies including crop production, fishery, aquaculture and forestry. As an official wing of MARD, NAEC has its own line of technology dissemination from top to down; it has offices at provincial and district levels, although those are physically incorporated into the general structure of the Department of Agriculture and Rural Development (DARD) at provincial level.

Furthermore, the Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP) plays a pivotal role in planning in agricultural development in southern provinces. Specifically, in coordination with DARD, it formulates land use plans. As for the authorization of the plans, Sub-NIAPP and its mother entity, NIAPP at Hanoi, coordinate with the Ministry of Natural Resources and Environment (MoNRE) as the land use is associated with conservation forest, national parks, and surface waters which are under the responsibility of MoNRE.

DARD and peoples' committee at provincial level maintains different responsibility and authority. 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 in the province; departments draft a development plan or specific activity plans and submit it to the committee for approval. Even the salary of technical staff at provincial departments is subject to the peoples' committee's enforcement.

As for the coordination among the provincial departments such as DARD and the Department of Natural Resources and Environment (DoNRE), provincial council functions as a coordination body, in which the representative from the provincial peoples' committee chairs the meetings. The provincial council is connected to the prime minister's office at the central government, and thereby related policies, decisions and orders made through the discussions in the provincial council can be reflected into the provincial overall policies.

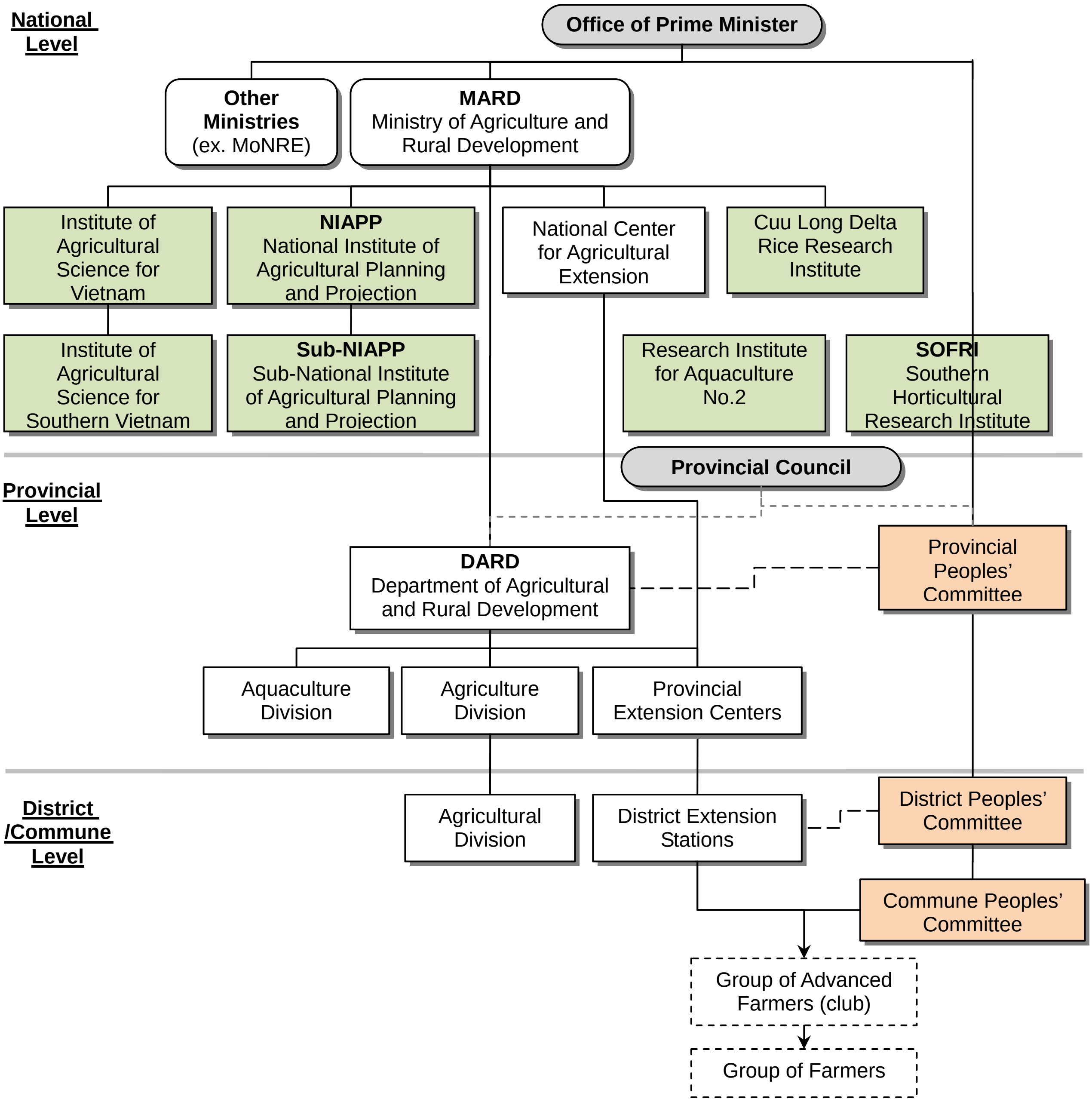


Figure 1.2.2 Government Agencies related to the Proposed Project

As for the implementing agency, it is required to address primarily climate change issues both for planning and implementation. As for the planning of agricultural and aquacultural production oriented toward the climate change issues, it is necessary to update the plan in accordance with the progress of climate change. Thus, rather than focusing only on the implementation of agricultural and aquacultural extension, capacity building on the planning side is very important.

Here, the Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP) is proposed as the main implementing agency. Sub-NIAPP is responsible for consulting works in southern provinces of Vietnam, which includes general research in agricultural planning, land use planning, and design and implementation of agricultural and rural development projects. As a part of its duty, Sub-NIAPP carries out survey and assessment of agricultural resources such as soil property, biological species, and human resources. Particularly, for land use planning and associated cropping-pattern planning, Sub-NIAPP plays a pivotal role in coordination with provinces and the central government.

In the project, Sub-NIAPP is also expected to be an administrative body coordinating with related agencies and institutions as to propose improved cropping systems suited to such areas where impact of climate change is apparent and to promote those new systems where applicable. For detailed information about Sub-NIAPP, refer to section 3.5.1 of this report.

1.2.3 Target Groups

The main objective of the project is to adapt agricultural and aquacultural systems to ever-changing climatic conditions. To this end, it is required to secure such a system wherein improved technologies be disseminated to farmer households through an extension mechanism (see a simplified concept in Figure 1.2.3). Under such circumstances, direct target groups of the project are set as provincial extension centers. As explained in section 2.4, provincial extension center maintains a pool of technical staff (on average 60 officers/ province) and, as a part of DARD, holds an enough authority in planning and implementation of agricultural and rural development activities in the province.

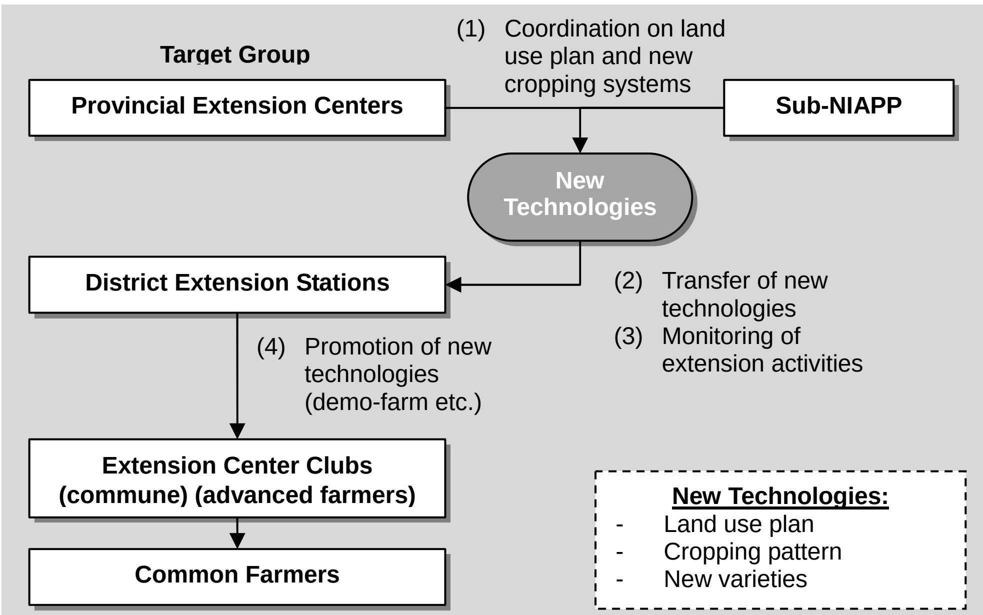


Figure 1.2.3 Implementing Agency and Target Group

To be sure, involvement of district extension station is crucial. District extension stations are the tail-end entity of the government's extension system in agricultural and aquacultural technology dissemination. As an interface to farmer households, district extension stations maintain, on average, six officers per office and sometimes they are attached to the peoples' committees' office at commune level for short-term or activity-basis.

Upon technical guidance from provincial extension center, those technical officers train a group of advanced farmers from communes, through which technologies are to be disseminated. To ensure an effective technology-dissemination, thus, it is necessary to activate the extension activities of those officials on the ground—that is the expected role of provincial extension centers in the project. Yet, it is difficult for implementing agency, Sub-NIAPP, to directly orchestrate the officers at district level as there are so many numbers of officers. Thus, the direct target group is set at the provincial extension centers.

In reality, promotion and execution of land use plan is under strong leadership of provinces. To materialize new cropping systems, therefore, coordination between Sub-NIAPP and province, namely provincial extension centers, is the most appropriate. Then, such land use plan is to be materialized on the ground through district extension stations down to the common farmer via advanced farmer groups.

CHAPTER 2 THE PROJECT AREA AND CLIMATE CHANGE

2.1 Salient Features of Project Area

Agriculture in the Mekong Delta is quite diversified. So-called “rice bowl” of rice production area is featured by strategic combinations of paddy, fruit trees, and aquaculture depending on specific conditions of agro-ecological environment in the Delta. One of those diversified farming systems is repeated production of paddy: two to three times of paddy productions a year. As moving to coastal area, brackish shrimp culture starts dominant, and even paddy-shrimp rotational cultivation is practiced. This sub-chapter discusses the agriculture in the Project area as well as for the Mekong Delta by large.

2.1.1 Location and Demography

1) Spatial Settings

The Project area, 7 coastal provinces, is located along the coastal line of the Mekong Delta as is called. The delta falls in the most southern part of Vietnam, bordering on Cambodia at its upstream, or north-western, side. The Delta area lies immediately to the south-west of Ho Chi Minh City, roughly forming a triangle stretching from My Tho in the east to Chau Doc 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[1]) 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) Area, Population and Population Density

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 region in Vietnam. In addition, Figure 2.1.1 shows the area and population by province in the Mekong Delta, while Figure 2.1.2 depicts population density that also compares the population density with other 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 24,631 km^2 equivalent to about 61% of the total Mekong Delta area. Population density arrives 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. High population density implies high carrying capacity of the land endorsed with high productivity.

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. On the other

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

hand, most of the population growth ratios of other regions surpass that of Mekong Delta. Only those of North Central and Central Coastal area are the exception. Nation-wide 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 ratio of the Project area as well as for the Mekong Delta may be attributed to high out-migration trend of the people. As indicated in the most right column of Table 2.1.1, net-migration for the Project area is as high as -10.1 % and that of Mekong Delta is -8.4%. It may be suggested that the population in the Mekong Delta are now moving out to urban and industrial areas, e.g. Ho Chi Min city as well as to an industrial area of Binh Duong province located north from Ho Chi Minh city.

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)

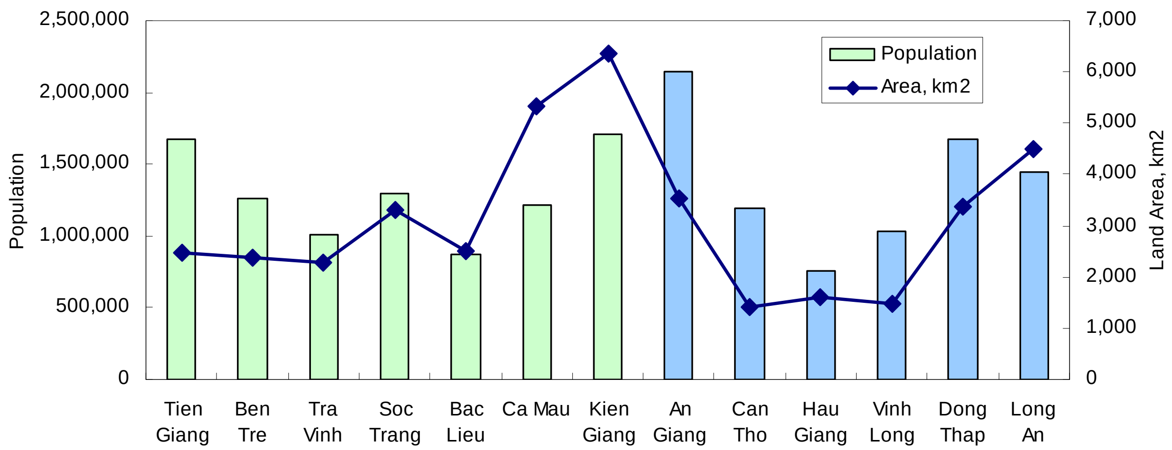


Figure 2.1.1 Population and Land Area by Province in the Mekong Delta

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

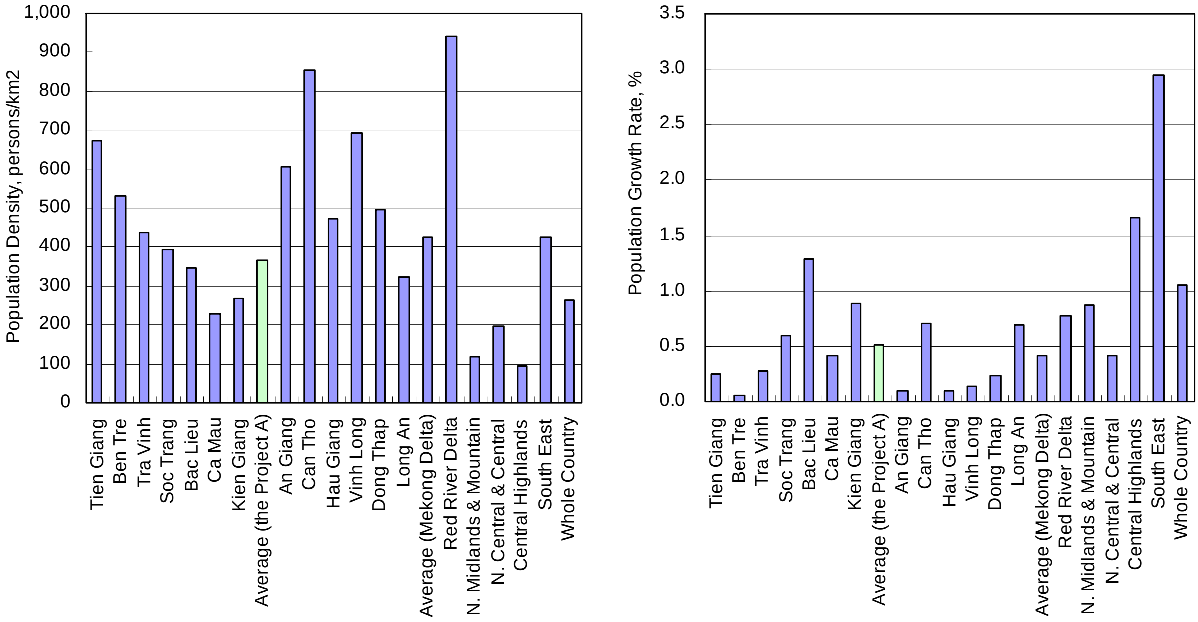


Figure 2.1.2 Population Density (Left) and Population Growth Ratio (Right) by Province in the Mekong Delta and by Region in Vietnam

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

2.1.2 Meteorology and Hydrology

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 2.1.3); 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.

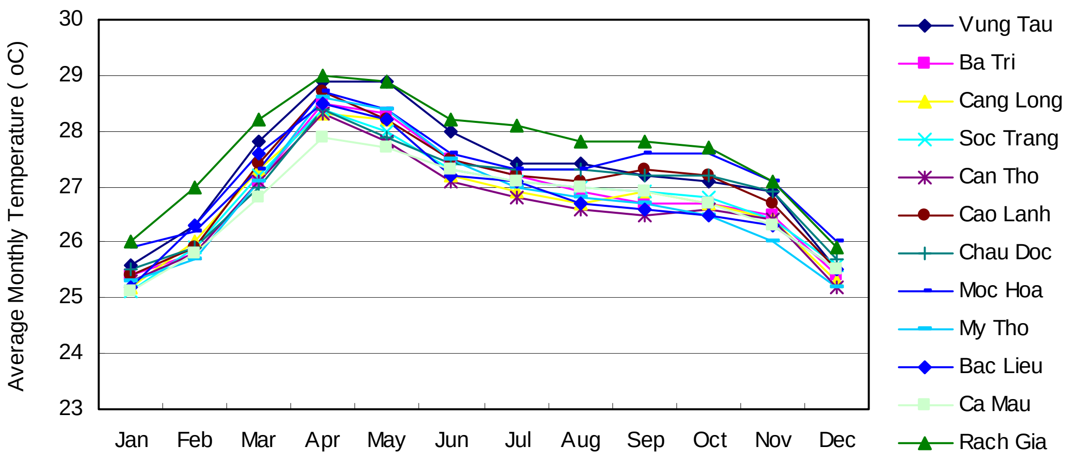


Figure 2.1.3 Average Monthly Air Temperature at Major Locations in Mekong Delta

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 average monthly air temperature at the same place. 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. 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 varies from 1,300 mm to as much as 2,300 mm dependent on the place.

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 2.1.4.

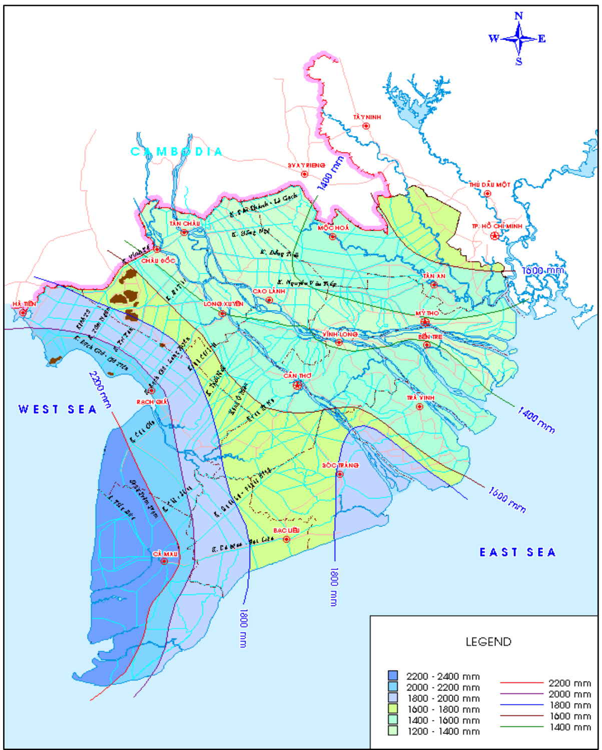


Figure 2.1.4 Annual Average Rainfall Counters
Source: SIWRP

A rainfall data probability analysis shows that a total amount of the annual rainfall in the Mekong Delta with 75% probability ranges between 1,200 and 1,400 mm or sometimes more. The highest rainfall at 75% probability shows up along western peripheral of Ca Mau - Rach Gia area with over 1,800 – 2,000 mm; while the lowest one is observed at Go Cong in Tien Giang province with only 900 – 1,000 mm.

Figure 2.1.5 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 remains only about 10%.

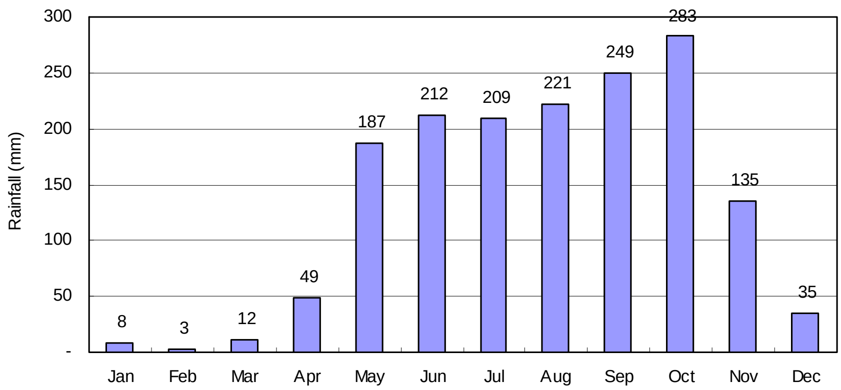


Figure 2.1.5 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month
Source: Southern Institute for Water Resources Planning

2.1.3 Major Features of Agriculture (Diversified Agriculture)

In the upper and mid parts of the Mekong Delta, the agriculture is focused on paddy production. There used to be one paddy crop area over such flooded areas as Plain of Reed, composed of Dong Thap and Long An provinces, and Long Xuyen Quadrangle composed of An Giang province and northern part of Kien Giang province. However, provided with irrigation and drainage canals and also flood protection dykes surrounding farm lands, the areas have turned into 2 paddy cropping farm lands coupled with introduction of new varieties of paddy, mainly short maturity variety.

From the mid part of Mekong Delta, the magnitude of flood becomes less since the flood water after getting into Vietnam territory is dispersed over huge extent of the Delta. Thus, paddy cultivation can be more intensified, and in and around the areas between the 2 big tributaries of Mekong River; Tien and Hau Rivers, there are lots of areas where farmers practice 3 times paddy cultivation in a year, supported by rich amount of water.

The best environment for paddy production where farmers can practice 3 times cultivation, though, cannot extend further down to the coastal areas. 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 and aquaculture especially shrimp, which is seen in many place of the Project area.

In the coastal areas of Mekong Delta, e.g., the Project area, there are vast ranges of areas where seasonal salinity intrusion takes place. In such areas, brackish-water shrimp culture is undertaken during the dry season and then paddy production is organized in the rainy season in the same farm plot. In this system, brackish water shrimp production and fresh water paddy production are alternatively carried out in the same farm plot. Further along the coastal areas where fresh water is hardy available, brackish shrimp culture becomes dominant throughout year.

One may say it seems impossible or not recommendable for the alternate culture between paddy and brackish shrimp. However, it is manageable and actually being done in the vast extent of 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. In such areas where relatively abundant fresh water is available, fresh-water shrimp/fish and paddy are produced at the same time at the same place. In this management, surrounding of the paddy field is dug much deeper than central part of the field, more than 1m deep. While paddy is planted in the central part of the paddy field, shrimp/fish is cultivated in the deep water of the surrounding. By combining the two commodities, environment especially water quality, can be kept better for shrimp/fish culture and the expected profitability can also be kept higher.

2.1.4 Agricultural and Aquacultural Land Use

1) Overall Land Use

As shown in Figure 2.1.6, land use in the Mekong Delta is quite diverse. By and large, double and triple cropping of paddy is dominant in the upper delta especially along the River, while brackish fishery stretches out along the coastal areas. Those major two patterns of land use are further diversified by the different types of forest areas (protective, productive, reforestation etc.), annual crops, and freshwater fishery (in this classification, shrimp culture is included in “fishery”).

As seen in the Land Use Map, brackish shrimp culture is extensively practiced along the coastal areas of Mekong Delta except for some places e.g. coastal areas of Tien Giang province (refer to location 'A' in the figure), western parts of Ca Mau Peninsula (refer to locations of 'B' and 'C'), and central coastal part of Kien Giang (refer to 'D'). In these areas, there are sluice gates already in place, which prevent saline water from coming into the farm lands. With those sluice gates, farmers still can cultivate paddy though some farmers express they prefer shrimp culture as it is more profitable.

Figure 2.1.6 Land Use Map of the Mekong Delta as of 2008
Source: SIWRP (2011)

Moving into some inland areas from the coastal brackish shrimp areas, paddy-shrimp alternate cultivation in a year can be seen; paddy cultivation during rainy season while brackish shrimp culture during dry season. This alternate culture between paddy and shrimp is dominant in Ca Mau province (refer to 'E'), Bac Lieu province (refer to 'F') and Soc Trang province (refer to 'G'), and to lesser extent it is observed in Tra Vinh and Ben Tre provinces. In these areas, by utilizing the saline water during dry season rather than preventing it, this alternate culture has been practiced since late 1980s.

The largest area of this alternate culture is seen in northern part of Bac Lieu province. This area can barely receive fresh water from Hau River (southern tributary of Mekong River) due to the fresh water shortage in the River during dry season despite the fact that there is a long distance canal, called Quan Lo – Phung Hiep, stretching to as far as Ca Mau center. Saline intrusion from East Sea comes as far upstream as this ‘paddy-shrimp’ culture area (refer to ‘F’) during the dry season making possible the shrimp culture. On the other hand, fresh water from Hau River pushes back the saline water during rainy season, thus farmers change to paddy cultivation during the rainy season.

Going into further inland areas or upstream sides along the Mekong River, now dominant cropping is the paddy cultivation. In most of these areas, farmers there practice 2 times paddy cultivation and in the limited areas along and around the Mekong River, they enjoy 3 times paddy cultivation. There is another dominant farming practice, which can be seen in Ben Tre province and Tien Giang province. There are extensive orchard farm lands in upstream and mid parts of Ben Tre province and southern parts of Tien Giang province. The fruits are marketed in the local area and to the Ho Chi Minh city, and then further to abroad, according to interviews to the farmers.

2) Land Use by Province

Referring to the statistical data, difference of land use types in each province is clarified. As shown in Figure 2.1.7 and Table 2.1.2, ratio of agricultural land use in the Mekong Delta is much higher than other areas of the Country. While 63% of the area is used for agricultural purposes in the Mekong Delta, only 29% is used in the whole country, which is far greater than any other regions including the Red River Delta (36%). Among the provinces in the Mekong Delta, there are also some variations: while the agricultural land use in most of provinces ranges around 50% to 75%, Bac Lieu and Ca Mau, coastal two provinces, result in 39% and 27% only. It is probably reflects the large aquacultural area in those two provinces.

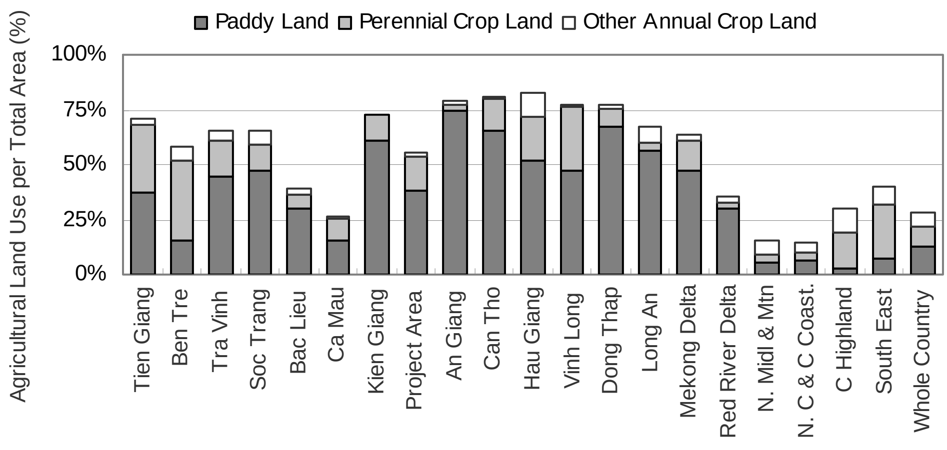


Figure 2.1.7 Agricultural Land Use per Total Land Area (%))

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. As shown in Figure 2.1.8, percentage of paddy in the whole Mekong Delta (75%) is first of all higher than that of whole country (44%), which is after the Red River Delta (83%). Among the provinces of the project area, Kien Giang (83%) was the highest, which was followed by Bac Lieu (75%) and Soc Trang (73%). On the other hand, paddy area of Ben Tre (23%) was quite limited, suggesting that the most of agricultural area in Ben Tre province is not suited to paddy production but perennial crops.

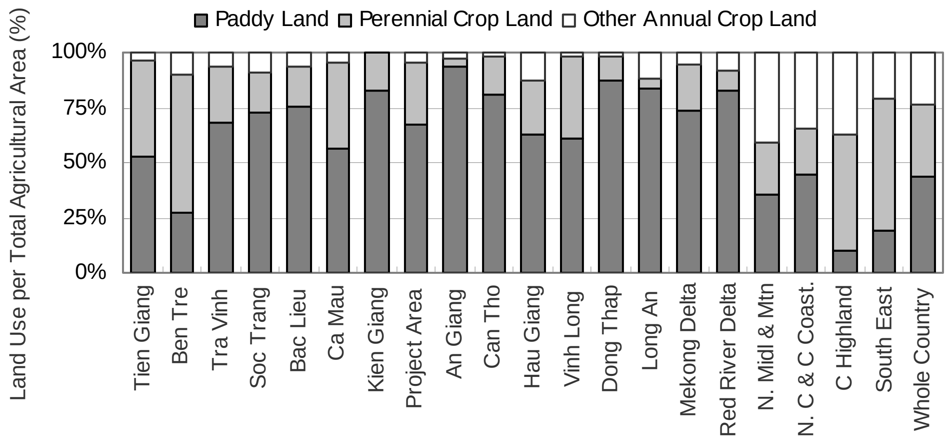


Figure 2.1.8 Agricultural Land Use per Total Agricultural Area (%)

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

Table 2.1.2 Agricultural Land Use in the Project Area

Province/ Region	Agricultural Production Land					Ratio of Agricultural Land per Total Land Area								Ratio per Agricultural Land Area			
	Total, '000ha, *2	Total Annual Crop Land	Paddy Land	Other Annual Crop Land	Perennial Crop Land	Total Land Area	Total Agricultral Area	Agri-land per HH	Agri-land per HH	Annual Crop Land	Paddy Land	Other Annual Crop Land	Perennial Crop Land	Annual Crop Land	Paddy Land	Other Annual Crop Land	Perennial Crop Land
	000ha	000ha	000ha	000ha	000ha	(km2)	%	ha/HH	ha/HH	%	%	%	%	%	%	%	%
Tien Giang	176.05	98.94	92.97	5.97	77.11	2,484	71%	0.40	0.47	40%	37%	2%	31%	56%	53%	3%	44%
Ben Tre	136.68	50.90	37.50	13.40	85.78	2,360	58%	0.38	0.42	22%	16%	6%	36%	37%	27%	10%	63%
Tra Vinh	150.77	112.67	102.63	10.04	38.10	2,295	66%	0.60	0.72	49%	45%	4%	17%	75%	68%	7%	25%
Soc Trang	216.53	177.09	157.29	19.80	39.44	3,312	65%	0.70	0.88	53%	47%	6%	12%	82%	73%	9%	18%
Bac Lieu	98.20	80.11	73.92	6.19	18.09	2,502	39%	0.51	0.70	32%	30%	2%	7%	82%	75%	6%	18%
Ca Mau	142.05	87.11	80.66	6.45	54.94	5,332	27%	0.49	0.63	16%	15%	1%	10%	61%	57%	5%	39%
Kien Giang	441.34	365.76	358.50	7.26	75.58	6,346	70%	1.12	1.53	58%	56%	1%	12%	83%	81%	2%	17%
Project Area	1,361.62	972.58	903.47	69.11	389.04	24,631	55%	0.61	0.75	39%	37%	3%	16%	71%	66%	5%	29%
An Giang	280.65	271.39	263.09	8.30	9.26	3,537	79%	0.53	0.75	77%	74%	2%	3%	97%	94%	3%	3%
Can Tho	113.68	94.15	92.25	1.90	19.53	1,402	81%	0.39	1.19	67%	66%	1%	14%	83%	81%	2%	17%
Hau Giang	132.41	99.83	83.05	16.78	32.58	1,601	83%	0.70	0.88	62%	52%	10%	20%	75%	63%	13%	25%
Vinh Long	114.67	71.70	69.83	1.87	42.97	1,479	78%	0.42	0.50	48%	47%	1%	29%	63%	61%	2%	37%
Dong Thap	259.97	232.84	227.45	5.39	27.13	3,375	77%	0.62	0.77	69%	67%	2%	8%	90%	87%	2%	10%
Long An	304.25	289.35	254.33	35.02	14.90	4,494	68%	0.82	1.00	64%	57%	8%	3%	95%	84%	12%	5%
Mekong Delta	2,567.25	2,031.84	1,893.47	138.37	535.41	40,519	63%	0.60	0.78	50%	47%	3%	13%	79%	74%	5%	21%
Red River Delta	756.26	684.03	623.38	60.65	72.23	21,063	36%	0.14	0.19	32%	30%	3%	3%	90%	82%	8%	10%
N. Midl & Mtn	1,485.99	1,136.43	524.50	611.93	349.56	95,339	16%	0.54	0.66	12%	6%	6%	4%	76%	35%	41%	24%
N. C & C Coast.	1,402.55	1,108.41	628.12	480.29	294.14	95,885	15%	0.29	0.38	12%	7%	5%	3%	79%	45%	34%	21%
C Highland	1,615.92	756.90	160.74	596.16	859.02	54,641	30%	1.32	1.91	14%	3%	11%	16%	47%	10%	37%	53%
South East	1,608.17	630.54	300.73	329.81	977.63	40,519	40%	0.44	1.00	16%	7%	8%	24%	39%	19%	21%	61%
Whole Country	9,436.14	6,348.15	4,130.94	2,217.21	3,087.99	331,051	29%	0.42	0.61	19%	12%	7%	9%	67%	44%	23%	33%

*1: The 2009 Vietnam Population and Housing Census
*2: Rural, Agricultural and Fishery Census, Data in 2006

3) Cropping Pattern

Cropping systems in the Project area and Mekong Delta are quite diverse and highly sophisticated. There are several combinations of various crops including paddy, upland crops, and aquaculture. As for the cropping calendar of paddy, there are four major seasons: winter-spring, summer-autumn, autumn-winter and spring-summer in an order of popularity in terms of planted areas. 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 Project area. A typical cropping in the coastal areas is the combination with brackish shrimp culture as aforementioned. Typical cropping patterns in the Project area are illustrated in Table 2.1.3.

Paddy production is organized with various combinations in accordance with the availabilities of 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. 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, summer-autumn paddy and autumn-winter paddies are commonly cultivated. The latter means that there are two-paddy cropping in a rainy season, which is the majority in the Project area.

Table 2.1.3 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

In cultivating 2 paddy crops in a rainy season from May to November, farmers may face water shortage toward end of the rainy season. To avoid the water shortage, they carry out transplanting of 30 to 45 days nurseries into the main field for the 2nd paddy crop (Note that direct seeding is the common practice in the Mekong Delta). In cases, some farmers use even 60 days nurseries which have grown more than 40 cm height. This practice shortens the growing period of the 2nd paddy in the main field, and whereby they could accommodate 2 times paddy cultivation in a rainy season.

In such areas along the coastal region where salinity intrusion takes place, rain-fed paddy production is often combined with shrimp culture. Surprisingly, in dry season, paddy field is filled with saline water for shrimp culture and then after a certain time for leaching of salinity by fresh water, i.e. rainfall, paddy is planted in the same plot in rainy season. The farm plots used for the shrimp-paddy culture are enclosed with high embankment. In most cases, the farm plots are enclosed with about 1.5 meter height dyke in order to keep water depth enough for shrimp culture. In addition, trench is made along the inner side of the dyke whereby shrimp can stay in the deeper zone during hot hours of day.

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.

2.2 Agriculture in the Project Area

2.2.1 Farmland per Household

Figure 2.2.1 summarizes the average farm production area per farm household (2006) and indicates the share of the farm household by the farm scale as compared with those of other regions of Vietnam. From Figure 2.2.1, it is known that the average farm production area in the Project area and also in the Mekong Delta is rather bigger than the national average. The averages are 1.21 ha and 1.20 ha for the Project area and Mekong Delta respectively while that of national level is only 0.81 ha. Among the provinces in the Projects area, Tien Giang and Ben Tre provinces show rather smaller average areas by 0.63 ha and 0.58 ha respectively while Kien Giang shows the biggest area, 2.49 ha.

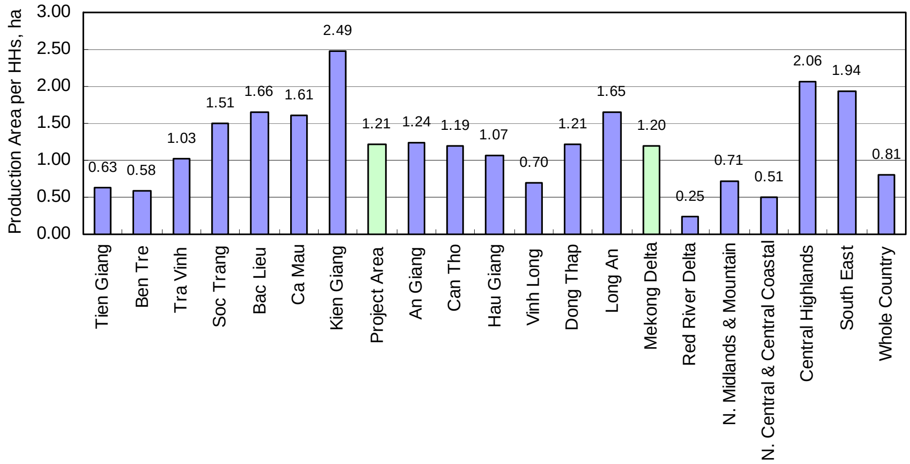


Figure 2.2.1 Average Farm Production Area as Compared with Other Regions

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

With regard to the farm production area size, Tien Giang and Ben Tre provinces show that the share of the farm households whose lands are less than 0.2 ha comes to about a quarter percentage while the average share of the farm households in the Project area is about 19%. Note that Ca Mau province shows the highest share, 35%, in the households whose farm lands are less than 0.2 ha. However, the average farm production area of this Ca Mau is 1.61 ha, not small in the Project area. This may imply that few farmers may have very big farm lands, raising the average size despite the fact that there are many number of smallholder farmers. Bac Lieu and Kien Giang provinces show relatively bigger shares in the farm households whose production lands are more than 2.0 ha, resulting in rather bigger average farm land area.

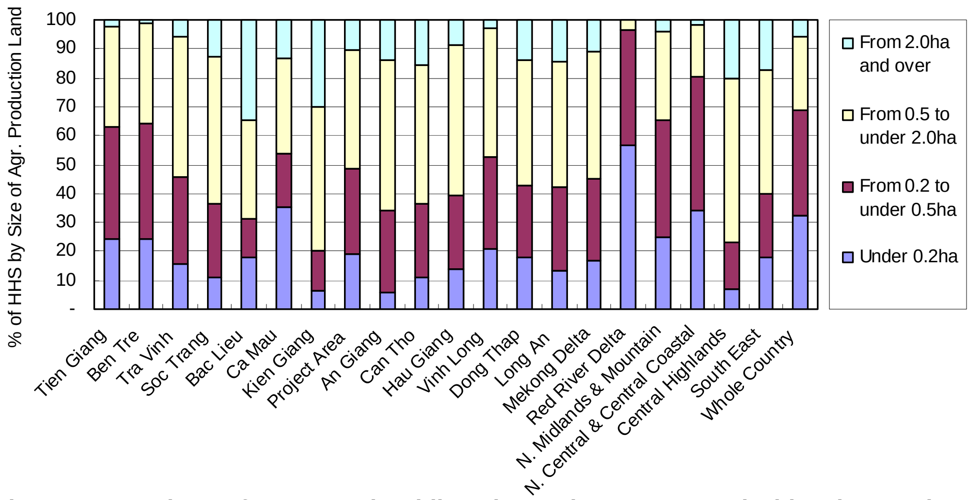


Figure 2.2.2 Share of Farm Land Holdings by Scale as Compared with Other Regions

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

2.2.2 Agriculture Production

The major agriculture production in the Project area and the Mekong Delta is paddy. The paddy production by province in the Mekong Delta is shown in Figure 2.2.3. It has been on an increasing trend and in 2010 the total production reached 9,618,000 tons for the Project 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 Project area produced 24% of the country's production and that of Mekong Delta shared as much as 54%.

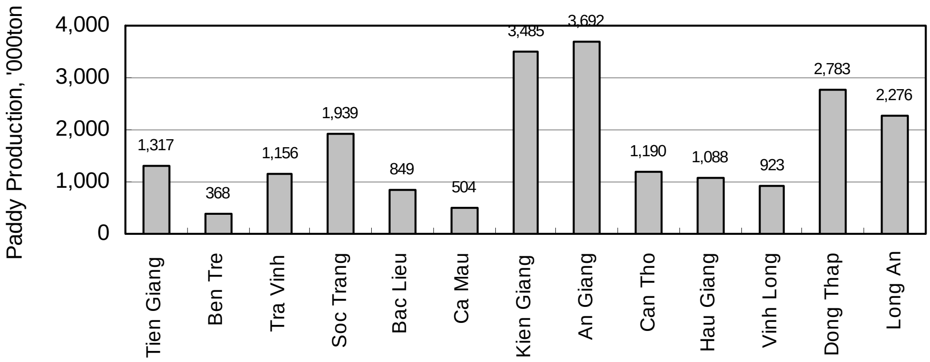


Figure 2.2.3 Paddy Production by Province in the Mekong Delta
Source: Statistical Year book 2010, GSO

Looking at the provincial production of 2010, Kien Giang produced by far paddy in the Project 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.

Furthermore, Figure 2.2.4 shows production of paddy per capita as compared with other regions of the County. As shown in the figure, the most paddy producing province per capita in 2010 is Kien Giang, 2,046 kg/capita or 164% of the Mekong Delta's average, while the least paddy producing province is Ben Tre with 293 kg/capita or 23% of the Mekong Delta's average, followed by Ca Mau province (416 kg/capita, 33% of Mekong Delta's average). The low production in Ben Tre can be explained by a fact that the farmlands in the province has already devoted for fruit production. In Ca Mau province, saline intrusion takes place to a great extent thereby paddy cultivation is difficult.

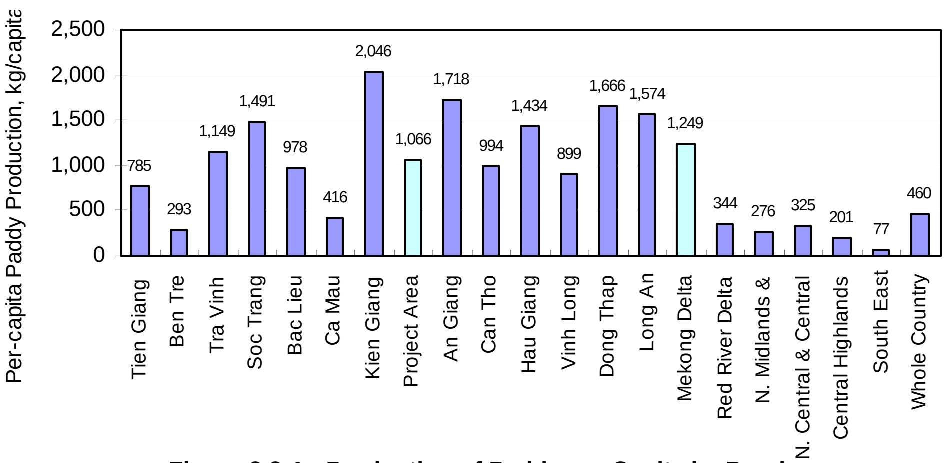


Figure 2.2.4 Production of Paddy per Capita by Province
Source: Statistical Year book 2010, GSO

National average of the paddy production per capital is 460 kg. Even that of Red River Delta arrives only at 344 kg. On the other hand, the paddy production per capita comes to 1,066 kg and 1,249 kg for the Project area and the Mekong Delta respectively. This comparison shows how large amount of paddy the Mekong Delta is producing, contributing much to the nation's staple food self-sufficiency as well as for export of paddy. In fact, a typical adult consumes about 150 kg of milled rice per annum, which is approximately equivalent to 250 kg of paddy (60% conversion to milled rice). With this simple estimation, it can be said that the Country has a huge export potential for rice and it comes from Mekong Delta.

More detailed statistical data on paddy production by season are available, as shown in Figure 2.2.5, production of paddy is in an increasing trend, notwithstanding some stagnation in area planted. In particular, summer-autumn production and winter-spring production have been increasing in the past two decades, while the production of autumn-winter paddy is in a decreasing trend. General trend of increase in production is probably attributed mainly to the introduction of improved varieties and increase in the use of chemical fertilizer. A series of interview made to some farmers revealed that about 200-400 kg/ha of chemical fertilizer is being applied in the area, which is quite a high level of application in accordance with the available standard of the Philippines for example[2].

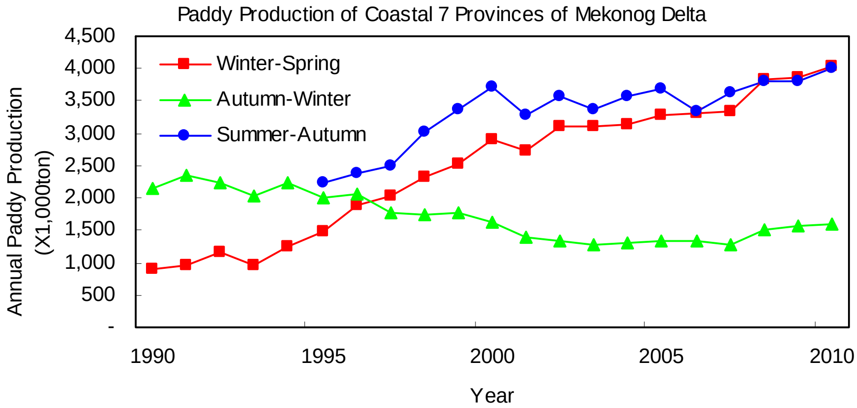


Figure 2.2.5 Paddy Production in Coastal Seven Provinces
Source: Statistical Yellow Book of Vietnam (2011)

Figure 2.2.6 and Table 2.2.1 shows the yield of paddy for three different seasonal categories. As all the three categories shows basically increasing trends in the past two decades. Especially spring paddy has kept the highest yield as compared to other two categories, which recorded 6.4 ton/ha in 2010 as an average of seven provinces. Looking at each provinces, An Giang province recorded 7.3 ton/ha in 2010.

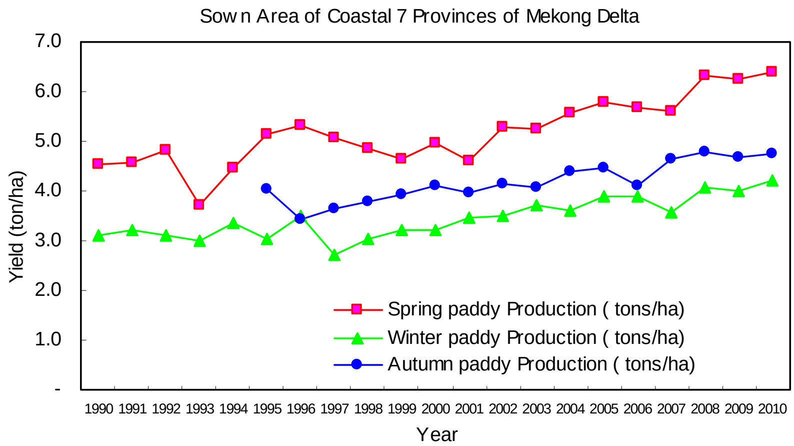


Figure 2.2.6 Yield of Paddy in the Project Area
Source: Statistical Yellow Book of Vietnam (2011)

2 In the Philippines, it is recommended to apply 275 to 300kg/ha of chemical fertilizer to achieve 5-6 ton/ha (Quick guide for fertilizing transplanted rice in Laguna, DA, PhiRice, OPAg, IRRI, May, 2009).

Table 2.2.1 Yield of Paddy from 2000 to 2010

Cropping Season	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Ave.
Spring paddy Production												
Mekong Delta	5.3	5.0	5.7	5.7	5.9	6.1	6.0	6.0	6.4	6.4	6.6	5.9
Project Area	5.0	4.6	5.3	5.3	5.6	5.8	5.7	5.6	6.3	6.3	6.4	5.6
Winter paddy Production												
Mekong Delta	3.1	3.4	3.4	3.6	3.6	3.8	3.8	3.5	4.0	3.9	4.2	3.6
Project Area	3.2	3.5	3.5	3.7	3.6	3.9	3.9	3.6	4.1	4.0	4.2	3.7
Autumn paddy Production												
Mekong Delta	3.7	3.7	4.0	4.0	4.4	4.5	4.1	4.6	4.8	4.7	4.8	4.3
Project Area	4.1	4.0	4.2	4.1	4.4	4.5	4.1	4.6	4.8	4.7	4.7	4.4
All												
Mekong Delta	3.7	3.7	4.0	4.0	4.4	4.5	4.1	4.6	4.8	4.7	4.8	4.9
Project Area	4.1	4.0	4.2	4.1	4.4	4.5	4.1	4.6	4.8	4.7	4.7	4.6

Source: Statistical Yellow Book of Vietnam (2011)

2.3 Aquaculture (Shrimp Culture) in the Project Area

Overall coastal areas of the Delta are characterized as brackish shrimp (Penaeus monodon) cultivation area under the condition that saline water intrusion takes place. In the coastal areas nearer to Ho Chi Minh (HCM) city, various types of cultivation systems are in operation. In Ben Tre and Tien Giang provinces, for example, the cultivation of mollusks such as blood cockles is becoming very significance.

On the other hand, freshwater aquaculture has flourished in the mid and upper parts of Mekong Delta. The upper parts of the Hau and Tien Rivers are becoming Pangasius cultivation areas. Initially in An Giang and Dong Thap provinces, the cultivation of Mekong catfish, Pangasius spp., was started in the late 1990's. The central parts of the Delta, such as Can Tho province, are introducing this export-oriented Pangasius cultivation but the areas placed under heavy floods still depend on other freshwater fish mostly for the domestic markets.

2.3.1 Aquaculture Production

Table 2.3.1 summarizes the aquaculture production in the Mekong Delta as compared with other parts of the Country, and Figure 2.3. illustrates per-capita aquaculture production of fish (left) and brackish shrimp aquaculture production (right). 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 2.3.1 Aquaculture Production in the Mekong Delta and Other Regions (2010)

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
Project 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 as shown in the Figure 2.3., 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 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 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.

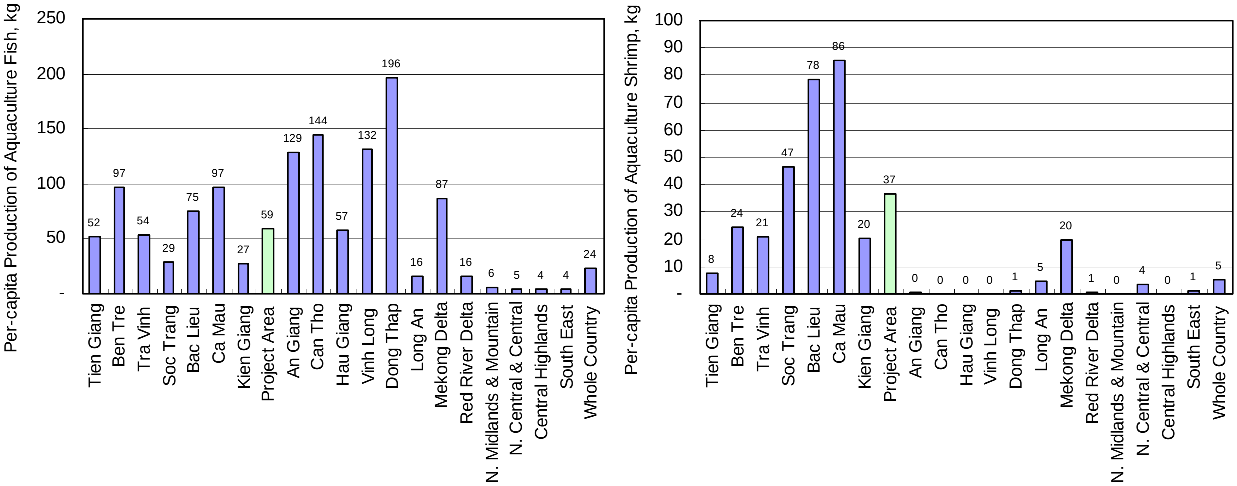


Figure 2.3.1 Per-capita Production of Aquaculture Fish (Left) and Shrimp (right) (2010)

Source: Statistical Year Book of Vietnam 2010, GSO

2.3.2 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. At that time, however, yield of the production was said to be only about 100 kg/ha with extensive farming method[3]. The shrimp production in Vietnam started increasing rapidly in 2000's in contrast to the black tiger shrimp production in Thailand. In Thailand, black tiger shrimp culture had become popular in the mid 1980's, and in the 1990's the production had reached a peak. However, with devastative negative impacts on the natural environment, the Thai government had restricted the culture, and instead white leg shrimp has become popular.

As the production of Thai black tiger shrimp had decreased, the production of the black tiger in Vietnam started increasing on the contrary. The production of the black tiger shrimp in Vietnam started increasing since early 2000s as indicated in Figure 2.3.2. The production of black tiger shrimp in

[3] R. E. Turner (1977); "Intertidal Vegetation and Commercial Yield of Penaeid Shrimp", Transactions of the American.

Vietnam has come to around 300,000 tons per annum in year 2008. Most of the production came from the coastal areas of Mekong Delta, which is the Project area. In recent years, white leg shrimp is cultivated in Vietnam but still the black tiger shrimp is the major species, unlike the trend in Thailand.

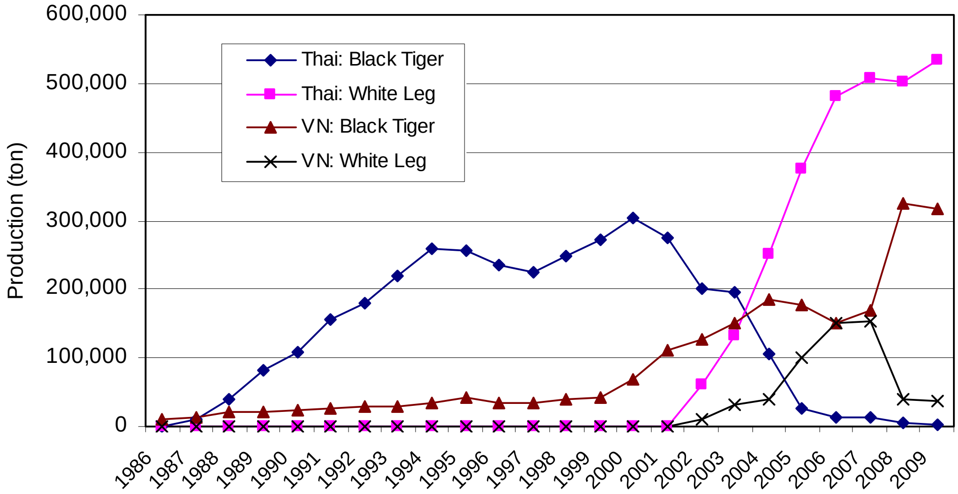


Figure 2.3.2 Trend of Shrimp Production in Vietnam and Thailand

Source: FAOSTAT (2011)

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 and semi-intensive shrimp cultures share only 10% in terms of the area cultivated as indicated in Figure 2.3.3; remaining one are all for extensive systems according to Research Institute for Aquaculture No.2[4].

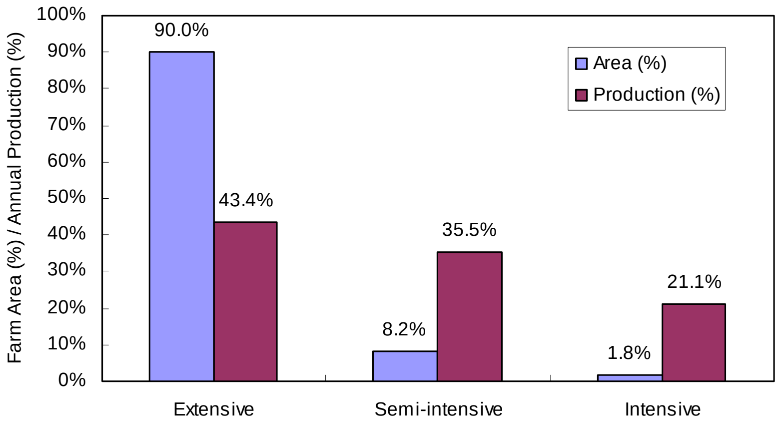


Figure 2.3.3 Shares in Area Cultivated and Production of Shrimp by Category

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

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[5], 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.

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

[4] 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

[5] 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

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.

Today, Research Institute for Aquaculture No.2 recommends an improved extensive system, in which no food is applied and shrimps are cultivated in a low population density. For the food of shrimps, fertilizer is applied, which is to increase the population of planktons in the water as a food for shrimp. In this system, deterioration of water quality is rarely observed whereby environment is kept sound.

1) Extensive Shrimp Culture

In the extensive system, larva are released at a low density of abut 1-2 shrimp only per square meter. There is no clear production cycle for the extensive system. Instead, shrimp is periodically harvested, once a month for example, and, at this time, small shrimps are released back into the pond. Larvas are also released periodically to supplement the deficit caused by the harvest. As those arrangements are done periodically and with no concrete measurement, actual population density is hardly monitored.

Extensive shrimp cultivation system is sometimes combined with paddy production. In this kind of system, shrimp is cultivated only in the dry season when saline intrusion takes place. In this system, as the period available for shrimp culture is limited, larvas are released only one time at the beginning of the dry season in most cases. After they have harvested the shrimp at end of dry season, they usually leave the farm land for two to two and half months during the early rainy season. The farm plots where salt has been accumulated with shrimp culture are therefore washed by rainfall, becoming ready for paddy cultivation.

According to some interviews made to shrimp farmers[6], costs of fertilizer and larva shares a range of about 30% of the total expenditure. By subtracting the cost from the sale, farmers can fetch net profit of about 20 million VND to 40 million VND per ha from this extensive shrimp culture. This net profit of 20 to 40 million VND is about the same to twice as much as what one hector of paddy cultivation can fetch in net profit. Thus, if no disease occurs, shrimp culture even if it is extensive one can be more profitable than paddy production.

2) Intensive and Semi-intensive Shrimp Culture

As for the intensive shrimp culture systems, it is recommended by Research Institute for Aquaculture No.2 to do only one time cultivation per year. However, it was revealed that many shrimp farmers do twice per year for more income earning. According to the Institute, the intensive culture requires quite a high investment for feeds, purification of polluted water, and replacement of dead shrimps, and thus more farmers run for the semi-intensive system, which require relatively low investment.

Typical profiles of semi-intensive and intensive systems are summarized in Table 2.3.2 in comparison with those of extensive shrimp culture. As shown in the table, for the intensive systems, investment cost shares 40-60% of gross income, in which the cost of feed shares the most (usually a range of about 70% of total cost). The net profits for the semi-intensive and intensive are in fact quite high as exampled by a comparison with the net profit of extensive culture; about 3 times more for the case of semi-intensive and more than 10 times or even over 30 times in case of intensive culture depending on the level of the intensiveness.

[6] The interviewees were conducted in August and September in 2011 to 20 shrimp culture farmers in Ca Mau, Bac Lieu, Soc Trang, Ben Tre provinces.

Table 2.3.2 Typical Profile of Semi-Intensive and Intensive Systems

Category	Initial Population Density	Average Yield	Gross Income, VND/ha	Net Profit, VND/ha
Semi-Intensive	10 – 15 shrimps/m^2	1.5 – 3.0 ton/ha	175 – 500 million	75 – 100 million
Intensive	20 – 30 shrimps/m^2	5.0 – 7.0 ton/ha	600 – 1,200 million	325 – 650 million
Extensive	1 – 2 shrimps/m^2	200 – 300 kg/ha	30 – 60 million	20 – 40 million

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, Interviews to Shrimp Culture Farmers

2.4 Extension System for Agriculture and Aquaculture

2.4.1 Extension Systems

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 2.4.1.1).

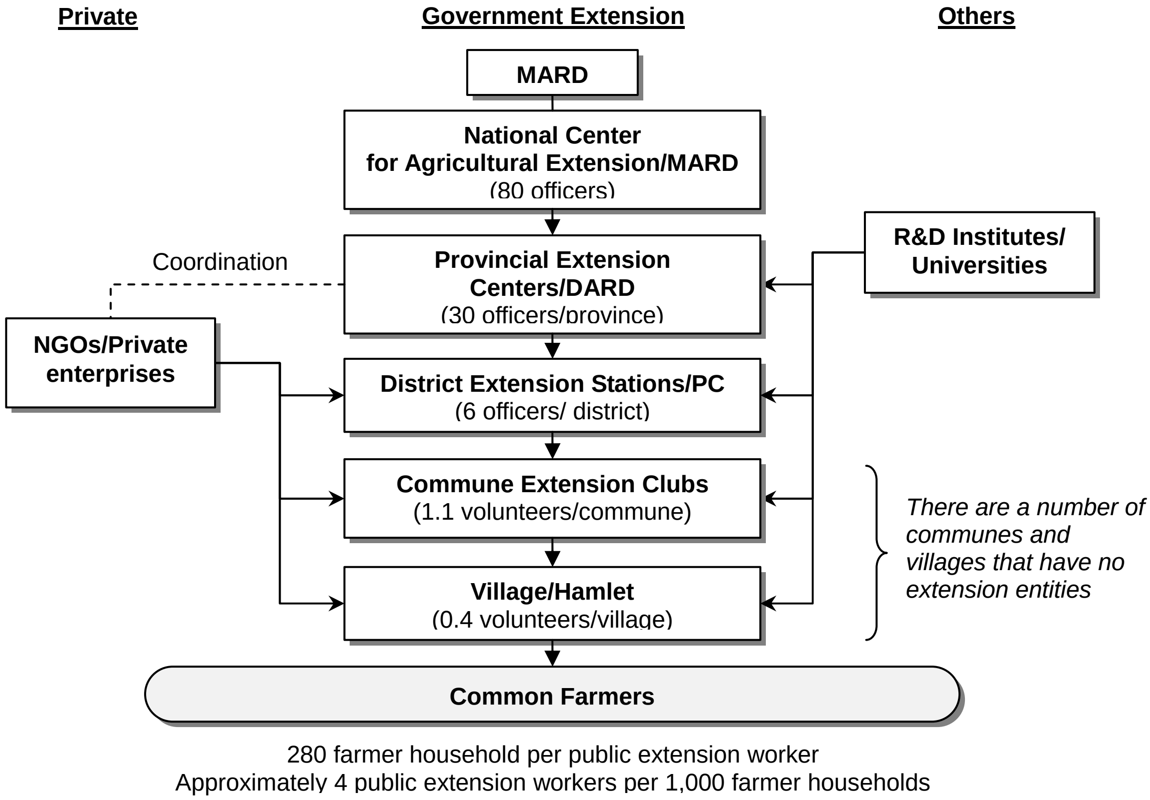


Figure 2.4.1 Agricultural Extension System

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 the 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, while at commune level, district officers sometimes stay 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.

2.4.2 Authorization of Agricultural Land Use Plan

There are two major land use plans: general land use plan and agricultural land use plan. General land use plan, which include conservation forest, public land, and water surfaces, is subject to the authorization of MoNRE, while agricultural land use plan is essentially authorized by MARD. Thus, any land use plans that are associated with non-agricultural land use, it first goes to the pre-approval process by MoNRE, which is then approved by the cabinet.

Land use plans are usually updated every five years for national plan and every year for provincial plans. It can be considered that national plan is the target officially decided by the government and the provincial plans are results of monitoring as milestones to achieve national plans. One of the issues associated with the land use planning and implementation is the conflict between the preset targets of the plan and intentions of provinces.

With regard to the above issue, for example, fruits were given higher priority a few years ago when the price of fruits was three to four times higher than that of paddy. It was then decreased to two times by today mostly associated with international demand and supply balance. Under such a circumstance, province has less incentive to change the commodity from paddy, a familiar type of commodity, to fruits, unfamiliar type of commodity. As a result, land use plan is not always achieved by the target year.

2.5 Expected Climate Change based on Simulation Analysis

IMHEN under MONRE had carried out a climate change simulation in 2010 by using Global Climate Model (GCM) and published those simulation results in November 2010. The resolution of GCM was 250 x 250 km, and IMHEN further carried out climate change simulation by using PRECIS model. PRECIS model provides a high resolution climate change regional simulation. IMHEN undertook 3 climate change scenarios of A2, B1 and B2, and presents all the results in the published literatures e.g. Impact of Climate Change on Water Resources and Adaptation Measures.

IMHEN does not mention which scenario out of the A2, B1 and B2 should be applied in Vietnam, and this is because it is dependent upon which development pass the world should undergo, e.g. economic oriented development or environmental friendly oriented development and also pursuing globalization or otherwise localization. This issue cannot be pertinent to Vietnam only but to the whole world. Therefore, the IMHEN does not specify which scenario is the best for Vietnam, but very often the results of the B2 scenario have been referred to in many cases. This may be simply because the results of B2 fall somewhat in between the results of A2 and B2. Following are the summaries of the climate change prediction as well as some simulation results especially for saline intrusion:

2.5.1 Temperature

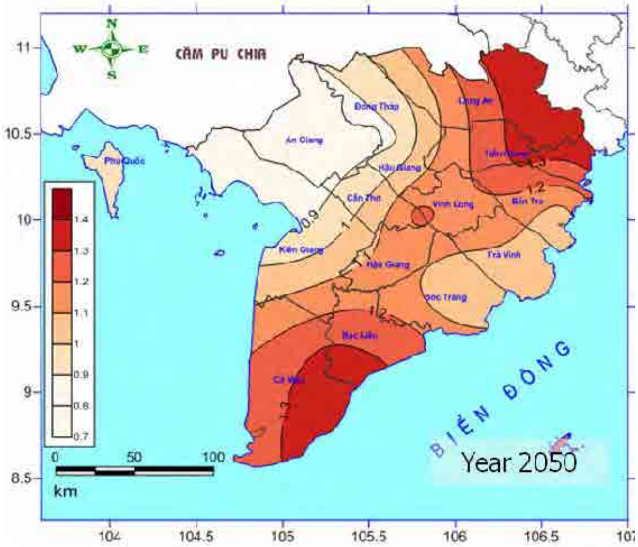


Figure 2.5.1 Mean Annual Temperature Rise at Year 2050 in Percentage under Scenario B2

Figure 2.5.1 shows isolines of mean annual temperature rise at year 2050 under climate change 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.

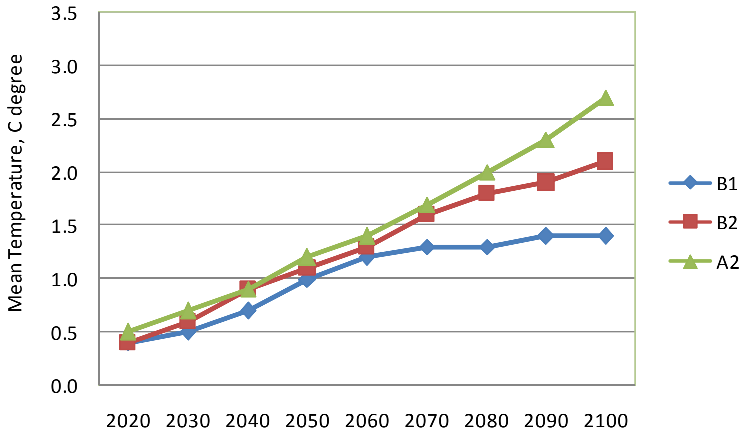


Figure 2.5.2 Mean Annual Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS simulation

Figure 2.5.2 to Figure 2.5.4 show change of mean annual temperature, mean annual maximum temperature, and mean annual minimum 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. As the figure shows, 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.

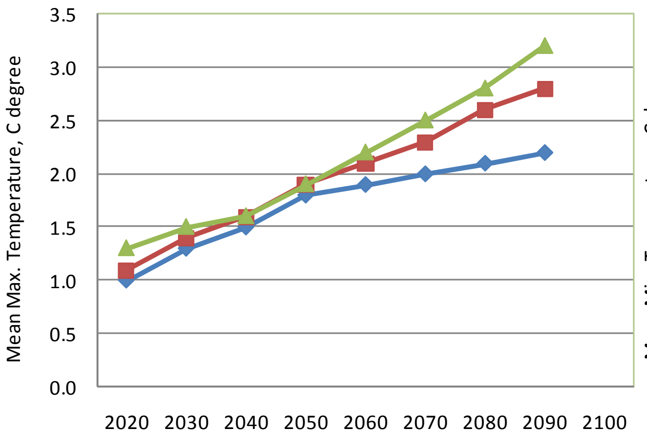


Figure 2.5.3 Mean Annual Max. Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS

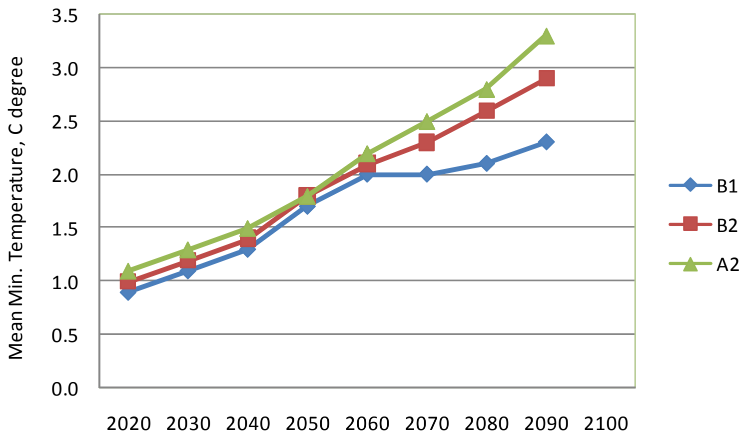


Figure 2.5.4 Mean Annual Min. Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS

For the mean annual maximum temperature, the increase is more than that of mean annual temperature. It shows already more than 1 ^{o}C increase in year 2020 against the average temperature for the period of 1980 and 1999, nearly about 2 °C increase in 2050 and then 2.2 °C to 3.2 °C increase in 2090. The mean annual minimum temperature shows almost same trend of mean annual maximum temperature.

Figure 2.5.5 shows the mean annual temperature change for scenario B2. It shows almost linear increase trend toward 2100. The increase is about 0.8 °C to 1.4 °C by year 2050 and 1.6 °C to 2.6 °C by year 2100 depending on the place. Mean annual temperature under scenario A2, high greenhouse gas emission scenario, has exponential increase trend as shown in Figure 2.5.6. The increase by year 2050 reaches 0.9 °C to 1.4 °C and 2.1 to 3.3 by year 2100. Lowest increase shows up in Kien Giang while the highest increase is seen at Ca Mau, followed by Tien Giang, and Bac Lieu.

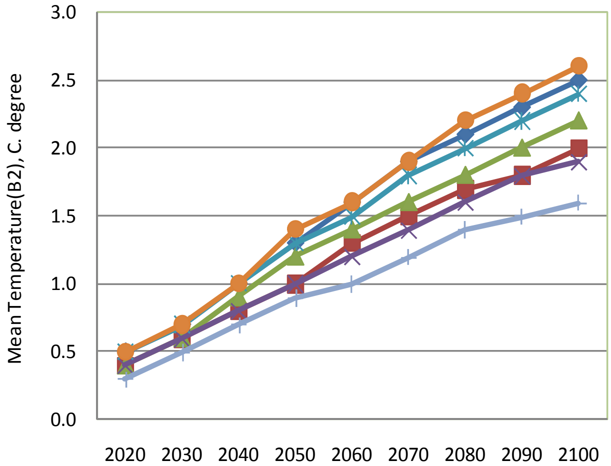


Figure 2.5.5 Mean Annual Temperature Change under Scenario B2 by Province, Source; PRECIS simulation

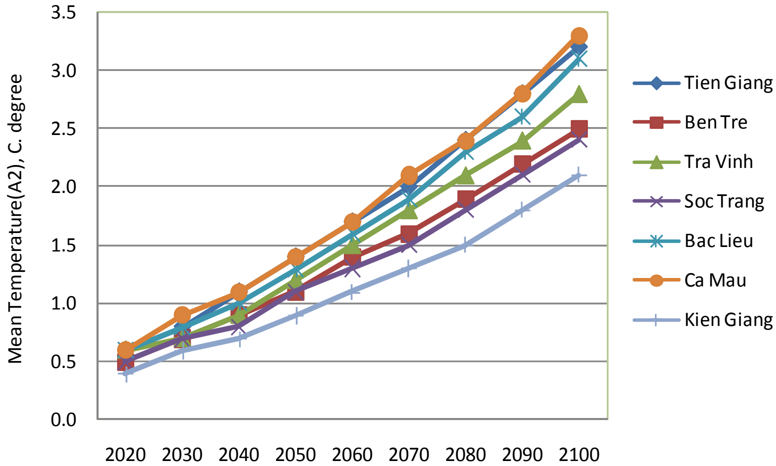


Figure 2.5.6 Mean Annual Temperature Change under Scenario A2 by Province, Source; PRECIS simulation

Figure 2.5.7 to Figure 2.5.9 show monthly temperature change for Mekong Delta under scenario B1, B2 and A2 by year. Temperature tends to increase more during rainy season than dry season. In the rainy season, at year 2050 expected temperature increase is to be about 1.2 °C, 1.3 °C and 1.4 °C for the scenarios B1, B2 and A2. At year 2100, the increase will be about 1.6 °C, 2.5 °C, and 3.2 °C respectively. One thing unique tendency is that there is a drop during the rainy season temperature increase, which shows up in August.

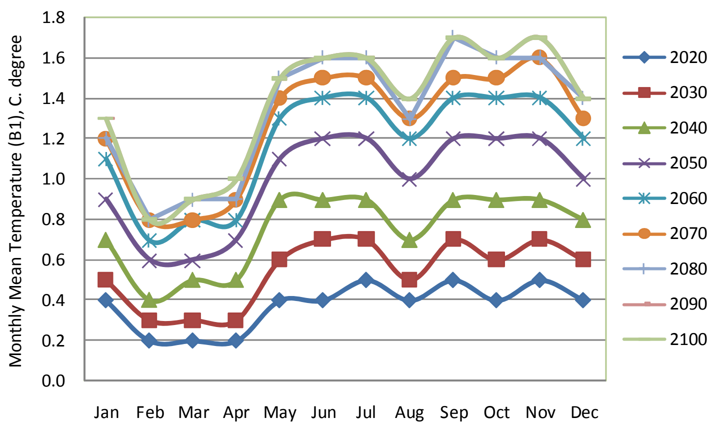


Figure 2.5.7 Mean Monthly Temperature Change in Mekong Delta under B1, Source; PRECIS simulation

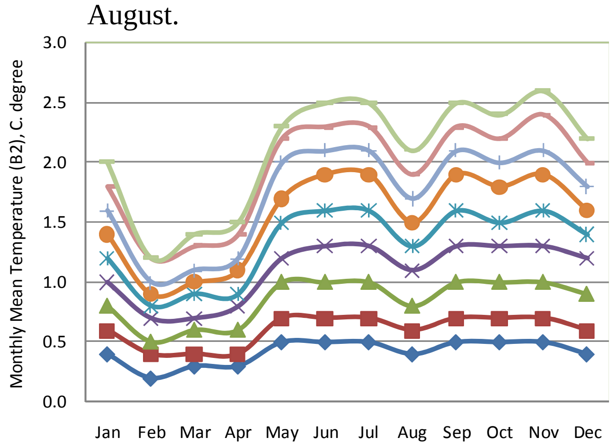


Figure 2.5.8 Mean Monthly Temperature Change in Mekong Delta under B2, Source; PRECIS simulation

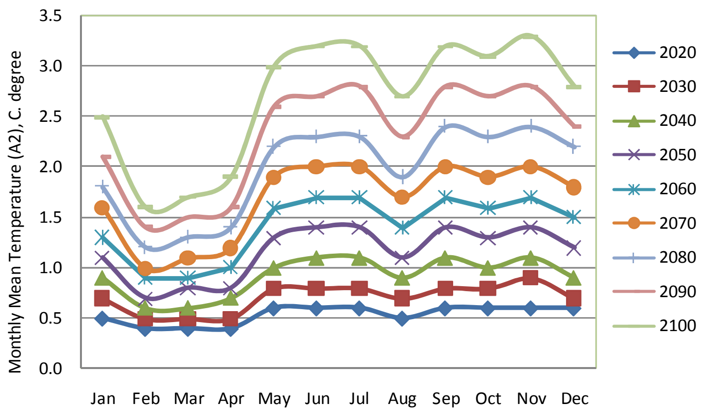


Figure 2.5.9 Mean Monthly Temperature Change in Mekong Delta under A2, Source; PRECIS simulation

During dry season, temperature increase is not much especially between February and April. The increase at year 2050 is about 0.6 °C, 0.7 °C, 0.8 °C for the scenario B1, B2 and A2 respectively. At year 2100, the increase becomes more as about 0.9 °C, 1.4 °C, and 1.7 °C for the scenario B1, B2, and A2 respectively. Trend of increase ratio by year is somewhat different by scenario as; less increase ratio toward 2100 for the scenario B1, even increase ratio toward 2100 for the scenario B2 and greater increase ratio toward 2100 for the scenario A2.

2.5.2 Rainfall

Figure 2.5.10 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.

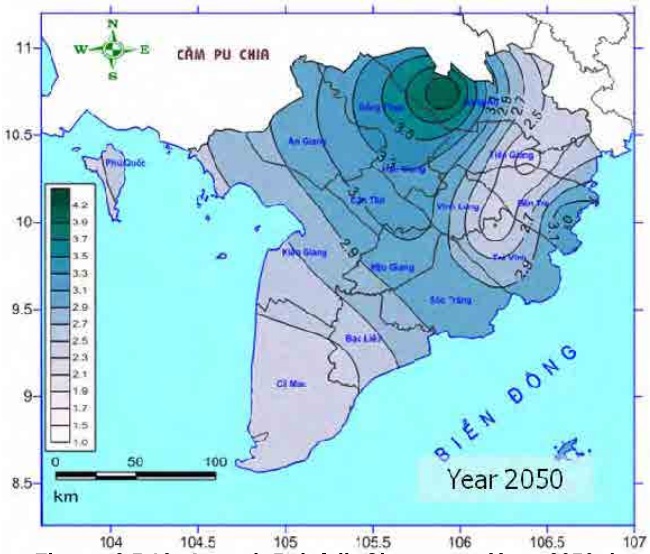


Figure 2.5.10 Annual Rainfall Change at Year 2050 in Percentage under Scenario B2

Figure 2.5.11 shows the simulated overall annual rainfall change of Mekong against the average rainfall between 1980 and 1999 under 3 Scenarios of B1, B2 and A2. The rainfall is predicted to increase for all the 3 scenarios with a general trend that the higher green gas emission the scenario is the more the rainfall takes place and vice versa. Scenario A2 shows the highest rainfall increase as about 3% at year 2050 and over 7% at the 2100. For the B1 scenario, low green gas emission scenario, the increase trend is smaller than the others and the increase ratio after 2070 is very little.

Figure 2.5.12 to Figure 2.5.14 show the annual rainfall change by province under scenario B1 (top), scenario B2 (down left) and scenario A2 (down right). Overall trend of the increase is of course similar to those of increases indicated in Figure 2.5.12. The highest rainfall increase can be seen in Ben Tre, followed by Soc Trang, Bac Lieu and Kien Giang while the lowest increase shows up in Tien Giang. Difference between the provinces comes to about 1 % only at year 2050 and it becomes about 1.5 %, 2.0 % and 3.0% for the scenarios of B1, B2 and A2.

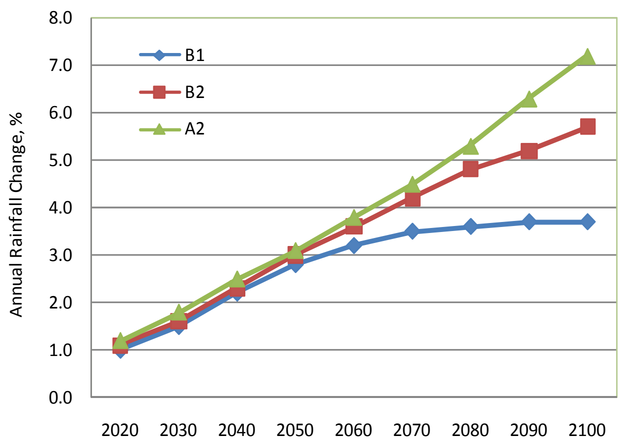


Figure 2.5.11 Annual Rainfall Change in Mekong Delta under 3 scenarios, Source; PRECIS simulation

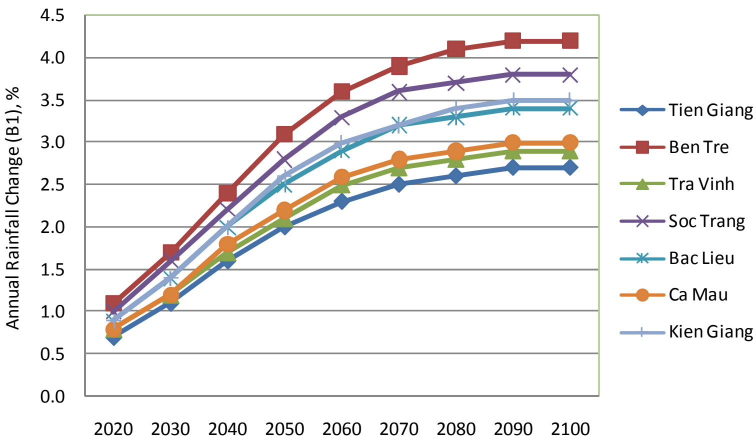


Figure 2.5.12 Annual Rainfall Change by Province under Scenario B1, Source; PRECIS simulation

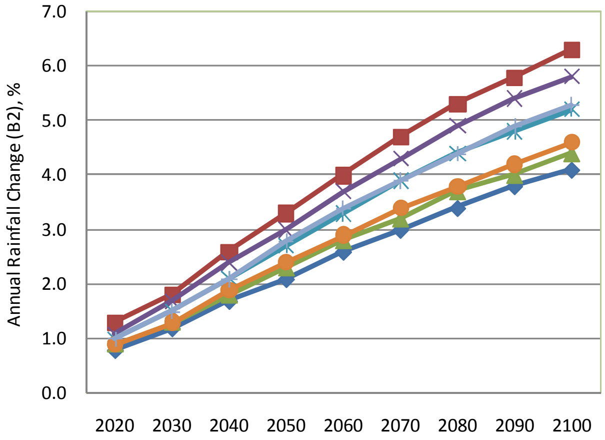


Figure 2.5.13 Annual Rainfall Change by Province under Scenario B2, Source; PRECIS simulation

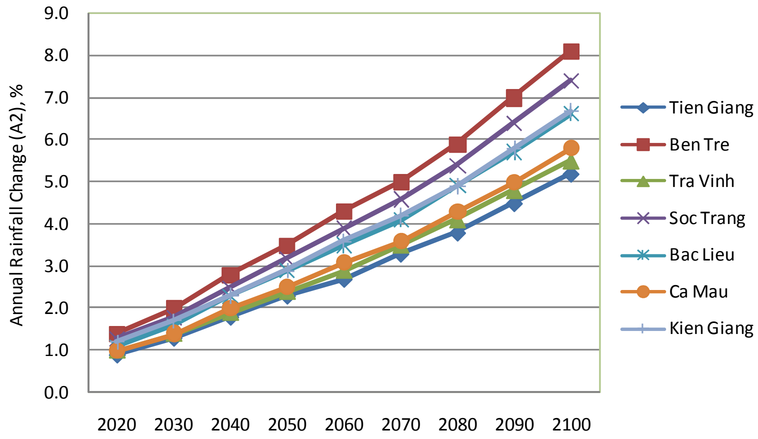


Figure 2.5.14 Annual Rainfall Change by Province under Scenario A2, Source; PRECIS simulation

Figure 2.5.15 to Figure 2.5.17 show monthly rainfall change for the 3 scenarios of B1, B2 and A2 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 20%, 30% and nearly about 40% at year 2100 for the scenarios of B1, B2 and A2 respectively.

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 15%, more than 20% and more than 30% at year 2100 for the 3 scenarios respectively. It can be said in future, it is projected that the rainfall tends to increase especially at the end of rainy season.

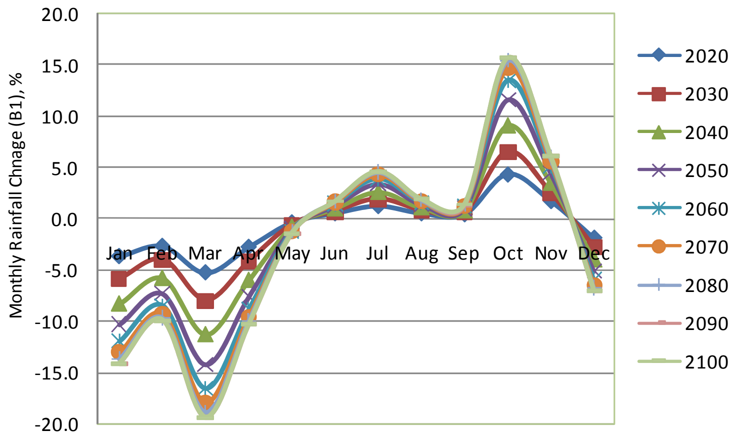


Figure 2.5.15 Monthly Rainfall Change in Mekong Delta under Scenario B1, Source; PRECIS simulation

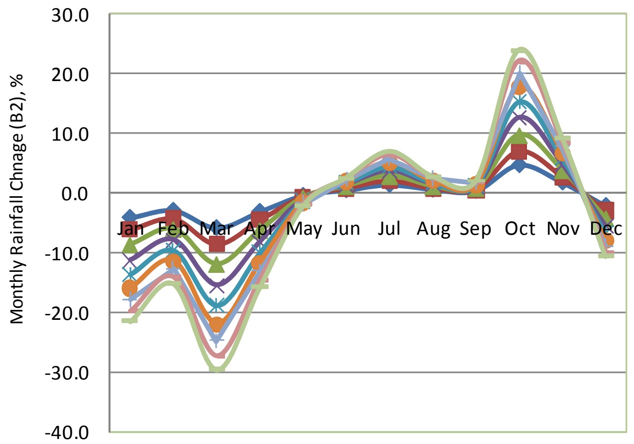


Figure 2.5.16 Monthly Rainfall Change in Mekong Delta under Scenario B2, Source; PRECIS simulation

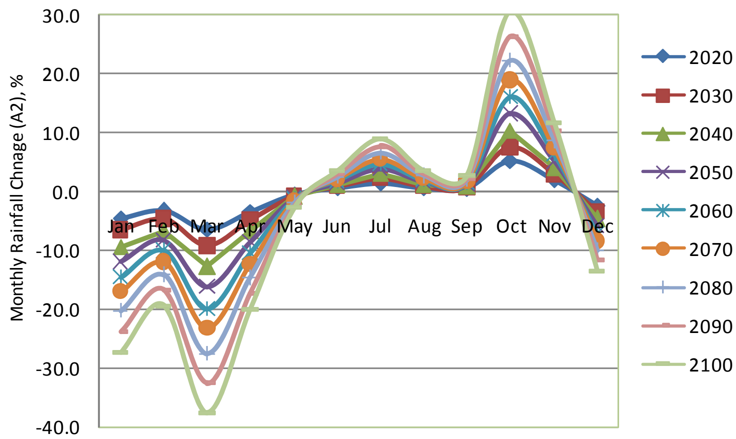


Figure 2.5.17 Monthly Rainfall Change in Mekong Delta under Scenario A2, Source; PRECIS simulation

2.5.3 Sea Level Rise

Figure 2.5.18 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 seas 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 2.5.19 to Figure 2.5.21 show sea level rise by province for the 3 scenarios respectively. Sea level rise by province does not differ much and the difference between provinces is 5 cm even at the year 2100.

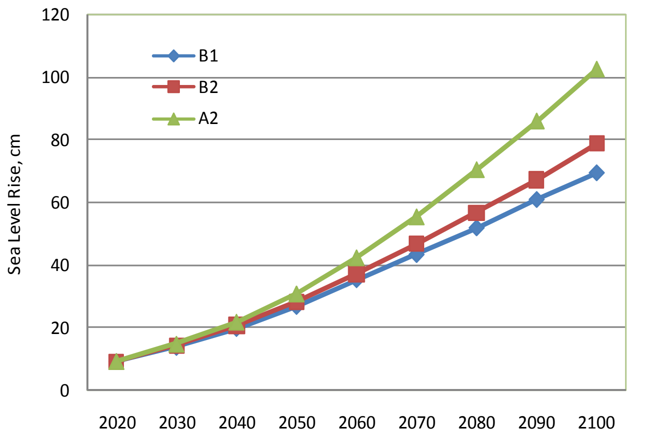


Figure 2.5.18 Sea Level Rise of Mekong Coastal Area under 3 Scenarios, Source; PRECIS simulation

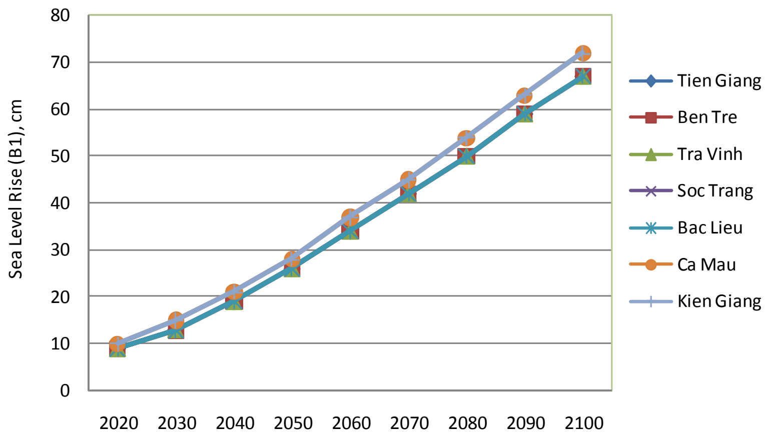


Figure 2.5.19 Sea Level Rise by Province Under Scenario B1, Source; PRECIS simulation

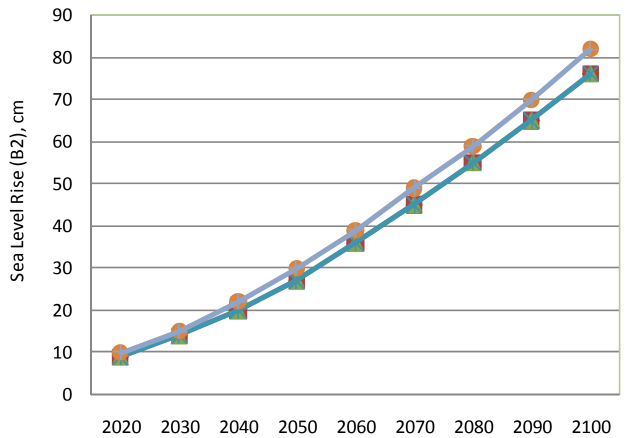


Figure 2.5.20 Sea Level Rise by Province Under Scenario B2, Source; PRECIS simulation

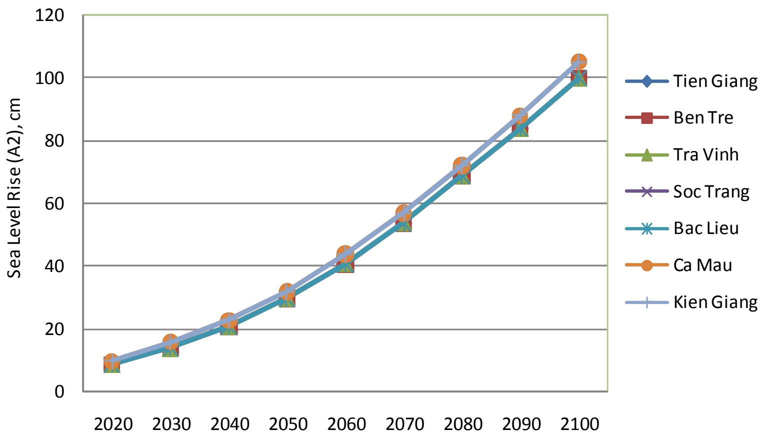


Figure 2.5.21 Sea Level Rise by Province Under Scenario A2, Source; PRECIS simulation

2.5.4 Mekong River Flow Regime Prediction (MRC)

Mekong River Commission (MRC) has carried out simulation on the future Mekong River discharge under climate change Scenarios of B2 and A1. Besides, the Commission carried out additional simulation taking into account various number of basin development projects in estimating the future Mekong discharge. Table 2.5.1 with Figures 2.5.21 to 2.5.25 summarize the monthly average discharges at Kratie station by every 10 years till 2050 under scenarios B2 and A1, and those ones considering water resources development projects till 2020 and also till 2050 in comparison with discharges of year 1998 (driest year), average of 1985 – 2000, and average of 1991 – 2000. From those table and figures, following are expected;

1) With respect to dry season as shown in Figure 2.5., discharge not considering future water resources development projects becomes bigger from the beginning till the direst season (end of

March) than the average discharge between 1991 and 2000. Then, the simulated discharges tend to be almost same as the average discharge of 1991 - 2000. Looking at the rainy season discharge not considering the development projects as shown in Figure 2.5., the simulated discharges do not show clear tendency of being bigger or being less than the 1991 – 2000 average discharge till the peak period of mid-September. However, after having reached the peak in around mid-September, simulated discharges tend to surpass the average discharge.

2) With respect to the future discharge considering the water resource development projects in the catchment, the dry season’s discharge shows very much increase trend. As illustrated in Figure 2.5., the simulated discharge during the driest periods of March and April comes to about 4,000 m^3/s while the average discharge between 1991 and 2000 is only 2,300 – 2,400 m^3/s. This implies that there might be a possibility that should the future development in the catchment be realize as planned, the dry season discharge after Kratie station could increase by as much as 70% (from around 2,350 to 4,000 m^3/s). The reason why it increases so much is the effect of hydropower dams which releases much amount of stored water during dry season for power generation.

3) For the rainy season discharge considering the planned development projects in the catchment shown in Figure 2.5.25, the simulated ones tend to be smaller than the average discharge from 1991 to 2000 during the course of ascending towards the peak, and then sometime after the peak period of mid-September, the discharges are revered, i.e., simulated ones now tend to be bigger than the average. This most probably means that hydropower dams considered in the simulation work to store the rainy season Mekong River discharge while ascending the hydro-curve, and once it has reached the peak, the dams start discharging the stored water for generating power.

4) On the Scenarios A1 and B2, there is not much difference between the two simulation results. In some years, discharge simulated under Scenario A1 may be bigger than that of Scenario B2 while vice versa takes place in other years. Note that simulated discharges in October tend to sharply increase in all the Scenarios A1, B2, and those cases considering planned water resources development projects in the catchment. This tendency seems to correspond to the increase of rainfall at the end of rainy season, October (refer to Figures 2.5.15 – 2.5.17).

Table 2.5.1 Monthly Average Discharges at Kratie Simulated under Different Scenarios

Month	Past Record (average)			Scenario B2 (average)				Scenario A2 (average)			
	1998	1985-2000	1991-2000	2011-2020	2021-2030	2031-2040	2041-2050	2011-2020	2021-2030	2031-2040	2041-2050
Jan	3,724	3,793	4,077	4,398	4,858	5,627	4,702	4,556	5,268	5,364	5,064
Feb	3,140	2,694	2,943	2,994	3,377	3,700	3,144	3,039	3,445	3,837	3,500
Mar	2,236	2,161	2,337	2,343	2,417	2,751	2,301	2,350	2,610	2,828	2,574
Apr	2,560	2,189	2,420	1,848	2,304	2,662	2,143	2,233	2,299	2,432	2,594
May	3,057	3,988	4,303	3,399	6,976	4,996	3,459	3,897	5,707	3,151	5,450
Jun	6,286	11,472	11,602	11,360	10,931	10,788	9,803	12,161	14,330	10,526	13,791
Jul	17,040	21,222	23,418	22,297	21,245	21,097	16,571	17,681	22,251	23,923	24,983
Aug	23,472	31,173	33,138	30,760	27,829	34,238	29,045	31,101	29,557	37,908	32,662
Sep	31,178	32,587	35,236	30,994	37,302	40,168	33,430	30,134	34,934	39,331	39,117
Oct	17,946	21,851	22,296	23,942	25,013	27,121	25,180	26,081	24,822	27,586	25,435
Nov	11,585	11,927	12,209	13,986	13,892	16,983	14,111	13,984	14,282	15,726	14,840
Dec	7,569	6,471	6,784	7,595	8,461	9,500	7,792	8,059	8,490	9,080	8,428
Month	Past Record			Basin Development 2020, B2				Basin Development 2050, B2			
	1998	1985-2000	1991-2000	2011-2020	2021-2030	2031-2040	2041-2050	2011-2020	2021-2030	2031-2040	2041-2050
Jan	3,724	3,793	4,077	4,695	4,800	5,212	4,767	4,658	4,762	5,150	4,745
Feb	3,140	2,694	2,943	3,795	4,086	4,036	3,878	3,806	4,085	4,048	3,887
Mar	2,236	2,161	2,337	3,499	3,618	3,697	3,499	3,592	3,730	3,835	3,634
Apr	2,560	2,189	2,420	3,541	3,891	3,926	3,727	3,638	3,936	4,011	3,803
May	3,057	3,988	4,303	4,597	7,647	6,224	4,957	4,637	7,460	5,976	5,017
Jun	6,286	11,472	11,602	10,754	11,587	10,713	9,704	10,293	11,215	10,272	9,141
Jul	17,040	21,222	23,418	19,857	19,161	18,864	14,829	19,028	18,201	18,153	14,118
Aug	23,472	31,173	33,138	27,870	24,994	31,156	25,789	26,956	24,225	30,233	24,776
Sep	31,178	32,587	35,236	28,498	34,781	38,305	30,582	27,693	33,932	37,443	29,450
Oct	17,946	21,851	22,296	22,400	22,783	25,870	23,279	21,780	22,112	25,328	22,720
Nov	11,585	11,927	12,209	12,827	12,570	16,135	13,025	12,688	12,270	15,830	12,853
Dec	7,569	6,471	6,784	7,023	7,767	8,614	7,119	6,884	7,538	8,286	6,921

Source: Mekong River Commission

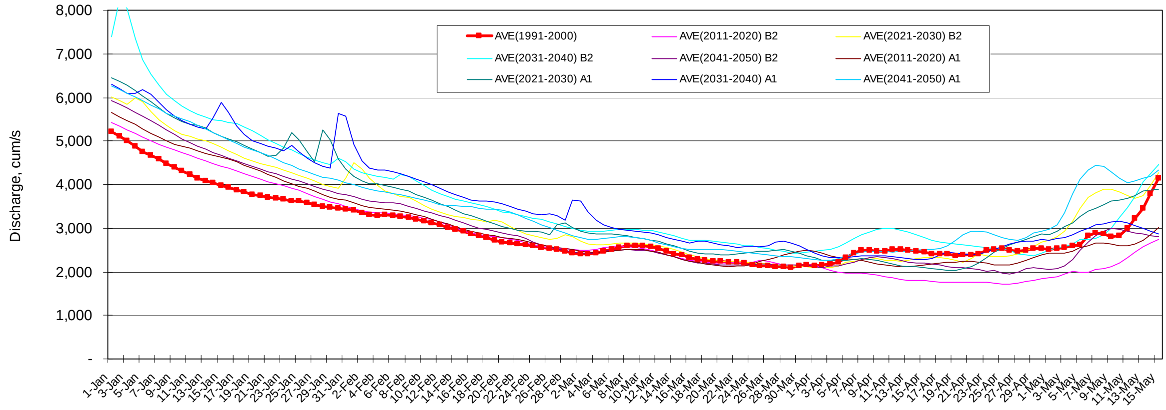


Figure 2.5.22 Mekong River Discharge at Kratie during Dry Season (A1 and B2)

Source: Mekong River Commission

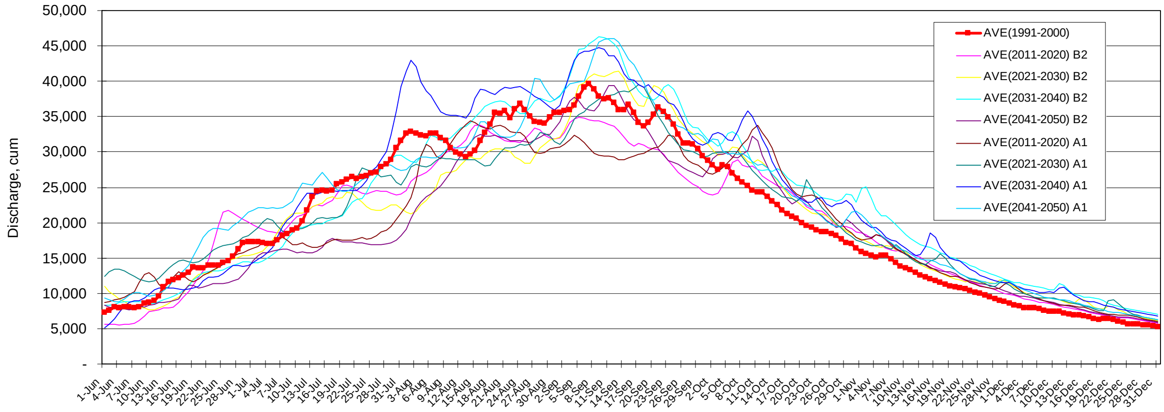


Figure 2.5.23 Mekong River Discharge at Kratie during Rainy Season (A1 and B2)

Source: Mekong River Commission

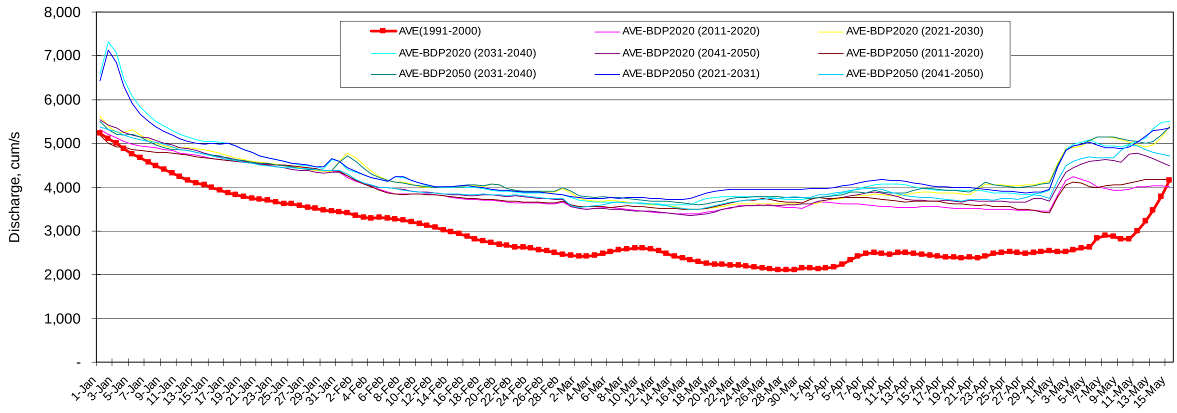


Figure 2.5.24 Mekong River Discharge at Kratie during Dry Season with Basin Development Projects

Source: Mekong River Commission

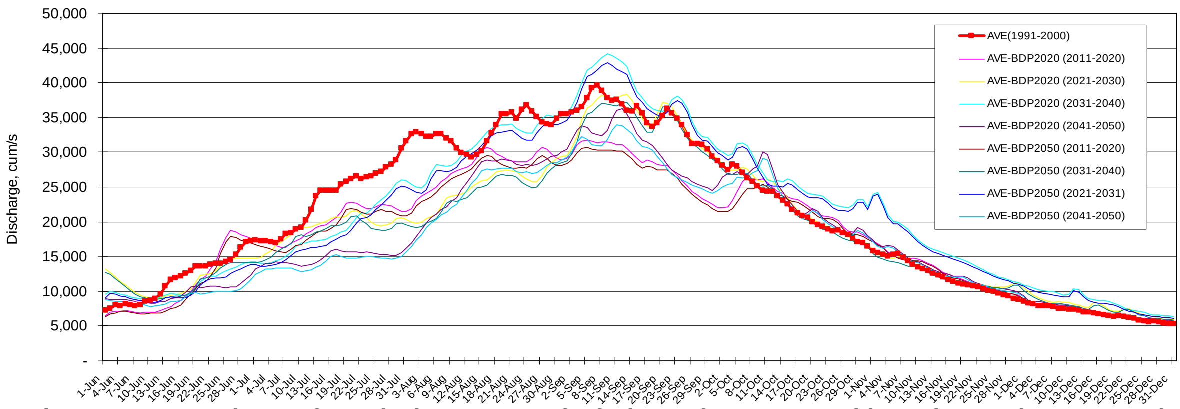


Figure 2.5.25 Mekong River Discharge at Kratie during Rainy Season with Basin Development Projects

Source: Mekong River Commission

2.6 Expected Impact by and Adaptation to Climate Change

Climate change prediction in future was elaborated in the previous sections, and this sub-section summarizes expected impacts to be caused by future climate change taking into account sea level rises, Mekong River future discharge, etc. Sanding impacts are to show up on such crops as paddy, fruit, vegetables, etc. under 2 major issues of temperature rise and also saline intrusion coupled with sea level rise.

2.6.1 Impact on Crop Production by Temperature Rise under Climate Change

1) Correlation between Temperature Rise and Paddy Yield

There is a relationship between temperature and crop yield often reported. For example, extremely high temperatures during vegetative growth are well known to reduce tiller number and plant height, and negatively affect panicle and pollen development. This causes reduction of paddy yield potential. High temperature is of particular importance during flowering, which typically occurs at mid-morning. Exposure to high temperature (i.e. greater than 35 Celsius degree) can greatly reduce pollen viability and thereby causes irreversible yield loss because of spikelet sterility.

Higher temperature shows up in spring in Vietnam just before the rainy season starts, which means the winter-spring paddy could be affected the most by this high temperature. Maximum monthly temperature data and winter-summer paddy harvest data (paddy yield) have been collected to examine the correlation between the past temperature and the harvest data. This examination established a relationship of how temperature rise, in terms of maximum monthly temperature, affects the yield of winter-spring paddy as shown in Figure 2.6.1.

The correlation indicates that as the temperature rises, there shows up yield reduction as depicted by a formula; $y = -0.042x^2 + 2.404x - 29.09$ ($R^2=0.41$). This indicates that there is approximately 0.57 ton/ha yield reduction against 1.0 Celsius degree temperature increase within the temperature range of 31 – 33 Celsius degrees. The reduction of 0.57 ton/ha is equivalent to about 11% reduction in the yield. This reduction, 11% reduction, is similar to what was reported by ‘Rice Production and Global Change: Scope for Adaptation and Mitigation Activities, R. Wassmann, SVK Jagadish, SB Peng, K Sumfleth, Y. Hosen, and BO Sander’ wherein 10 % reduction was reported.

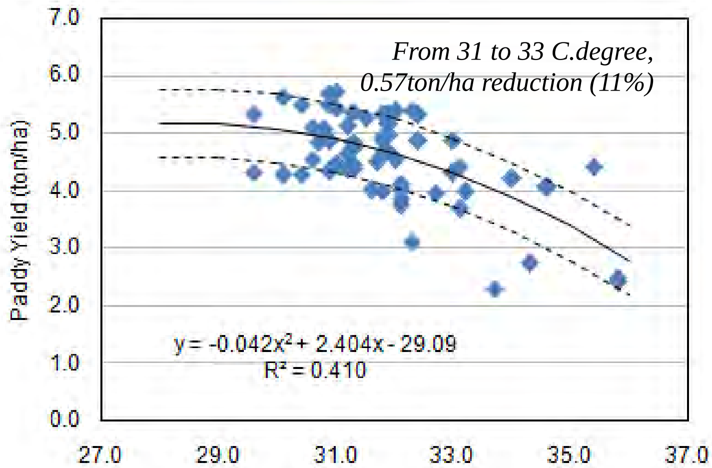


Figure 2.6.1 Correlation between the Paddy Yield and Maximum Monthly Temperature
Source: MONRE for meteorological data, DARD for Paddy Yields.

2) Damage on Paddy Production caused by Temperature Rise

Given this correlation, future winter – summer paddy production can be estimated under the climate change temperature rise. Figure 2.6.2 to Figure 2.6.4 show yield change by province, its rate of yield change, and production change by province as well as its summated change, which were all estimated under climate change scenario B2. In addition, Figures 2.6.5 – 2.6.7 show same production changes estimated under temperature rise forecasted with climate change scenario A2. Note that ‘present’ means the average yield/production from year 2005 to 2000. The following figures indicate such yield changes in future as the temperature goes up;

1) Present yield of winter – spring paddy stays at around 4.5 to 4.9 tons/ha by province and this yield starts going down as the temperature goes up in future. Under the climate change scenario B2, where 0.9 – 1.4 (1.6 – 2.6) Celsius degree temperature rise is expected at year 2050 (2100) as compared to the base year 2000, the yield may reduce to 3.8 – 4.2 (3.2 – 3.8) tons/ha at year 2050 (2100) depending on the province (see Figure 3.3.2). This yield reduction is corresponding to 12 – 18 (22 – 29) % yield loss at the year 2050 (2100) depending on the province (see Figure 3.3.3). According to the Figure 3.3.4, total production of the winter – spring paddy for the Project area is now about 4 million tons and this total production reduces to 3.4 (3.0) million tons at year 2050 (2100). This means 15 (25) % loss at year 2050 (2100) could take place as compared with the present production.

2) Under the climate change scenario A2, where 0.9 – 1.4 (2.1 – 3.3) Celsius degree temperature rise is expected at year 2050 (2100) as compared to the base year of 2000, the yield may reduce to 3.7 – 4.2 (2.9 – 3.6) tons/ha at year 2050 (2100) depending on the province (see Figure 3.3.5). This yield reduction is corresponding to 14 – 18 (27 – 36) % yield loss at the year 2050 (2100) depending on the province (see Figure 3.3.6). According to the Figure 3.3.7, total production of the winter – spring paddy for the Project area which is now about 4 million tons may reduce to 3.4 (2.7) million tons at year 2050 (2100). This means 15 (33) % loss at year 2050 (2100) as compared with the present production. Note that the reduction till 2050 is not much different between the 2 climate change scenarios of A2 and B2 while the change after 2050 towards 2011 tends to be bigger since the PRECIS prediction for A2 scenario shows an accelerated incremental trend towards 2100.

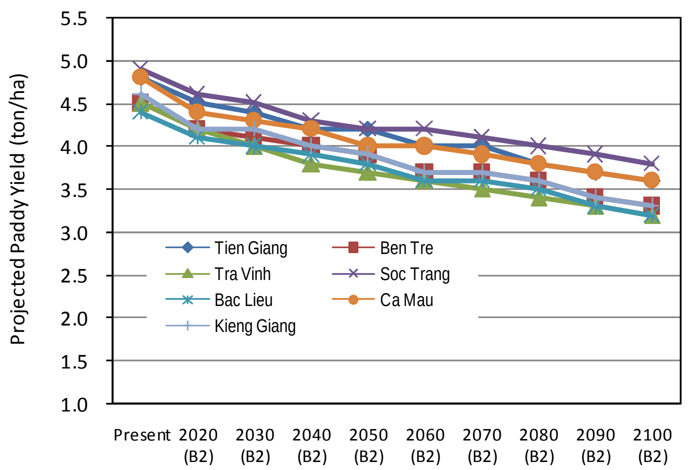


Figure 2.6.2 Yield Reduction under B2 Scenario

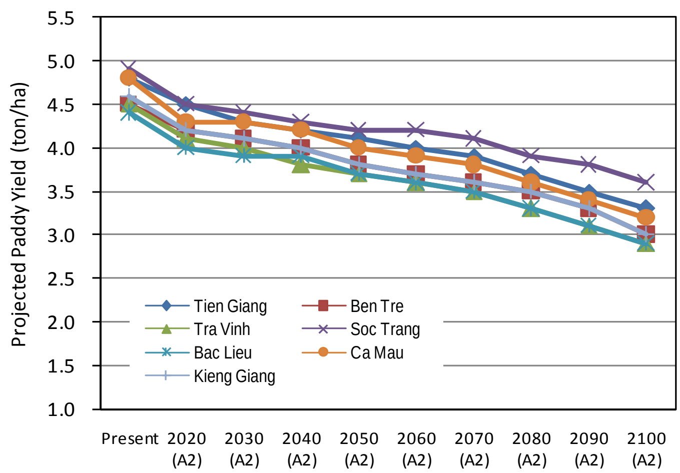


Figure 2.6.4 Yield Reduction under A2 Scenario

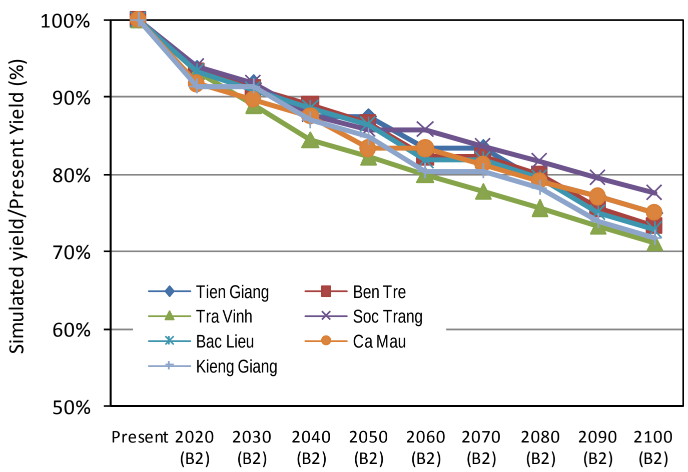


Figure 2.6.3 Yield Reduction in % under B2 Scenario

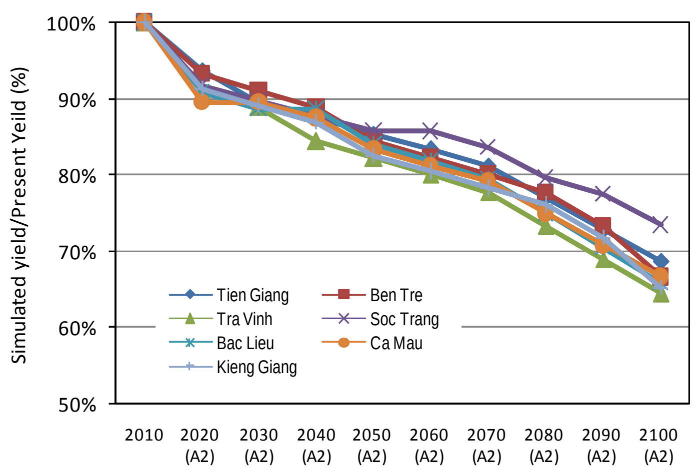


Figure 2.6.5 Yield Reduction in % under A2 Scenario

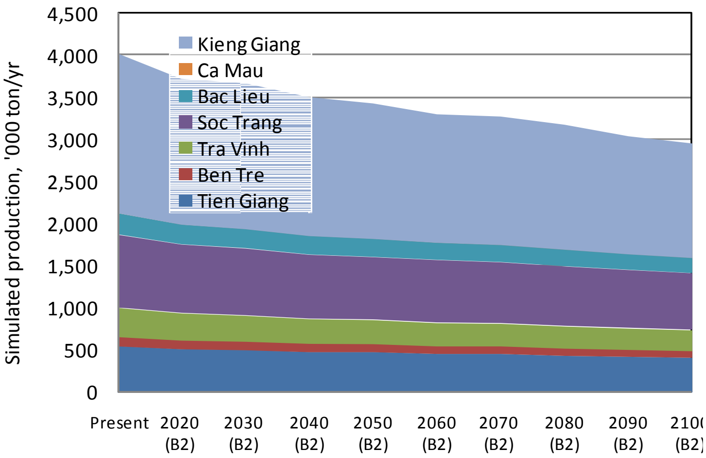


Figure 2.6.6 Production Reduction under B2 Scenario

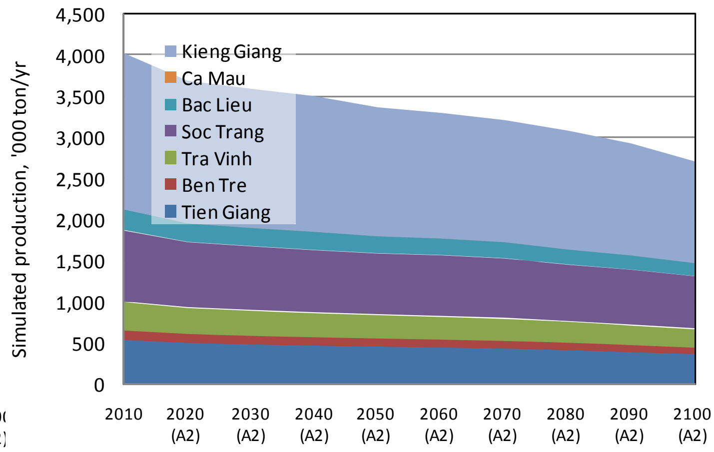


Figure 2.6.7 Production Reduction under A2 Scenario

2.6.2 Impact on Crop Production by Saline Intrusion under CC

Saline intrusion simulation was carried out for; 1) cases with the driest year's Mekong River discharge (1998), and 2) cases with projected discharges by MRC including 1991-2000 average discharge. Sea level rises have also been taken into account, e.g., 12 cm, 17 cm, 30 cm, 50 cm and 100 cm corresponding to relevant years and different climate change scenarios.

1) Damage Indexes under Saline Intrusion

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. Table 2.6.1 summarizes the relationships taken into the assessment of damage loss under saline intrusion.

Table 2.6.1 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: Ayers & Wescot (1989), FAO, modified by JICA Study Team

2) Yield Loss and Damages by Saline Intrusion

Figure 2.6.8 to Figure 2.6.11 show 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. These figures indicate;

1) Most of the coastal areas are affected by large extent of saline intrusion except for Kien Giang province where there are already many saline 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 prevention sluice gates.
3) Looking at the figures by month, it is obvious that the salinity level hits the peak in April, and with the onset of rainfall from May, it starts descending.

Figure 2.6.12 and Figure 2.6.13 show the change in production/area in terms of percentage by province. Likewise, Figure 2.6.14 and Figure 2.6.15 indicate the change (damage) in terms of monetary value by province. As shown in these figures, 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.

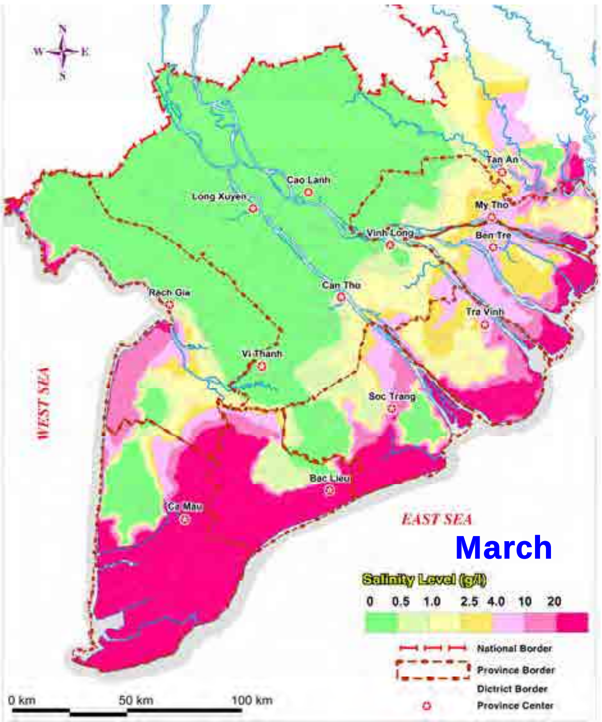


Figure 2.6.8 Salinity Isolines of March for DY 1998 MR Discharge with 30 cm SRL (2050)

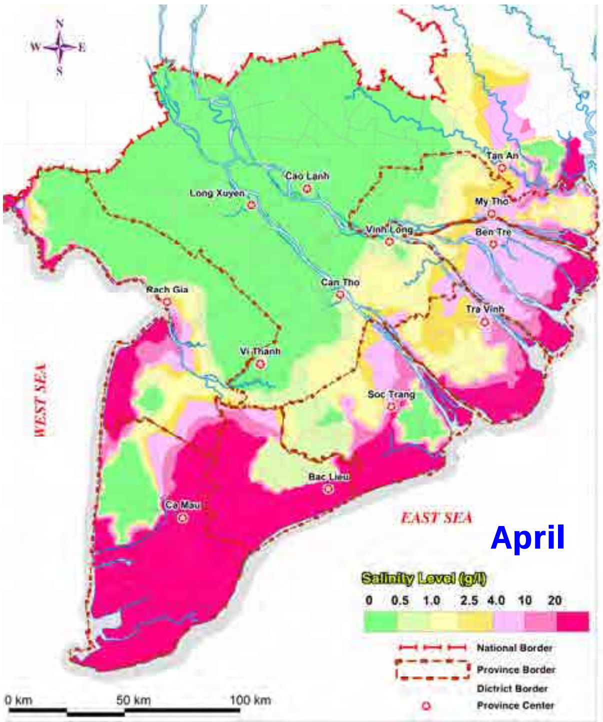


Figure 2.6.9 Salinity Isolines of April for DY 1998 MR Discharge with 30 cm SRL (2050)

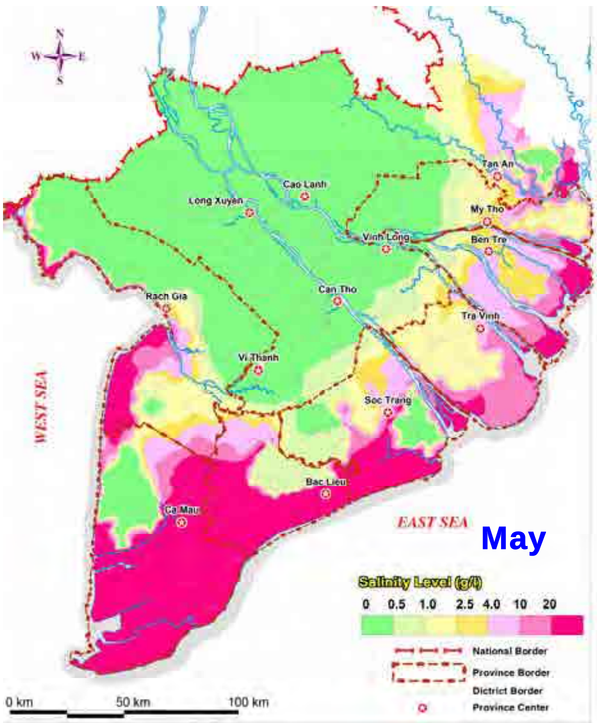


Figure 2.6.10 Salinity Isolines of May for DY 1998 MR Discharge with 30 cm SRL (2050)

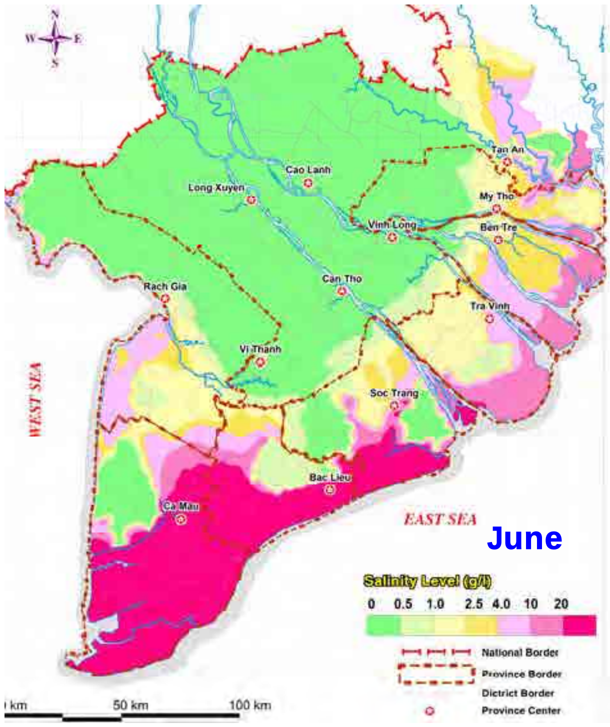


Figure 2.6.11 Salinity Isolines of June for DY 1998 MR Discharge with 30 cm SRL (2050)

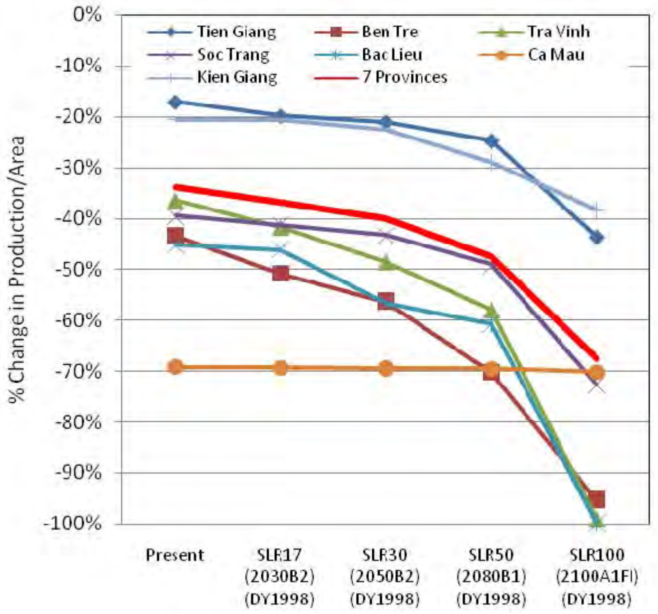


Figure 2.6.12 Production Loss(%) by Province
(DY1998 MR Discharge with Different SLR)

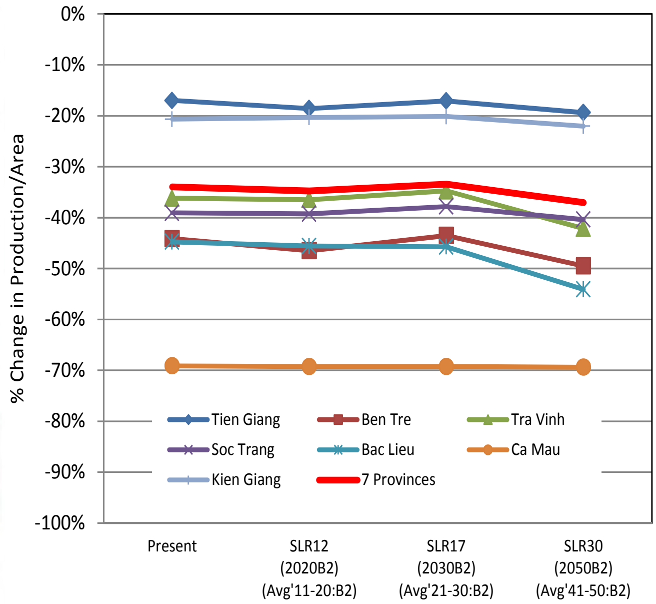


Figure 2.6.13 Production Loss(%) by Province
(Scenario B2 MR Discharge with Different SLR)

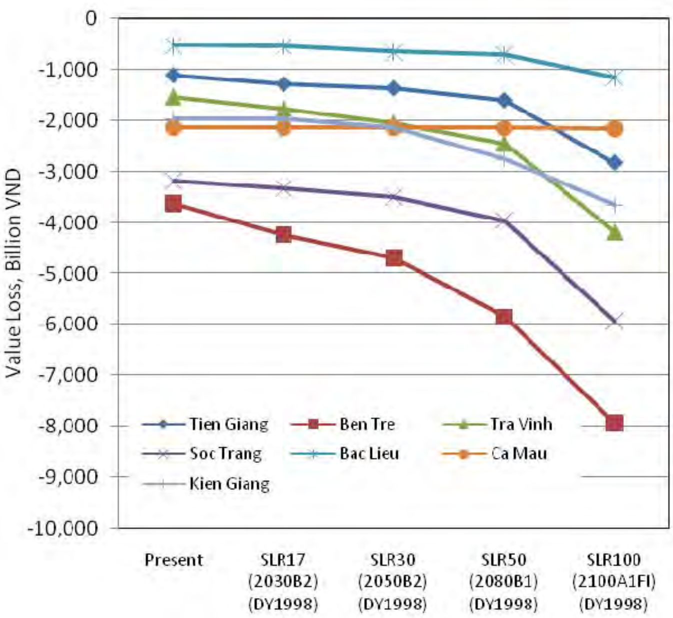


Figure 2.6.14 Production Loss(VND) by Province
(DY1998 MR Discharge with Different SLR)

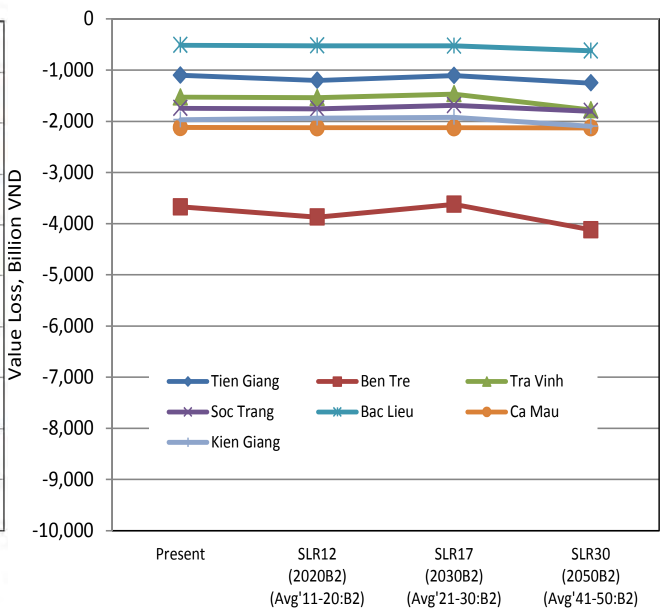


Figure 2.6.15 Production Loss(VND) by Province
(Scenario B2 MR Discharge with Different SLR)

CHAPTER 3 DESIGN OF THE PROJECT

3.1 Current and Up-Coming Issues Identified

In the JICA Study (Climate Change Adaptation in Mekong Delta), issues related to climate change had been identified by 1) government officers and 2) villagers, aside from the results of computer simulations. This sub-section addresses the issues identified by those stakeholders as follows;

3.1.1 Government Officers' Perception on Climate Change

Table 3.1.1 summarizes the issues by province and by priority order from the top to the bottom of the table. Issues identified by all the provinces were saline intrusion and seashore-line erosion inducing sea dyke breach, and those issues identified by most of the provinces were flood and/or inundation, lack of fresh water in conjunction with saline intrusion, and drought.

Rainfall pattern change, e.g. uneven distribution and falling at wrong time, were identified by 3 provinces of Bac Lieu, Ca Mau and Kien Giang. Storm (tornado) was identified by 3 provinces of Ben Tre, Ca Mau and Kien Giang. Two provinces such as Ca Mau and Kien Giang listed forest fire as the top priority. Bac Lieu province listed 'inundation' as the top priority issue while other provinces in most cases listed saline intrusion or drought. Bac Lieu centre, located near sea, is easily affected by tidal effect and when accompanied with heavy rainfall, the center is inundated. Thus, the Bac Lieu province listed the inundation issue as their top priority.

Table 3.1.1 Issues with Priority Order related to Climate Change identified by 7 Provinces

No.	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
1	Saline intrusion	Saline intrusion	Drought, saline intrusion, lack of fresh water	Saline intrusion	Inundation	Sea-level rise (saline intrusion, erosion, lack of fresh water)	Drought
2	Sea dyke breach	Lack of fresh water	Shoreline erosion	Shoreline erosion	Welfare of farmers	Temperature rise (drought, forest fire)	Saline intrusion
3	Shoreline erosion	Shoreline erosion	Flood-tide increasing (sea dyke breach)	Lack of fresh water	Infrastructure for production	Storm and tropical low pressure	Forest fire
4	Flood	Livelihood and health of farmers	Epidemic disease for fruits and livestock	Inundation	Shoreline erosion	Depletion of ground water resource	Sea-level rise
5	Inundation	Decreasing of mangrove forest		Biological diversity reduction	Saline intrusion	Rainfall pattern (uneven distribution)	Shore line erosion
6	Change of the ecosystem	Storm/ Tropical low pressure		Crop production system	Production of agriculture, forestry, fishing		Inundation (flood)
7	Drought			Drought	Rainfall pattern (at the wrong time)		Storm - Tornado
8							Rainfall pattern (uneven distribution)

Source: JICA Project Team, based on the 1-day workshop held on October 27, 2011

Those issues are divided into 2 groups: those directly affected or caused by climate change, and those associated with but not directly caused by climate change. Following table summarizes the priority of the issues; i.e. for the first group, saline intrusion being the first priority, followed by drought and/or lack of fresh water, erosion and damage of sea dyke, frequent storm, inundation and flood, rain in dry season, and forest fire.

Table 3.1.2 Priority Order of the Issues related to or caused by Climate Change

Priority	Issues directly caused by CC	Issues associated with CC
1	Saline intrusion	Ecosystem change
2	Drought, Lack of fresh water	Livelihood change
3	Erosion, Damage of sea dyke	Worsening of public health
4	Frequent Storm	Damage of infrastructure

5	Inundation, Flood	Decrease of mangrove forest area
6	Rainfall in dry season (rainfall pattern change)	
7	Forest fire (associated with temperature rise and drought)	

Source: JICA Project Team, based on the 1-day workshop held on October 27, 2011

3.1.2 Villagers' Perception on Climate Change

1) Problem Analysis

To identify climate change issues at village level, a series of workshops and questionnaire survey were carried out in six communes: two communes in Ben Tre Province, and one commune in each of Tra Vinh, Soc Trang, Bac Lieu, and Ca Mau province. In the workshop, "Problem Analysis" method was employed. To the core problem set as "life is difficult," several causal issues were identified through participatory approach. Following are the major findings in the problem analysis regarding climate change issues, which are also shown in Table 3.1.3:

a) Drought is one of the most common issues related to the climate change. Five communes out of the six communes listed the problem of drought in the problem trees. Only shrimp farmers in Soc Trang Province did not mention the problem of drought. On the detail of the trees, there is some different consciousness between farmers. Farmers in Ben Tre Province put the issue of 'irrigation system is not working' under the 'drought', but farmers in Ca Mau Province did not mention irrigation problem; instead they put the issue of 'drought period becomes longer' as the reason for the drought problem. This means that paddy farmers in Ben Tre Province think the drought problem being as irrigation problem, whereas paddy and shrimp farmers in Ca Mau Province think the drought problem is directly related to the climate change.

b) Inundation is the main problem for the farmers in Phuoc Long commune in Bac Lieu Province. This is because other communes did not mention the problem of inundation except for Thuan Dien commune. There is no 'Heavy rain' issue as their problem in other five communes, however it was found in the problem tree of Bac Lieu Province. Furthermore, Phuoc Long commune in Bac Lieu Province is located in an inland area of Ca Mau Peninsula. Flood often happens in inland areas because of heavy rainfall and also flooded water comes from northern areas. From this point of view, farmers in Phuoc Long commune face inundation problem more seriously than other communes.

c) Vinh Hai commune in Soc Trang Province suffers from an influence of tide. According to their problem trees, farmers in this commune put the 'Flood tide' as one of their direct causes of the core problem. Flood tide means that inundation takes place worse influenced by high tide. Flood tide is common problem in this commune. Also, they mentioned that there are sea dykes, yet high tide overflows these dykes during storms. This indicates that the influence of flood tide is getting more serious for the people in this costal commune.

d) Saline intrusion gives impact mainly on the paddy farmers in Ben Tre and Tra Vinh Provinces. Saline intrusion is also one of the most common climate change issues in these communes. Four communes listed up the problem of saline intrusion in the problem trees. However, it seems that shrimp farmers in Ca Mau Province and Bac Lieu Province are not negatively influenced by saline intrusion because the problem of saline intrusion has never come up in the problem trees. There are possibly two reasons. One reason is that paddy production is more affected by saline intrusion while shrimp production rather takes advantage of the saline intrusion. They need brackish water for the shrimp culture. Hence, shrimp farmers in Ca Mau did not think saline intrusion as their problem. The other reason is that saline water has not reached Vinh Hai commune in Ca Mau and Phuoc Long commune in Bac Lieu Province.

Table 3.1.3 Climate Change Issues Identified in the Problem Trees of Each Commune

Commune	Thuan Dien	An Binh Tay	Huyen Hoi	Vinh Hai	Phuoc Long	Tran Thoi	Nos.
Province	Ben Tre	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	
Drought	●	●	●		●	●	5
Inundation	●				●		2
Flood tide	●			●			2
Heavy rain	●				●		2
Saline intrusion	●	●	●	●			4

Source: JICA Project Team, based on the Problem Analysis

2) Trend Analysis

Trend Analysis was conducted to know the general trend on some of the issues related to the climate change and villagers' livelihood. There were six time periods: 'before 1975', '1976-1985', '1986- 1995', '1996-2000', '2001-2005', and '2006 to present'. Trend was described as percentage change with regard to those time periods.

a) Thuan Dien commune in Ben Tre Province and Tran Thoi commune in Ca Mau Province have rapid upward trend of drought (see Figure 3.1.1). Farmers in Thuan Dien commune in Ben Tre Province described the rapid growth of drought influence since 1995. Farmers in Tran Thoi commune in Ca Mau Province stated its rapid growth since the period of 1996- 2000. On the other hand, the trend of after 1976 has not fluctuated in other three communes: Huyen Hoi commune in Tra Vinh, An Binh Tay commune in Ben Tre, and Phuoc Long commune in Bac Lieu. Therefore, Thuan Dien commune in Ben Tre and Tran Thoi commune in Ca Mau Province have been affected by drought severer than other communes in recent years.

b) The trend of inundation in Phuoc Long commune in Bac Lieu Province and Vinh Hai commune in Soc Trang Province has steadily increased since 1976 (see Figure 3.1.2). As mentioned, Phuc Long commune in Bac Lieu Province has been the most influenced by inundation. According to the farmers' description of trend, the influence of inundation has increased steadily, but not rapidly. Also, the trend of An Binh Tay commune in Ben Tre Province indicates the steadily increase of inundation. From this

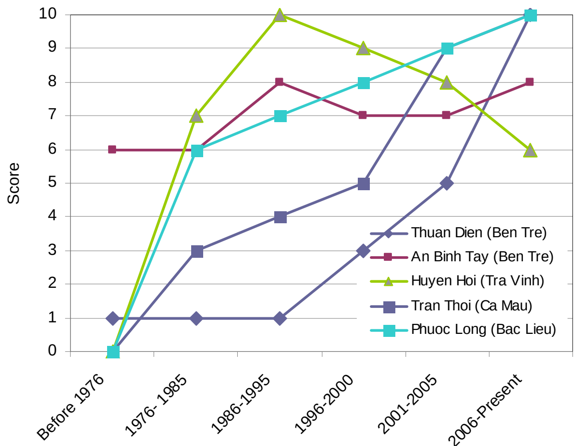


Figure 3.1.1 Trend of Drought (Fresh Water Shortage)

Source: Village Workshop

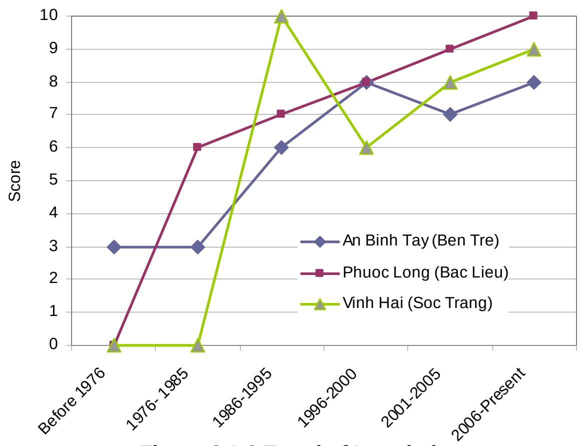


Figure 3.1.2 Trend of Inundation

Source: Village Workshop

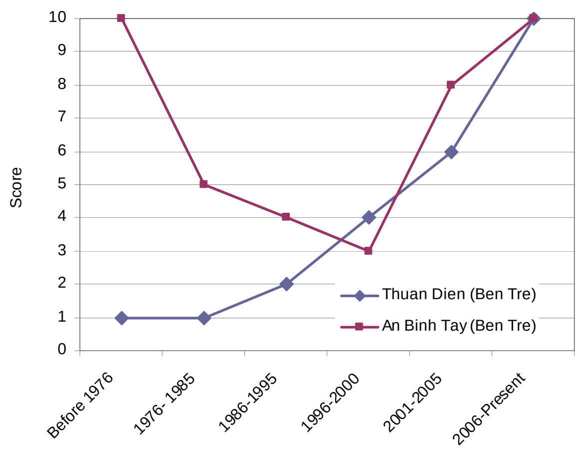


Figure 3.1.3 Trend of Saline Intrusion

Source: Village Workshop

point of view, influence of inundation is surely increasing, but affecting farmers' livelihood relatively slowly as compared to other climate change issues such as drought and saline intrusion.

c) Although there is some difference between Thuan Dien and An Binh Tay communes in Ben Tre Province, the trend of saline intrusion in both communes has been increasing dramatically (see Figure 3.1.3). The trend of Thuan Dien commune has steadily increased since the period of 'before 1975' to '2006- present' while the trend of An Binh Tay fluctuated. The influence of saline intrusion in An Binh village peaked in 'before 1975', and then it decreased until the period of '1996- 2000'. After 2001, the trend has been soaring. The reason for this difference is the location of the communes. Thuan Dien commune is located in an inland area of Ben Tre Province while An Binh Tay commune is in downstream area. Hence, An Binh Tay commune is influenced by saline intrusion from the old days, and its trend becomes more fluctuated. The trends of both communes indicate that the area of saline intrusion has been expanding.

3) Villagers Perception on Climate Change by Questionnaire Survey

a) Type of Climate Changes Observed

In the questionnaire survey which was conducted after the workshop, it was asked what kind and what degree of climate change respondents observed in the past few decades; the answers were summarized in Table 3.1.4. Of a total of 367 respondents, the observation the most frequently pointed out was "(prolonged) high temperature" receiving 84 responses or 23% of the total number of responses. The second most prevalent observation was "unusual rain" including two antagonistic patterns of too prolonged or increased rainfall and decreased rainfall (72 responses, 20%).

Then, the third popular observation was saline intrusion having 58 responses (16%). To be sure, this issue did not prevail in all the communes but concentrated only in An Binh Tay and Thuan Dien both in Ben Tre Province, suggesting the saline intrusion as a location specific issue. The forth one was general "weather change" or "irregular climate," which provably represents the unsynchronized weather with ordinal seasons (54 responses, 15%) constituting temperature and precipitation. Other observations suggested include: flood/ high water level (26 responses, 7%), increase in disease/ insect (20 responses, 5%), and drought (19, 5%).

Table 3.1.4 Climate Change Respondents Observed

District	High Temperature (prolonged)	Unusual Rain (prolonged/ increase/ decrease)	Saline Intrusion	Weather Change/irregular climate	Flood/High Water Level	Increase in Disease/insect	Drought	Water Pollution	Change of Season (dry-wet)	Not Particular	Others	Total
Thuan Dien	23	17	26	9	10							85
An Binh Tay	16	11	22	1		6	6					62
Huyen Hoi	10	8	1	13		5	4	1		6		48
Vinh Hai	6	5	1	4	1	1	1		2			21
Phuoc Long	19	22	2	9	5	8	6	4	5	1	4	85
Tran Thoi	10	9	6	18	10		2	10			1	66
Total	84	72	58	54	26	20	19	15	7	7	5	367
	23%	20%	16%	15%	7%	5%	5%	4%	2%	2%	1%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)
Note: Based on a multiple answering and open-ended question

b) Damages or Losses in Agriculture and Aquaculture Caused by Climate Change

The respondents of the questionnaire survey claimed some tangible damages or losses caused mainly by climate change on their own reality. As shown in Table 3.1.5, there were a total of 462 valid responses. The most frequent issue was "damage to coconuts" including the reduced size of coconut fruits and also fallen fruits by strong wind (211 responses, 46% of the total number of responses). The second most common issue was "decreased production" associated with any kind of commodities (not specified). This issue (57 responses, 12%) was observed only in An Binh Tay and Thuan Dien of Ben Tre province.

Negative impact in aquaculture was also addressed; damage to shrimp (51) accounts for 11% of the total number of responses. Then, increased disease and insects were also given 50 responses (11%); increased temperature tends to harness viruses, pathogenic bacteria, and insects—farmers claim. Damage to paddy was claimed by 3 communes, sharing altogether 4%. Farmers in Thuan Dien claimed particularly about loss of seedlings (7 responses, equivalent to 2%). It sounds realistic considering the fact that plants easily receive damages especially at the early stage.

Table 3.1.5 Major Damages or Losses Caused by Climate Change

District	Damage to Coconut	Decreased Production	Damage to Shrimp	Increased Disease/insect (common)	Yield Loss (common)	Damage to Paddy	Loss of Seedling	Others	Total
Thuan Dien	42	26		19			7	5	99
An Binh Tay	38	31		11		7		1	88
Huyen Hoi	30			6	18	3		6	63
Vinh Hai	21		5		1			2	29
Phuoc Long	41		24	14	7	8		7	101
Tran Thoi	39		22		10			11	82
Total	211	57	51	50	36	18	7	32	462
	46%	12%	11%	11%	8%	4%	2%	7%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)
Note: Based on a multiple answering and open-ended question

c) Countermeasures Taken

To cope with climate change problems, the respondents have taken a series of countermeasures. As shown in Table 3.1.6, the most common countermeasure was "application of chemicals/ medicines" that is to cope with diseases enhanced by increased temperature or prolonged hot weather (27 responses, 28% of the total responses). The second frequent answer was "construction or improvement of embankment," implying that farmers do some earthworks by themselves to protect their paddy field, shrimp pond or other agricultural plot from saline water intrusion (26 responses, 27%).

Table 3.1.6 Countermeasures Taken by the Households

District	Application of Chemicals/ Medicines	Embankment Construction/ Improvement	Irrigation/ Water Control	Canal Dredging/ Drainage	Change of Cropping Pattern	Change in the use of fertilizer	Not Particular	Others	Total
Thuan Dien	6	22	2		1	2			33
An Binh Tay	7		7				1		15
Huyen Hoi	3		2	4			1	6	16
Vinh Hai				1					1
Phuoc Long	4	3	3	1	1				12
Tran Thoi	7	1	6	1	1	1		2	19
Total	27	26	20	7	3	3	2	8	96
	28%	27%	21%	7%	3%	3%	2%	8%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)
Note: Based on a multiple answering and open-ended question

Application of irrigation or water control is also seen as a countermeasure to deal with saline intrusion and unstable rainfall, having 20 responses (21%). Those three countermeasures shared 76% of the total number of responses. Other countermeasures claimed by the respondents were: “canal dredging/ drainage (7 responses, 7%)”, “change of cropping pattern (3 responses, 3%)”, “change in the use of fertilizer (3 responses, 3%)”, and others. It is noteworthy that some farmers have changed or shifted their cropping pattern and changed the method of fertilizer application; they have already “adapted” their farming style to some extent along with the climate change.

d) People’s Observation on Saline Intrusion

Table 3.1.7 shows the respondents’ observation on any change in the condition of saline intrusion at their field or canals nearby. Of a total of 183 valid responses, 132 respondents, or 72% of the total number of respondents, answered “yes” that they have observed some changes on saline intrusion. Among total 39 valid responses that specified what actually happened in their field or around, 11 responses (28% of the total number of responses) answered either of “prolonged” and/or “increased.”

To add with, saline intrusion has become “erratic (6 responses, 15%)” and “early starting (2 responses, 5%)”. In this survey, a total of 30 responses (77%) were given generally to negative connotations: “increased”, “prolonged”, “erratic”, and “early starting”. By location, there were four communes where change in the situation (yes) is dominant. Specifically in Thuan Dien, 41 responses were given to “yes”, while only one response was given “no”. On the other hand, the number of responses given to “no” was dominant in Huyen Hoi and Vinh Hai, although the numbers given to each answer were not so different.

In the meantime, there were a total of nine responses given to “decreased”, which was due to the installation of sluice gates and/or increased rain. While saline intrusion per se is increasing to a wider extent, totally different situation can be created by artificial manipulations location by location. It suggests that location specific conditions of saline intrusions are intermixed by area.

Table 3.1.7 Saline Intrusion at Farmers’ Field or Canals Nearby

District	Yes	No	Total	Prolonged	Increased	Decreased	Erratic	Early starting	Total
Thuan Dien	41	1	42	8					8
An Binh Tay	26	5	31	2					2
Huyen Hoi	13	16	29	1		7		1	9
Vinh Hai	9	11	20		2				2
Phuoc Long	19	11	30		6	2			8
Tran Thoi	24	7	31		3		6	1	10
Total	132	51	183	11	11	9	6	2	39
	72%	28%	100%	28%	28%	23%	15%	5%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)

Note: Based on a multiple answering and open-ended question

3.1.3 Saline Intrusion as Main Issue Considered in this Project

As is discussed above, there are a number of issues associated with climate change: yield loss by temperature rise, direct damage by saline intrusion, and destruction by inundation, all of which are already in place and simulated to be much severer in the future in terms of area affected and also frequency of severe situation. Among all, Figure 3.1.4 shows a situation of saline intrusion in 1998 when it became severest once in recent years (left) as well as an expected one in 2020 based on simulation model (right). As shown in the figure (left), saline intrusion had spread wide range of areas along the coastal provinces at a saline content level 20g/L or more (red color) in 1998. As a result, vast areas of paddy field were affected. Thus, the saline intrusion is already a pressing issue in these areas, which is expected once in a while.

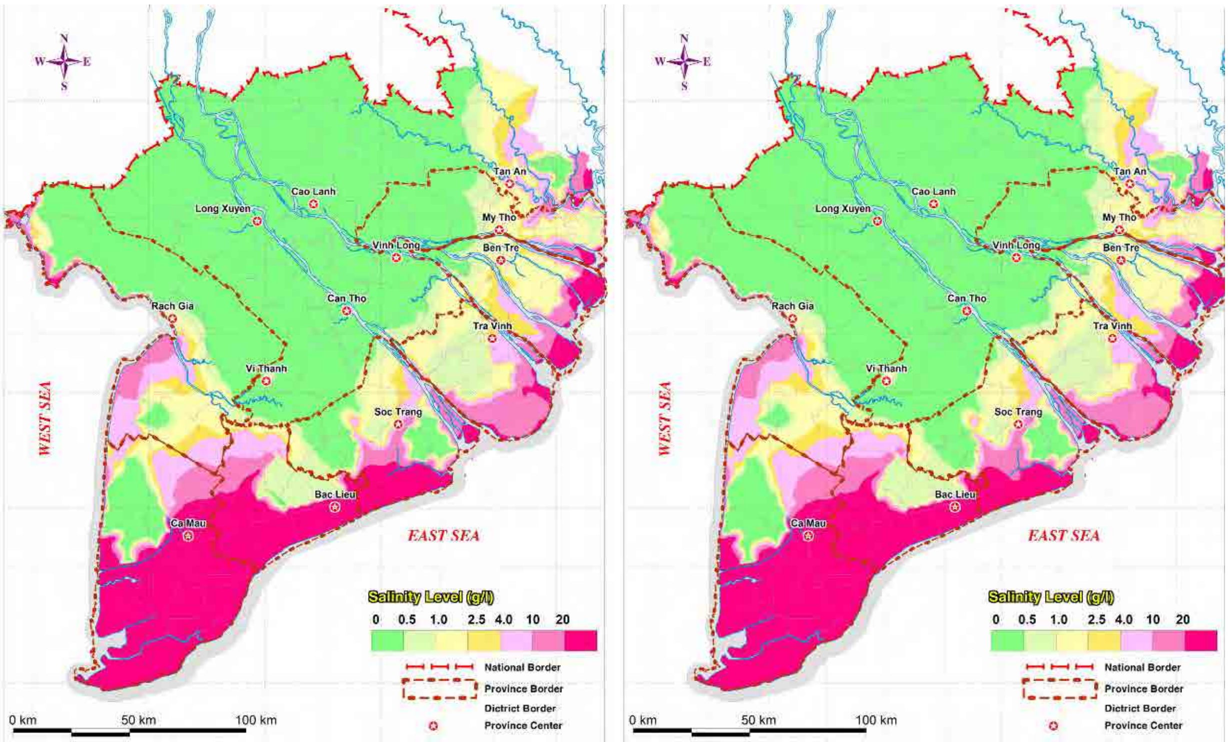


Figure 3.1.4 Saline Intrusion in 1998 and 2020 based on Simulation

Source: JICA Project Team (2012)

Furthermore, saline intrusion is also expected to be as severer as or much severe than 1998 by 2020. As shown in the figure (right), the severest situation in recent years would, expectedly, be the normal situation in the future, suggesting that implementation of possible measures should be put in place, or otherwise large extent of damage to such commodities as paddy, vegetables, fruits, and also shrimps are to take place.

To be specific, it should be clarified how those damages are caused by saline intrusion. Table 3.1.8 shows a typical cropping pattern in saline prone areas. Usually, paddy cultivation starts at the early stage of rainy season in and around June and continues up until September to November, depending on the variety of paddy and cropping system. In the meantime, saline intrusion occurs in dry season, corresponding to the decreased amount of water discharge mainly from Mekong River. Then, damage is caused in and around June, during the early stage of paddy cultivation. In this context, cultivation of paddy should be avoided in June.

Table 3.1.8 Typical Cropping Pattern in Saline-Prone Areas

Type of Land Use	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2 Paddy (SA/WS) /Fish		WS/Fish			SA/Fish						WS/Fish	
High-yielding (RS) Paddy								High - yield RS				
Rainfed Paddy (SA-RS)						SA				RS		
Paddy (RS)/Fish									RS/Fish			
Paddy (RS)/Shrimp							RS				Shrimp 1	
Shrimp (1 or 2 times)				Shrimp 1st					Shrimp 2nd			
		Critical for shrimp culture (salinity needed)				Critical for Paddy Cultivation (fresh water needed)						

Source: SIWRP (2012)

Note: SA: Summer-Autumn crop; WS: Winter-Spring; RS: Rainy Season crop

Moreover, those issues should be also seen from an area-wised perspective. There are wide range of areas where paddy is cultivated twice a year in which second cropping extend to an early stage of dry season. In this arrangement, second paddy would encounter a risk of saline intrusion. As a result, there are, and there will be a certain hectarage of areas where second paddy is no longer suitable due to an increased risk of saline intrusion during dry season. In such areas, therefore, a "paddy-paddy" cropping system is no longer applicable.

Based on the simulation analysis, it is expected that some of currently "paddy-paddy" cropping areas would be situated as saline-prone areas in the future. As shown in Table 3.1.9, a total of 126,168 ha is expected to be non-suitable area for paddy cultivation due to saline intrusion, which accounts for 14% of the area that is now under any kind of paddy cultivation systems, such as paddy, paddy-paddy, and paddy-aquaculture. Of a total of 126,168 ha, 30,616 ha (24%) is expected to be at a level which should be converted to brackish aquaculture –paddy system and 95,552ha (76%) is for brackish aquaculture.

Furthermore, even for such areas where paddy-based systems can be continued, 117,031 ha or 15% of the said area is expected to expose to a risk of saline water at a level 4-10g/L either February or June. Thus, some countermeasures to control the salinity at the filed level are required.

Table 3.1.9 Saline Prone Area of Currently Paddy Area Expected in 2050 (ha)

Land Use	No Change			Change to			Grand Total
	Without Risk	With Risk	Total	Bracksih-Paddy	Brackish Aqua	Total	
	< 4g/L both in Feb&Jun	4-10g/L in either Feb or Jun		>10g/L in Feb <10g/L in Jun	>10g/L both in Feb & Jun		
Paddy	28,768	21,257	50,025	8,801	28,221	37,022	87,048
Paddy (1 crop)	47,722	27,365	75,087	12,535	25,334	37,869	112,956
Paddy (2 crop)	333,068	45,053	378,121	7,815	36,355	44,170	422,291
Paddy (3 crop)	207,820	18,931	226,750	1,455	3,314	4,769	231,519
Paddy and annual crops	741	1,767	2,508	10	2,327	2,337	4,845
Paddy-Fresh aqua	17,236	91	17,327	0	0	0	17,327
Paddy-Fish	13,918	2,567	16,484	0	0	0	16,484
Paddy Total	**649,272**	**117,031**	**766,303**	**30,616**	**95,552**	**126,168**	**892,471**
	85%	15%	100%	24%	76%	100%	
	73%	**13%**	**86%**	**3%**	**11%**	**14%**	**100%**

Source: JICA Project Team based on Sub-NIAP (2012)
Note: Saline-prone area is categorized based on the saline content designated in the table

3.2 Project Components

In this sub-section, proposed project components are described as: 1) Cropping Calendar Adjustment and Improvement Programme, 2) Salinity Tolerant Variety Development and Extension Programme (tolerant to saline and/or high temperature for rice), and 3) Crop Diversification and Extension Programme. Simplified Project Design Matrix (PDM) of each project component is attached in the following pages.

Of the 3 components, the most outstanding one is the 'Cropping Calendar Adjustment and Improvement Programme'. Under this component, major activities are to be 'experimental researches' and 'agriculture extension activities'. As indicated in the following figure, major adjustments of the cropping patterns could be;

1) Shifting of the planting of dry season (winter-spring) paddy towards a little bit later stage (see 'A' in the figure). Since the rainfall at the end of rainy is expected to increase due to the impact of climate change, flooding and inundation during the late rainy season will be intensified, and therefore the commencement of the winter – spring paddy will automatically be delayed.

2) Contrary to the delay of winter – spring paddy planting, the harvest of the paddy should be done earlier than what is practiced now (see 'B' in the figure. Temperature in future is to increase, by

which winter – spring paddy will be affected especially in March. Also, saline intrusion becomes severer in March and April, and therefore the winter – spring paddy should be harvested earlier. To make it possible, early maturity variety may have to be introduced and transplanting can also be tried by which growing period on the main field can be shortened.

3) Introduction of brackish shrimp culture during dry season should be considered while maintaining the rainy season paddy, wherein the rainy season paddy shall be shifted towards latter part of rainy season since there should be idling period between shrimp culture and paddy culture in order to wash away the salt accumulated with shrimp culture in the farm plot (see 'C' in the figure), and

4) Introduction of 2 times paddy cultivation in a rainy season may be tried while maintaining brackish shrimp culture during rainy season. Since idling period for washing salt is required prior to the commencement of rainy paddy cultivation, there is usually a difficulty of cultivating 2 times paddy in this rainy season. However, if the second paddy is practiced with short maturity variety and transplant of 40 – 60 days nursery (see 'D' in the figure), the growing period in the main field can be greatly shortened, whereby 2 times paddy cropping could be realized.

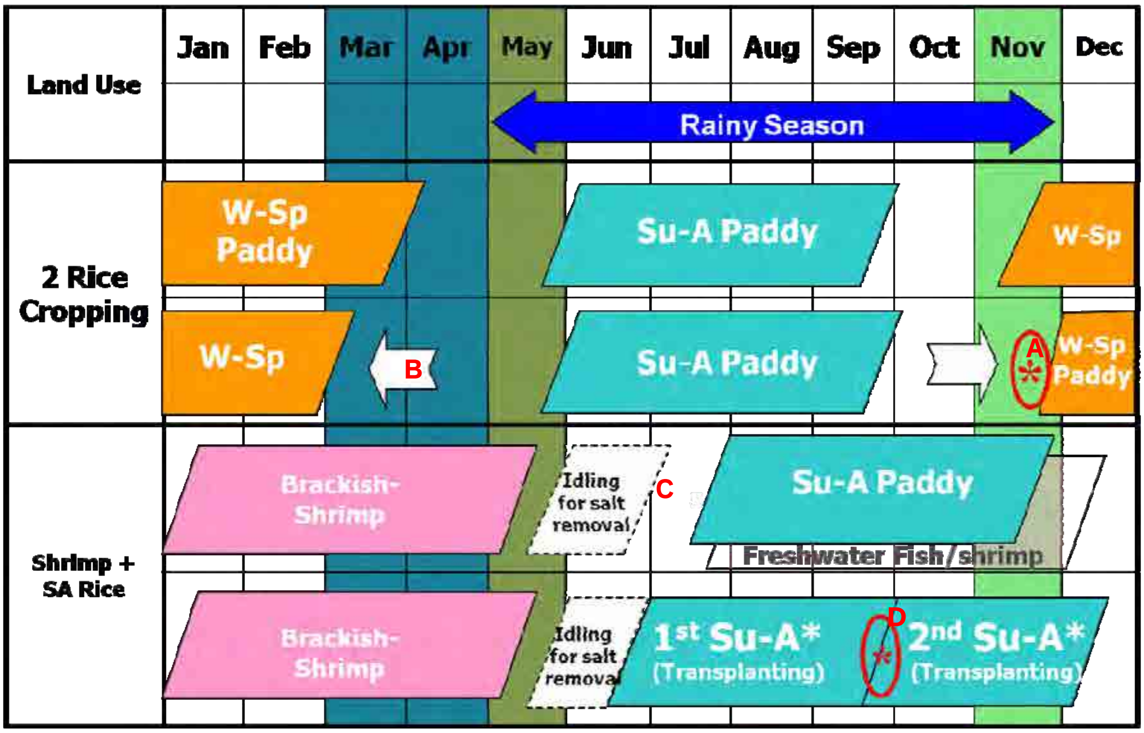


Figure 3.2.1 Recommended Adjustment for Cropping Patterns, Source: JICA Project Team

In addition to above cropping pattern adjustment, there should be research for developing and/or introducing new varieties of paddy; e.g. early maturity variety, salt tolerant variety, and different time flowering variety as recommended under 'Salinity Tolerant Variety Development and Extension Programme'. In fact, there are already varieties of e.g. 90-day maturity paddy, and salt tolerant variety. However, already available varieties have not been well disseminated due to taste of the rice, low yield, etc. Therefore experimental researches of developing such varieties of early maturity and salt tolerant paddy should also be implemented. In addition, IRRI has invented a new variety, which flowers early morning time to evade from high temperature. Such new variety should also be tried under the 'Salinity Tolerant Variety Development and Extension Programme'.

3.2.1 Cropping Calendar Adjustment/Improvement Programme

Project Title	**Cropping Calendar Adjustment and Improvement Program**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		◎	○		○		
Target Groups	Paddy farmer and aquaculture farmers						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To adjust cropping calendars adapting to saline intrusion

Rationale: Saline water intrusion is the first priority among the issues related to climate change. Saline intrusion occurs at the end of dry season As a result, paddy cultivation areas are expected to undergo saline intrusion more than the level paddy can be produced: more than 0.4 g/litter of saline content. In fact, about 70% of paddy harvest of Tra Vinh was lost by saline intrusion in an area of 8,000 ha (2011 dry season). Thus, it is highly recommendable to adjust/shift the cropping calendar. For the areas where saline remains longer period of time, for example, it is effective to set back the preparation of paddy cultivation for the summer-autumn season. For the areas where saline intrusion is far severer, changing paddy to shrimp may be a better solution. In so doing, introduction of new cultivation methods should be considered as a means for adaptation: saline-tolerant varieties, application of transplanting, and rotation between rice and shrimp—all of which need to be promoted through effective extension systems.

Project Implementation	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
	━━	━━	━━	━━	━━	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■

Expected Outputs	**Development Indicators**
• Farmers' income is secured. • Paddy cultivation and aquaculture are sustainable. • Cost of infrastructure development necessary for protecting paddy area is saved.	• Farmers' income in the saline-prone area is kept more than 90% of the other areas • Paddy cultivation schedule is adjusted in saline prone area (80% of targeted areas in new land use plan) • Paddy is changed to shrimp in severe saline area (80% of targeted area)

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
• Productions of agricultural and aquacultural commodities are secured • An entire process is systematized • New systems are promoted • New systems are put in the land use plan • Improved agricultural systems are established • Vulnerable areas are identified	A total of US$ 5,000,000 (US$ 1,000,000/year). • Chief advisor/ agricultural planning • Coordinator/ GIS • Short-term experts as required • Audio visual equipment • Trainings	MARD, Donors

Project Risk: Paddy cultivation and shrimp cultivation conflict to each other as the former requires fresh water (not more than 4 PPT), while the latter need a certain content rate of saline water (not less than 10 PPT). Saline water withdrawn into the canal for shrimp cultivation, or discharged from shrimp pond, affects the growth of paddy nearby fields. In the process of changing land use patterns, therefore, some conflict could occur among them who prefer doing paddy cultivation and those who would like to go for shrimp culture.

Environment Assessment (B): Excessive concentration of shrimp culture, especially as a form of "intensive" culture, increase the risk of diseases, in which disease can transmit from one pond to the other. In case disease happened in a wide range of area, disease may transmit to the other surrounding environment and could affect shrimp and other aquatic animals in nature. Also, if farmers newly open the shrimp pond through reclamation of mangrove, area of mangrove forest would decrease and shoreline may be exposed to a risk of erosion. Although it is not expected to use antibiotics, use of such chemicals may harm the neighbor farmers.

3.2.2 Development of New Rice Varieties

Project Title	**Development of New Rice Varieties and Extension Program** (Tolerant to Salinity and High Temperature)

Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
			○	○			●

Target Groups	Paddy farmers
Implementing Agency	Cuulon Rice Research Institute, Can Tho University, DARD, MARD
Collaborators	International research institutes (IRRI, concerned institute in Japan)

Objectives: To develop new varieties tolerant to salinity and to promote them

Rationale: Saline water intrusion is the first priority climate change issues. 10% (91,470ha) of current paddy cultivation areas of the Project area are expected to undergo saline intrusion more than the level paddy can be produced: more than 0.4 g/litter in saline content. In fact, about 70% of paddy harvest of Tra Vinh was lost by saline intrusion in an area of 8,000 ha (2011 dry season). In a long run, increase in temperature also hinders proper pollination of paddy and affect the yield. To cope with those issues in the future, introduction of new varieties is required in such areas where climate change is influential. Specifically, saline tolerant varieties are useful where high saline remains at the early stage of paddy cultivation even after shifting the schedule of paddy cultivation; where risk of saline contamination is high near shrimp cultivation areas; and where paddy is cultivated under the rotation system with brackish shrimp. Also, such varieties that open flower early morning is seen as effective as it can avoid high temperature during daytime. Application of modern technologies and the extension of such varieties remain as a bottleneck due to insufficient development capacity, limited capacity of extension officers. Thus, improvement of technology development and dissemination system is an urgent issue.

Project Implementation	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
	━	━	━	━	━	━	━	━	■ ■	■ ■	■ ■	■ ■	■ ■

Expected Outputs	**Development Indicators**
・ Production of paddy is secured. ・ New rice varieties are cultivated. ・ Saline tolerant rice varieties are developed.	・ More than four types of saline tolerant rice varieties are developed and fixed. ・ New rice varieties are cultivated (more than 1,000 ha). ・ Production of paddy is secured in targeted provinces (same as the level in 2012). ・ Average yield in saline prone area is more than 80% of non-prone areas.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Yield of paddy in saline-prone area is kept as it was in 2012 ・ Effectiveness of new varieties are evaluated ・ New varieties are cultivated ・ New extension modalities are introduced. ・ Modern technologies are introduced ・ New rice varieties are promoted. ・ New varieties are developed. ・ Existing and promising varieties are identified	As total of US$5,000,000 (approx. US$1,000,000/year) ・ Chief advisor/ plant breeding ・ Agricultural extension ・ Short-term experts as required (genetics, crop science, equipment)	MARD, Donors

Project Risk:
The program is composed of development of new rice varieties and extension of new varieties. In the development stage, however, it is difficult to anticipate exact period of time required and the performance of the varieties on the ground. In addition, extension of new varieties depends heavily on the existing extension system, which is under the control of recipient government and not necessarily fully operational due to the lack of funding etc. Thus, there is a certain risk in managing schedules of the entire program and levels of commitment to be made by the extension personnel.

Environment Assessment (C):
This program is not associated with construction of any infrastructure or resettlement of local people. For the experimental fields, existing fields are to be procured so that only minor works are to be expected in order to improve the fields, not causing any harmful environmental impacts.

3.2.3 Crop Diversification and Extension Program

Project Title	**Crop Diversification and Extension Program**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
Target Groups	Paddy farmers/Fruits farmers/						
Implementing Agency	DARD, MARD						
Collaborators	Can Tho Univeristy/ SOFRI						

Objectives: To diversify crop production through an improved extension system.

Rationale:
Despite the vociferous alerts, it is actually difficult to anticipate a true extent, timing and impact of climate change. As one of effective and realistic strategies to get ready for the forthcoming but uncertain risks of climate change, it is recommended to diversify the means of livelihood. Each crop entails different risks against climate change: paddy is tolerant to excessive water but prone to drought or saline water, while fruits crops are relatively suited to dry area instead of its weakness to salinity and excessive water. Under climate change phenomenon, risks in crop production are increasing.
Diversifying the commodities with different types of risks can minimize the total risk in achieving a same level of income. Hence, it is recommended to diversify the commodities in a unit of area preferably at the household level. It is however quite challenging to change the current land use patterns as farmers are conservative and yet comes the climate change. Moreover, insufficient coordination between research and development institute and extension entities is always an issue. It is reported that even after flood tolerant variety of fruit crops are developed by SOFRI, for example, it would not be easily put on the channel of existing extension system. Thus, in averting the risk through diversification of crops, improved extension systems are due necessary.

Project Implementation	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
	■	■	■	■	■	- -	- -	- -	- -	- -	- -	- -	- -

Expected Outputs	**Development Indicators**
• Income level became stable • Crops in target areas are diversified • Guideline on crop diversification is prepared	• Crops are diversified (on average 4 types of crops per household) • Total risk of cultivation is decreased (smaller standard deviation of expected income than mono-cropping) • Appropriate extension modalities are identified (two effective modalities recommended)

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
• Diversification of crops is monitored • Crop diversification is promoted through new extension modalities (radio broadcasting, TV program, and farmer field schools) • On-farm trials are conducted at pilot farms • Research on diversified cropping systems is done at experimental plots • Cropping pattern improvement guideline is prepared	A total of US$5,000,000 (US$1,000,000/year) • Chief advisor/ agricultural dev. • Agricultural extension • Short-term experts as required (aquaculture, horticulture, land use planning, agricultural marketing)	MARD, Donors

Project Risk:
The program is to be carried out since before the actual occurrence of climate change. Therefore, at an early stage of the program, it would be no difference clearly recognized between the risks for the diversified and non-diversified cultivation systems. In addition, averting the risks would sometimes result in lower level of income than mono-cropping especially in a shorter term. Without proper understanding of the mechanism, therefore, promotions would not go well in the long run. Also, marketing of newly introduced crops is one of challenges.

Environment Assessment (C):
This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no particular social and environmental concerns are expected.

3.3 Proposed Technical Assistances and Inputs for the Project

Among those project components aforementioned, priority components are compiled as a proposal of specific project under the title ‘Cropping System Improvement Program toward Climate Change Adaptation’ to be funded by any donor (see section 3.3). This Project is specifically designed as a potential technical-assistance project to be funded by any donor including the government of Japan. The project is so recommended to be a model project that can be a basis of further application of the activities in the future if forecasted climate-change issues became critical in other areas.

That is, fundamental purpose of this technical assistance project called ‘Cropping System Improvement Program toward Climate Change Adaptation’ is to accumulate knowledge and experiences in the sector, and to strengthen the capacity of the people, by which agricultural and aquacultural systems can be smoothly adapted to force coming climate change.

3.3.1 Technical Assistances Required

This Project aims to adapt agricultural systems in the selected areas of coastal provinces more suited to such an agro-ecological condition that is predicted to spread as a result of climate change—more specifically saline intrusion along the coastal provinces. Therefore, the project starts with the identification of such areas where saline intrusion has already become problematic especially to paddy cultivation. Then, through an existing extension modality, improved agricultural and aquacultural production systems will be introduced in the area, by following up five steps as follows:

1) Vulnerable areas where saline intrusion has already become problematic are identified,
2) Improved agricultural systems are established, which are suited to saline prone areas,
3) New systems are put in the land use plan accordance to the progress of saline intrusion,
4) New systems are promoted through the existing extension system,
5) An entire process is systematized as an improved extension system, and
6) Productions of agricultural and aquacultural commodities are secured along with the government policy

Considering the capacity and readiness of the implementing body in Vietnam, it is better to carry out the Project with a technical assistance from donor. To smoothly and effectively adapt the agricultural system, decision making or planning on implementation of such countermeasures—changing cropping patterns—comes as a first and most challenging issue. As there is always a fluctuation in many factors both in production side and marketing side, rational decision-making is required based on scientific ground.

For example, planner should be able to analyze the trend of saline intrusion in the area to decide the critical point that a specific cropping system in that location is no longer appropriate, to which an comparatively appropriate cropping system can be then recommended. In addition to the factor of saline intrusion, other factors need to be also considered. For example, popular cropping pattern in the area need to be considered as a way of saline water control conflicts between shrimp culture that require high salinity and paddy that needs fresh water.

Furthermore, marketability of recommended commodities also influences the behavior of target farmers. They would not introduce new technologies or new system unless there is a certainty to be able to sell their products at fair and stable price. In addition, as the change of agricultural land use entails a change of water management, land use planning should be conducted with a view to physical and political possibility in the change of water management.

After all, as a set of decision making criteria, all those scientific, technical and social issues altogether should be incorporated into the planning mechanism of agricultural land use and its implementation.

To this end, advanced technologies and broad-based institutional approach from donor countries could be quite helpful.

3.3.2 Inputs Required

To realize institutional development in assessing climate index and planning agricultural land use, process-oriented approach is required, for which involvement of experts in long-term position is appropriate, who is then supported by a range of expertise in short-term position.

Donor

1) Long Term Experts

- Chief advisor/ agricultural planning	1 person	
- Coordinator/ GIS	1 person	

2) Short Term Experts (to be decided in the project)

- Climate change	1 person	
- Water resource management	1 person	
- Cropping system/paddy cultivation	1 person	
- Aquaculture	1 person	
- Agricultural marketing	1 person	
- Agricultural extension	1 person	
- Public relations	1 person	

3) Materials/Equipment

- Audio visual equipment (extension)	1 unit	
- Office equipment (copy machine etc.)	1 unit	
- Computer software (GIS etc.)	4 unit	
- Vehicle (4WD)	2 units	

4) Training Courses

- Training of provincial officers	30 officers/time	(2 times/year)
- Third country training	10 officers	(2 times/year)
- International training	2 officers	(6 months)

5) Others

- Operation cost	as required	

Vietnamese Government

1) Counterpart personnel

- Land use planning (fulltime)	2 officers	
- Agricultural research (part-time)	4 officers	
- Extension officers (province)	30 officers/province	

2) Facilities

- Office space	1 unit	
- Farm plots for pilot activities	4 unit/district	

3) Others

- Operation cost	as required	
- Tax exemption	as required	

3.3.3 Proposed Project Sites

Specific districts and locations are to be selected after the Project has commenced. Through a development study "the project for climate change adaptation for sustainable agriculture and rural development in the coastal Mekong delta" funded by JICA, it was confirmed that cropping calendar adjustment and improvement is the top priority activity among other proposed projects in Ben Tre province. It was also second ranked in Tra Vinh, and third ranked in Tien Gian, Soc Trang, and Bac Lieu provinces. Thus, it is proposed to carry out the project activities first in Ben Tre and Tra Vinh provinces, also considering the fact that those provinces are adjacent to each other.

In those two provinces, specific districts are to be selected by the Project Implementing Committee (PIC) according to set criteria. In principle, project activities should be carried out where climate change issues, such as saline intrusion, have already become apparent and caused substantial problems. For example, there are some districts where saline intrusion in dry season becomes significant, at which cropping systems of individual farmer households in the area are not yet integrated due to complicated water management—some farmers cultivate paddy, while others do shrimp culture. In such places, coordination among the interest farmer groups is quite important and thus the project implementation.

3.4 Preparatory Project Evaluation

3.4.1 Evaluation by Five Criteria

1) Relevance

Relevance of this project is high with following reasons:

- ✓ The government of Vietnam is pursuing to keep the production level of paddy as it is today. In terms of the paddy cultivation, Mekong Delta shares 52.8% of the total planted area of paddy (3,970,500ha/ 7,513,700ha) and 54.4% of total production (21,769,500 ton/ 39,988,900ton) in the nation[7]. Despite its importance, this area is exposed to a threat of production loss due to foreseeable climate change. Meanwhile, production area of brackish shrimp culture is also targeted to increase. In this context, this Project helps prioritize the farmlands corresponding to the actual occurrence of climate change and maximize the effective use of those farmland to pursue keeping and increasing paddy production and shrimp production set forth in the national plan.
- ✓ Aside from the proposed Project, there are a number of project proposals that are oriented toward infrastructure development for controlling saline intrusion, i.e., installation/rehabilitation of sluice gates. Yet, infrastructure development often requires relatively large amount of investment cost and therefore it takes longer time for approval, budget arrangement, and implementation of those projects. Since this Project is focused on technical aspects and relatively applicable financially and technically, it can complement the delay of infrastructure development. In addition, as a matter of fact, this Project together with such infrastructure oriented projects could well cope with the impacts from climate change at a satisfactorily higher level.

2) Effectiveness

Effectiveness of the project is confirmed with following reasons:

- ✓ This Project aims at strengthening a planning capacity of the implementing body for making agricultural and aquacultural production system more suited to saline prone areas. As farmers on the ground are dully facing apparent problems incurred by saline intrusion, there is due needs for

[7] Statistical Yearbook of Vietnam, General Statistics Office (2010)

improving their farming systems adaptable to and coping with the climate change impact.

- ✓ In adapting new technologies or new cropping systems, farmers tend to be conservative. Unless the promoted system is truly necessary, they would never accept it by nature. In this regard, climate change issues are already in place, inducing a variety of problems in agricultural production. Thus, they are actually looking for any countermeasures to cope with those problems—probability to adapt the new systems is high.
- ✓ In general, provincial authorities maintain a strong leadership in execution of the land use plan. It means, if plan is not exactly in line with the current intention of the provincial authorities, it would be quite difficult to realize the plan in the actual field. This Project involves provincial officers as target groups and therefore it is fairly possible to fully reflect the intension of the provincial authorities in the plan.

3) Efficiency

- ✓ Through donor-funded projects/programs, Sub-NIAPP, the implementing agency, has already gained technical experiences in land use planning. For example, it maintains agricultural economy and GIS center, in which geospatial data processing and mapping are managed by themselves. With such essential capacities in agricultural land use planning, introduction of new approach can be smoothly conducted.
- ✓ In the Project, extension of new agricultural systems is to be disseminated through the existing government extension system under MARD in coordination with provincial authorities: essentially it is conducted through cascading system. Therefore, technology dissemination can be efficiently implemented.

4) Impact

Impact of the Project is expected as follows:

- ✓ By shifting agricultural and aquacultural production system to be suited to saline-prone areas, potential loss of agricultural and aquacultural production can be reduced and the rural livelihood becomes stable against negative impacts of climate change.
- ✓ Capacity of technical personnel is strengthened through the implementing process of the Project. In particular, they will be able to assess the climate change indicators and, based on them, formulate a suitable agricultural land use plan. Provided that climate change usually becomes critical in different timing and different degree by locations, the government institution can customize the agricultural land use plan according to the progress and locality of climate change.
- ✓ Cropping calendar adjustment and improvement was the top priority activity among other proposed projects in Ben Tre province, and it was also second ranked in Tra Vinh province. As the first step, the Project should deal with these 2 provinces where a total of 103.43 km^2 and 76.05 km^2 of paddy areas are expected to encounter severe saline intrusion by 2050 at more than 10g/L of saline content both in dry and rainy season. Thus, those areas will be expected to be the primary beneficiary areas, accounting for 37,855 people and 27,834 people—as core beneficiaries who are expected to adapt their agricultural systems.
- ✓ On average there are 30 officers per provincial extension center and 6 officers per district station. As there are 8 and 7 districts in the two proposed provinces, Ben Tre and Tra Vinh, there should be roughly 510 officers to be trained. As one public officer take care of 280 farmers, a total of 142,800 of farmers can benefit to some extent where they would change their current farming systems and adapt to climate change.
- ✓ Potential negative impact is that the shift of agricultural and aquacultural system could induce

some conflict of interest among the farmer households, such as conflict over the water management whether saline water should be avoided for paddy cultivation or recruited for brackish shrimp culture. To avoid such an unfavorable condition, thus, participatory approach inviting all the concerned beneficiary farmers should be incorporated into the planning process.

- ✓ Another negative impact may include an impact to marketing especially for shrimp. Although it is not highly likely as shrimp is mostly for exporting, increased production may have a negative impact to the price of shrimp. Likewise, increased area of shrimp culture may enhance a risk of disease especially when shrimp ponds are established closed to each other. Thus, proper arrangement of shrimp ponds at micro level should be also taken into consideration, and extensive shrimp culture entailing less risk of diseases should primarily be introduced.

5) Sustainability

It is expected that the outcomes of the Project is sustained by the improved capacity of the implementing body with following reasons:

- ✓ In its national development plan, the government of Vietnam emphasizes the importance of agricultural development. As Mekong delta region is seen as a production center of the country, this policy is expected to continue especially in the Project area. Hence, the project sustainability relating to policy change would not be affected.
- ✓ While climate change issues have already become a central issue especially along the coastal provinces, it is projected to expand and becomes severe in the long run. Given the fact, needs of adjusting cropping patterns more suitable to such agro-ecological conditions are expected to increase in the future.
- ✓ Sub-NIAPP, the expected implementing agency, has recently increased the number of its technical personnel. Once those technical personnel have gained more capacity in agricultural land use planning and its application through the Project, they will be a driving force to continue those activities after the projects.
- ✓ When trying to expand a production system of a specific commodity, surrounding systems required to such commodity should be also considered. For example, to expand the production area of shrimp culture, supply system of larvae should also be upgraded or commodity chain needs to be scaled up. In this regard, Research Institute for Aquaculture No.2 located in Ho Chi Min city can be a strong collaborator in pursuing the Project.

3.4.2 Consideration on Poverty, Gender, and Environmental Issues

- ✓ *Poverty*: due to climate change, agricultural and aquacultural in the coastal Mekong delta is expected to be on the verge of losing its production capacity. The Project thus employs an approach to adapt cropping pattern more suitable to environment that has been changed. In so doing, economic capacity of resource-poor farmers needs to be considered. For example, while expected profitability of intensive shrimp culture is greater than paddy cultivation, it requires a lot of investment cost—which is not always suitable to small-scale farmer households.
- ✓ *Gender*: it is generally understood that housewives maintain a substantial decision-making power in the household especially in financial aspect in the context of Vietnamese society. Thus, women should be involved in the planning process of specific activities at community level. Meanwhile, not much gender issue is expected in the planning process of land use plan.
- ✓ *Environment*: given pronouncedly increasing tendency of saline intrusion, general approach taken in the Project is to shift paddy-oriented production systems to brackish aquaculture-oriented production systems. While brackish aquaculture, especially shrimp culture, is seen economically

desirable than paddy cultivation, it always entails risk of disease especially when it is done in a wide range of area under relatively intensive input. Therefore, it should be considered to keep some variation of specific commodities, shrimp, fish, and crab, etc., to keep a certain distance from one shrimp pond to the others, and to keep the shrimp culture level at extensive one.

3.5 Institutional Arrangement for Project Implementation

3.5.1 Implementing Agency

In the project, Sub-NIAPP functions as the implementing agency. As a regional office of southern provinces, Sub-NIAPP is under the National Institute of Agricultural Planning and Projection (NIAPP), Ministry of Agriculture and Rural Development. It was established on March 23, 1979. This subsection describes the outline of Sub-NIAPP hereunder.

1) Task and Responsibility

Sub-NIAPP is responsible for the consulting works in the southern provinces with the tasks as follows:

- ✓ As a general research agency, give advices for the leaders of MARD and southern provinces in agricultural planning, land use planning, construction and designing of projects in agricultural and rural development,
- ✓ Organize investigation, survey and assessment of agricultural resources for zoning and planning of agricultural production,
- ✓ Build scenarios of land use planning for provinces, districts and communes, including socio-economic master plan, investment plans for agricultural development zones, development projects of specific livestock breeds and crops,
- ✓ Conduct scientific study for agricultural and rural development, provide training and transfer advanced techniques and modern technologies,
- ✓ Organize investigation and survey of topography, soils, geology, geomorphology, hydrology, and other supportive works for agricultural development,
- ✓ Facilitate overall planning and detailed planning of agricultural and rural development, including land use planning and zoning resettlement areas,
- ✓ Design land reclamation, road, irrigation systems, and forest areas,
- ✓ Investigate and assess environmental impact to agricultural production and rural development before and after taking construction works,
- ✓ Apply GIS techniques in agricultural land use, infrastructural planning and other fields related to database and mapping, and
- ✓ Examine investment of plan of agriculture and rural development project.

2) Structure and Human Resources

Sub-NIAPP maintains a total of 82 staff as of 2012: 46 official staff and 36 contract staff. Among all the staff, over 70% are technical/professional staff, of which 8 are doctors and 15 are masters in various sectors: economic, cropping system, livestock, water resources, fishery, land management, finance and foreign languages. Technical staff has from 10 to 30 years of working experiences, based on which they have gained knowledge on location specific situations of southern provinces, skills in application software, and methodologies and advanced technologies both in Vietnam and abroad.

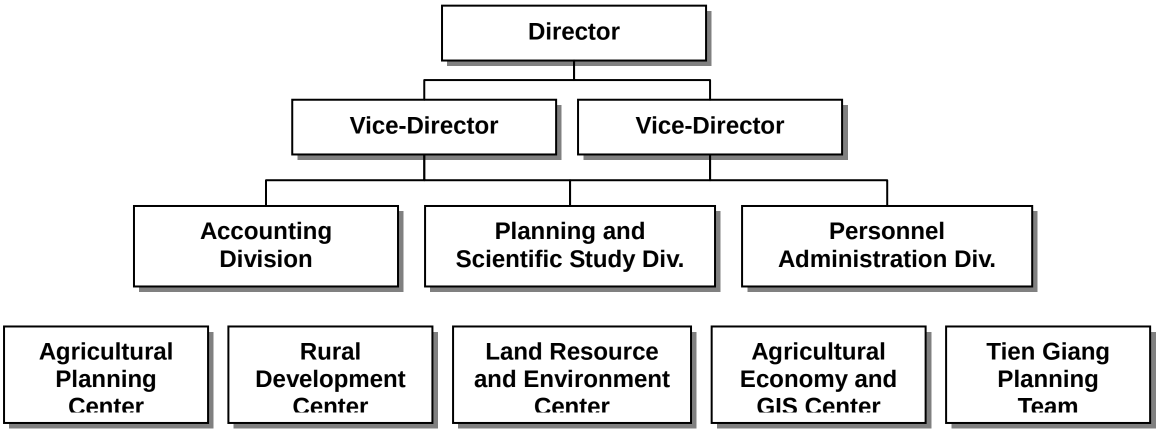


Figure 3.5.1 Organizational Structure of Sub-NIAPP

Source: Sub-NIAPP (2012)

Note: all the divisions, centers and team are under direct supervision of director and vice-directors

As shown in Figure 3.5.1, Sub-NIAPP has established several divisions, centers, and team: Division of Planning and Scientific Study, Personnel Administration Division, Accounting Division, Agricultural Planning Center, Rural Development Center, Center of Land Resource and Environment, Center of Agricultural Economy and Geographic Information System (GIS), Tien Giang Planning Team, and Vehicle Service. Having each function of the units as well as collaboration among the units, they conduct tasks assigned by the government or contracted works with the local authorities.

Agricultural Economy and GIS Center was established by the Mekong River Commission (MRC) in the 1980's and now regarded as the leading center in the field of GIS application in agricultural and rural development in the southern provinces.

3) Equipment

Technical divisions of the institute are equipped with computer systems, large size color printers with specific software for data processing and for land use mapping at different scales. The institute has one laboratory for soil analysis and water quality analysis, equipped with necessary equipment and machines that have ability to analyze and assess main indicators of chemical and physical characteristics of soil and water. The Center of Agricultural Economy and GIS maintains high capacity computer system synchronized with specific machines to carry out resource evaluation, land use planning, and database setup.

4) Operational Capacity

Sub-NIAPP is an administrative organization with a business license as to earn income from implementation of activities/ works. In collaboration with other professional institutions, the institute has worked in various programs, projects, and activities in the field of basic investigation, zoning for agricultural planning, land use planning, project formulation and evaluation, and scientific studies. The following summarize major activities Sub-NIAPP has accomplished:

- ✓ Soon after the end of the war, started various activities, e.g. conducted basic investigations; prepared soil maps for the districts; carried out district agricultural planning; and conducted zoning for agriculture, forestry, and fishery development for the provinces located in southern parts of Vietnam. The zoning scenarios at provincial level were officially approved by the government. One of recent examples for provincial level activities is an analysis in physical and chemical changes of soil property in Bac Lie province where major commodity was changed from paddy cultivation to brackish shrimp culture.
- ✓ Developed planning options for the specialized production areas, new economic zones, area of

raw materials for export agricultural products such as coffee in the central highland, rubber, sugarcanes and groundnuts in the south-east region, areas for rice cultivation and animal husbandry in the Mekong delta. The planning options have been approved and implemented at different levels. Recently, agricultural and rural development planning oriented to climate change is being conducted for 4-5 provinces in the Mekong delta, which is to be documented.

- ✓ Participated in preparation and implementation of key projects, such as Mekong delta master plan project and Dong Thap Muoi (Plain of Reeds) project on technical support for farmers.
- ✓ Investigated and prepared soil maps and evaluated land resources based on various kinds of maps in different scales for agriculture, forestry, and fishery development.
- ✓ Studied production systems, household economy, and farm economy in different localities for strategy establishment in agricultural economic development.
- ✓ Carried out land use planning by area and by economic sectors at regional, provincial, district and commune levels, contributing to the national land use strategy and the economic sector development strategy at all levels. It also includes a plan to protect people living in flood prone areas.
- ✓ Planned high-tech agricultural zones to serve for scientific researches and application of advanced techniques into agricultural production, breeding, modern agricultural production models and high-quality agricultural products.
- ✓ Developed GIS application models related to agricultural development planning, land use planning, and digitizing and storing of synthesis information system.

5) Others

As stated, Sub-NIAPP employs an independent accounting system, by which it should bid on any programs or projects funded by the government or local authorities. In principle, there is no budget support from the government either for recurrent cost or project cost.

3.5.2 Proposed Project Steering Committee

Proposed institutional arrangement is illustrated as Figure 3.5.2. First, Joint Coordinating Committee (JCC) is established at central level in Hanoi, which is composed of MARD, MoNRE, and JICA. As general land use plan is subject to the approval from MoNRE, MoNRE should also be a part of the JCC. The JCC is responsible to authorize the direction of the project and coordinate the project activities to be in line with the government policy. For example, proposed change of land use plan should be submitted to the JCC, at which the plan should be approved.

At regional level, Project Implementing Committee (PIC) is established in participation with responsible institutes in agriculture and aquaculture development. The PIC is responsible in monitoring and improvement of project activities. Sub-NIAPP is the primary institute that administrates the entire process of the Project in coordination with donor experts.

Those two parties, Sub-NIAPP and donor experts, coordinate with and get support from other agencies: provincial peoples' committee, provincial extension center that represents agricultural division of DARD, Aquaculture Research Institute No.2, Cuu Long Delta Rice Research Institute, and SOFRI. The institutes provide technical guidance and help establish a set of improved agricultural and aquacultural systems oriented to climate change adaptation, e.g. adaptation to saline intrusion.

Southern Institute for Water Resource Planning (SIWRP) also plays an advisory role in water resource management at provincial level. As land use plan is a basis for water use whether or not brackish water should be diverted into each canal, close coordination between the institutes responsible for land use planning and water management should be established. Therefore, SIWRP should be involved in the Project Implementing Committee (PIC).

Then, improved systems are to be disseminated through existing government extension system. Here, provincial extension centers supported by the experts and Sub-NIAPP carry out provincial level project activities, and supervise the frontline activities to be pursued by district extension stations. The district extension stations take a lead as an interface of extension entities to clientele farmers. Those participating officers from district extension stations are targeted to be functional and strengthened their extension capacities oriented to climate change adaptation through the project activities.

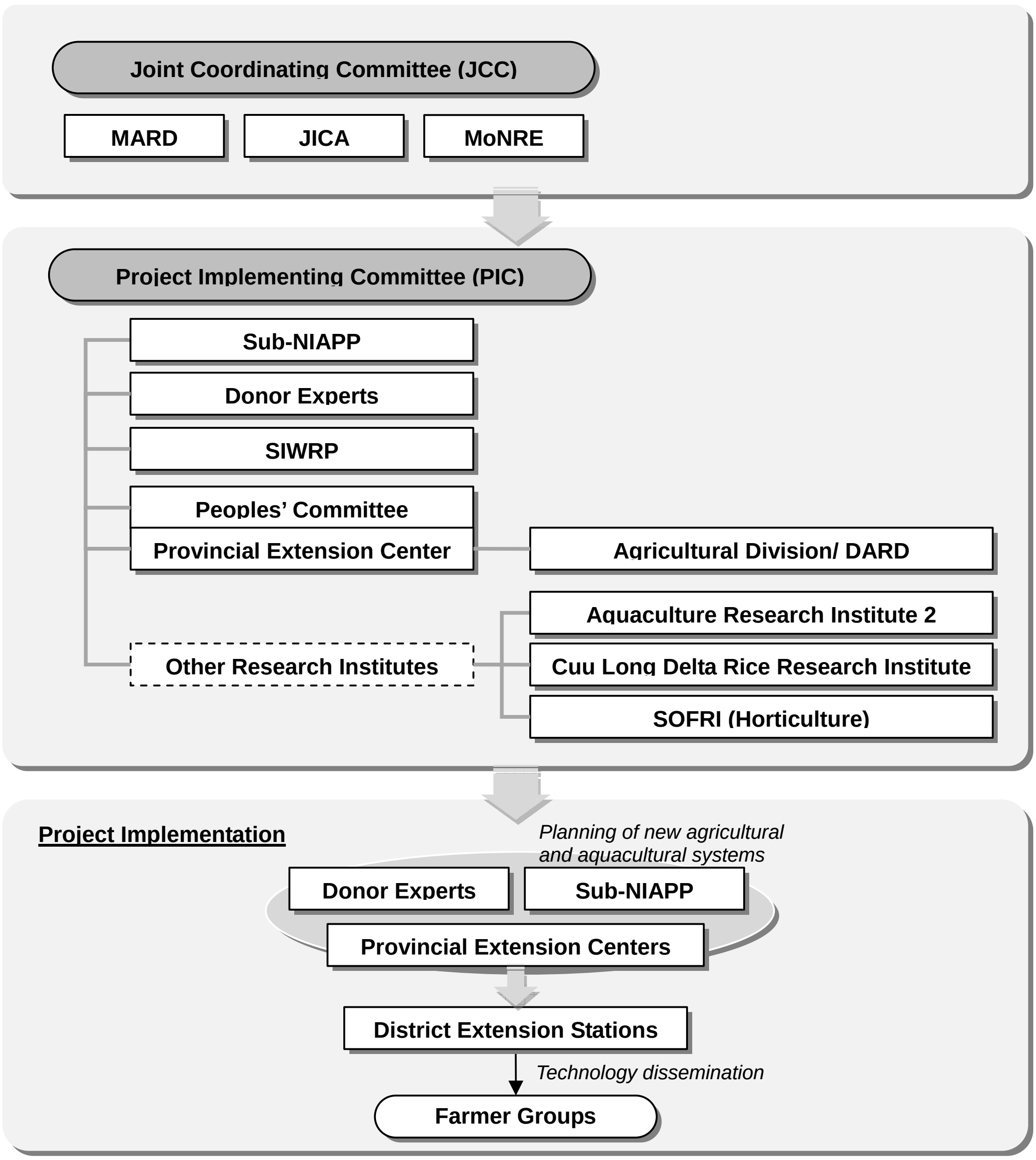


Figure 3.5.2 Institutional Arrangement

3.6 Project Implementation Schedule and Cost

3.6.1 Project Implementation Schedule

This Project is carried out in a five-year period, which is divided into three phases. In phase I, precise agricultural land use plan is established based fully on the latest status of climate change issues especially saline intrusion. As a part of it, improved cropping systems are proposed as technical packages. Example includes introduction of new rice varieties (saline tolerant, morning pollination type, early maturing, etc.), rotation between paddy cultivation and shrimp culture, and introduction of transplanting, all of which are suitable to avoid potential loss incurred by climate change issues.

In phase II, those technical packages are introduced, promoted, and adapted in areas where climate change issues have already become apparent. For the promotion of the technologies, the existing government extension system is fully used, through which capacity of extension officers at provincial and district levels are to be strengthened.

In phase III, activities of promoting new agricultural and aquacultural systems are expanded toward wider range of areas where climate change issues are in place. Through monitoring extension activities and application of the new technologies, entire process is reviewed and finalized.

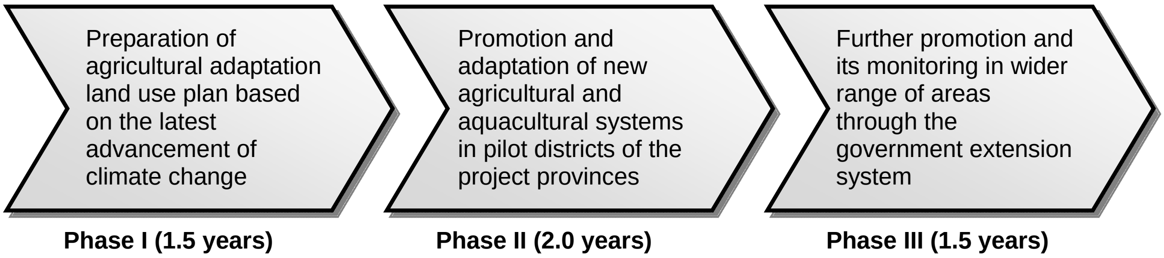


Figure3.6.1 Phasing of the Project

3.6.2 Project Cost

Table 3.6.1 summarizes the project costs, divided into donor side and Vietnamese side, and further categorized into expert, materials/equipment, training, and others. As summarized, total project cost for the 5 year project duration comes to US$ 5,178,000 composed of US$ 4,913,000 by donor and US$ 265,000 for counterpart fund:

Table 3.6.1 Summary of Project Cost, US$

Item	Amount	Unit Cost	Unit	Cost, US$	Remarks
Donor					
1) Long Term Experts					
-Chief advisor/ agricultural planning	60 MM	22,000	US$/MM	1,320,000	
-Coordinator/ GIS	60 MM	20,000	US$/MM	1,200,000	
Sub-Total				2,520,000	
2) Short Term Experts					to be decided in the project
-Climate change	15 MM	20,000	US$/MM	300,000	
-Agricultural extension	20 MM	20,000	US$/MM	400,000	
-Water resource management	10 MM	20,000	US$/MM	200,000	
-Cropping system/paddy cultivation	15 MM	20,000	US$/MM	300,000	
-Aquaculture	15 MM	20,000	US$/MM	300,000	
-Agricultural marketing	10 MM	20,000	US$/MM	200,000	
-Public relations	10 MM	20,000	US$/MM	200,000	
Sub-Total				1,900,000	
3) Materials/Equipment					
-Personal computer (note book)	5 units	2,000	US$/unit	10,000	
-Printer (plotter A0 size)	1 unit	9,000	US$/unit	9,000	
-Printer (printer A3 size)	2 units	5,000	US$/unit	10,000	
-Arc Info (GIS)	5 units	10,000	US$/unit	50,000	
-Photocopy machine	1 unit	10,000	US$/unit	10,000	
-Audio visual equipment	1 unit	10,000	US$/unit	10,000	for extension, mobile unit
Sub-Total				99,000	
4) Training Courses					

-Training of provincial officers	10	times	5,000	US$/time	50,000	2 times/year (30 officers)
-Third country training	10	times	10,000	US$/time/p	100,000	2 times/year (10 officers)
-International training	2	times	50,000	US$/time/p	100,000	6 months (2 officers)
Sub-Total					250,000	
5) Others						
-Vehicle	2	units	50,000	US$/Car	100,000	
-Operation cost	1	LS	44,000	US$/LS	44,000	1% of expert cost
Sub-Total					144,000	
Total of Donor					**4,913,000**	
Vietnamese Government						
1) Counterpart personnel						
-Land use planning (fulltime)	120	MM	1,000	US$/MM	120,000	2 officers
-Agricultural research (part-time)	80	MM	600	US$/MM	48,000	4 months/year (4 officers)
-Extension officers (province)	180	MM	400	US$/MM	72,000	4 months/year (60 officers)
Sub-Total					240,000	
2) Facilities						
-Office space	1	unit	5,000	US$/unit	5,000	5 year
-Farm plots for pilot activities	40	units	200	US$/unit	8,000	4 unit/district
Sub-Total					13,000	
3) Others						
-Operation cost			12,000	US$/unit	12,000	5% of expert cost
-Tax exemption						
Sub-Total					12,000	
Total of Vietnamese Gov.					**265,000**	
Grand Total					**5,178,000**	

Source: JICA Study Team

3.7 Project Design Matrix (PDM) and Plan of Operation (PO)

Project Design Matrix (PDM) of the technical cooperation project is attached hereunder, which is summarized based on the contents as described so far. Then, specific Plan of Operation (PO) is also drafted and attached.

Project Design Matrix (PDM) __Ver.0.1

Project Title: Cropping System Improvement Program toward Climate Change Adaptation
Target Area: Coastal Mekong Delta (Ben Tre and Tra Vinh Provinces)
Duration: April 1, 2014 to March 31, 2019
Target Group: Provincial Agricultural Extension Centers

October 26, 2012

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Suitable cropping systems are adapted in the coastal Mekong delta where climate change issues become apparent and potential loss of agricultural and aquacultural production is avoided.	- 80% of actual land use in targeted areas has shifted according to the land use plan of coastal Mekong delta by 2020. - Production of targeted commodities in the coastal Mekong delta in 2020 is kept at the same level as 2010.	- Monitoring report - Sample survey - Statistic data (MARD)	- National agricultural extension system is not drastically changed. - Government policy on agricultural and aquacultural production is not significantly changed. - Climate change happens generally as simulated.
Project Purpose Cropping systems suitable to such an environment being affected by climate change issues are developed and adapted in the target areas of the coastal Mekong delta.	- Suitable cropping systems are established by 2015. - Suitable cropping systems are promoted in the prone areas to climate change issues (i.e., saline intrusion) by 2019. - Production of targeted commodities in the coastal Mekong delta in 2020 is kept at the same level as 2010.	- Monitoring report - Sample survey - Statistic data (DARD) - Land use map (Sub-NIAPP)	- Cooperation from related agencies and local authorities are continued. - An extension system and personnel at provincial level are not radically changed. - Mandate and manpower of implementing agency is not changed
Outputs 1. Vulnerable areas where CC issues have already become apparent are identified.	- Current status of climate change issues, such as saline content, are measured and put in a map. - Specific location and extent of climate change issues are identified.	- Project report	- Expected number of extension officers is assigned to the project at provincial and district level. - Outputs from the model activities are applied in other areas along coastal Mekong
2. Improved agricultural systems are established, which are suited to features caused by CC.	- The latest agricultural and aquacultural production systems are identified. - Technical guidelines are prepared.	- Project report	

3. New systems are put in the land use plan in accordance with the progress of climate change.	- The latest land use plans are prepared at provincial level. - Suitable cropping systems are proposed along with the land use plans.	- Project report	delta.
4. New systems are promoted through the existing government extension system.	- More than 50 extension officers receive a training on agricultural and aquacultural technology extension - More than 5 times of training, demonstration, and lectures are carried out at district level per province - More than 100 farmers receive trainings.	- Project report	
5. An entire process is systematized as an improved extension system oriented to climate change.	- Climate change adaptation guideline is prepared inclusive of planning process and technical packages.	- Project report	
6. Productions of agricultural and aquacultural commodities are secured along with the government policy.	- Production of paddy and brackish aquacultural commodities in the target districts (CC prone area) are kept at the same level of non-affected areas.	- Project report - Sample survey	
Activities 1. <u>Vulnerable areas where CC issues have already become apparent are identified</u> 1.1: Review existing documents concerning climate change issues such as saline intrusion 1.2 Select pilot provinces where climate change issues are urgent 1.3 Study needs of farmer households to clarify the significance of CC issues and their impacts to the livelihood of target areas 1.4 Confirm existing policy of target provinces 1.5 Confirm the issues with related agencies including DARD 1.6 Select target districts	**Inputs** **<u>Donor</u>** 1) Long Term Experts - Chief advisor/ agricultural planning 1 person - Coordinator/ GIS 1 person 2) Short Term Experts (to be decided in the project) - Climate change 1 person - Water resource management 1 person - Cropping system/paddy cultivation 1 person - Aquaculture 1 person - Agricultural marketing 1 person - Agricultural extension 1 person - Public relations 1 person		- Counterparts are assigned continuously and work actively. - Inputs from the donor and the government of Vietnam are timely and adequately provided.

2. <u>Improved agricultural systems are established, which are suited to features caused by CC</u>
   - 2.1 In coordination with research and development institutes, universities, and government agencies concerned, identify useful technologies for agricultural and aquacultural production (i.e., varieties, cropping system, farming portfolio).
   - 2.2 Validate applicability of new technologies based on coordination with target farmers

3. <u>New systems are put in the land use plan in accordance with the progress of CC</u>
   - 3.1 Modify agricultural and aquacultural land use plan according to the progress of climate change issues
   - 3.2 Make agreement with agencies concerned and target farmer groups
   - 3.3 Make a strategic plan of technology dissemination in accordance with the land use plan

4. <u>New systems are promoted through the existing extension system</u>
   - 4.1 Survey existing extension system for agriculture and aquaculture technologies
   - 4.2 Produce extension materials related to new agricultural and aquacultural system
   - 4.3 Train extension officers at district extension stations in coordination with provincial extension entities, research and development institute and the implementing agency
   - 4.4 Supervise district extension officers carry out further extension to clientele farmers
   - 4.5 Monitor the improvement of agricultural and aquacultural system at sites

3) Materials/Equipment

- Audio visual equipment (extension)	1 unit
- Office equipment (copy machine etc.)	1 unit
- Computer software (GIS etc.)	4 unit
- Vehicle	2 units

4) Training Courses

- Training of provincial officers (2 times/year)	30 officers/time
- Third country training (2 times/year)	10 officers/time
- International training (6 months)	2 officers/time

5) Others

- Operation cost	as required

<u>Vietnamese Government</u>

1) Counterpart personnel

- Land use planning (fulltime)	2 officers
- Agricultural research (part-time)	4 officers
- Extension officers	30 officers/province

2) Facilities

- Office space	1 unit
- Farm plots for pilot activities	4 unit/district

3) Others

- Operation cost	as required
- Tax exemption	as required

Preconditions

- Project implementation is approved by related departments/agencies/organizations.
- Production of paddy and brackish aquacultural commodities are kept as higher priority
- Necessary infrastructure, such as sluice for saline water control, is well maintained and operated

4.6 Provide technical guidance to participating farmer households 4.7 Evaluate effectiveness and applicability of introduced technologies 5. <u>An entire process is systematized as an improved extension system oriented to CC</u> 5.1 Extension materials are finalized based on feedback from participants 5.2 An extension model is prepared as a guideline for agricultural and aquacultural production under changing environment associated with climate change 6. <u>Productions of agricultural and aquacultural commodities are secured along with the government policy</u> 6.1 Production of paddy and shrimp are kept as it was before the area was affected by the climate change issues		

Plan of Operation _Ver.0.1

Cropping System Improvement Program toward Climate Change

Activities	PERIOD (2014-2019)																								Remarks
	2014				2015				2016				2017				2018				2019				
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
0. Preparation of the project																									
0-1: Long-term experts are dispatched																									
0-2: Project office is set up																									
0-3: Necessary materials are procured and put in place																									
0-4: Joint committee is established																									
0-5: Short-term experts are dispatched											as required														
0-6: Joint committee meeting is carried out		▲		▲				▲				▲				▲					▲				
0-7: Monitoring is done																									
1. Vulnerable areas where CC issues have already become apparent are identified																									
1-1: Review existing documents concerning climate change issues																									
1-2: Select pilot provinces where climate change issues are urgent																									
1-3: Study needs of farmer households to clarify the significance of CC issues and their impacts to the livelihood of target areas																									
1-4: Confirm existing policy of target provinces																									
1-5: Confirm the issues with related agencies including DARD																									
1-6: Select target districts																									
2. Improved agricultural systems are established, which are suited to features caused by CC																									
2-1: Identify useful technologies for agricultural and aquacultural production																									
2-2: Validate applicability of new technologies																									
3. New systems are put in the land use plan in accordance with the progress of CC																									
3-1: Modify agricultural and aquacultural land use plan according to the progress of climate change issues																									
3-2: Make agreement with agencies concerned and target farmer groups																									
3-3: Make a strategic plan of technology dissemination in accordance with the land use plan																									
4. New systems are promoted through the existing extension system																									
4-1: Survey existing extension system for agriculture and aquaculture technologies																									
4-2: Produce extension materials related to new agricultural and aquacultural system																									
4-3: Train extension officers at provincia extension stations																									
4-4: Supervise provincial extension officers carry out further extension to district extension officers and clientele farmers																									
4-5: Monitor the improvement of agricultural and aquacultural system at sites																									
4-6: Provide technical guidance to participating farmer households																									
4-7: Evaluate effectiveness and applicability of introduced technologies																									
5. An entire process is systematized as an improved extension system oriented to CC																									
5-1: Extension materials are finalized based on feedback from participants																									
5-2: An extension model is prepared as a guideline for agricultural and aquacultural production under changing environment associated with climate change																									
6. Productions of agricultural and aquacultural commodities are secured along with the government policy																									
6-1: Extension is carried out in other areas using extension materials prepared																									

CC: Climate Change

CHAPTER 4 RECOMMENDATIONS

To have the Project to be successfully implemented, several issues need to be addressed before the commencement of specific project activities. These issues are presented below as recommendations for the project approval for implementation and also should be referred to in the process of implementation:

- ✓ *Unpredictable climate change*: this project is proposed as to cope with agro-ecological changes incurred by expected climate change such as increased saline intrusion. Yet, extent and degree of climate change is difficult to precisely predict as it is associated with multiple factors worldwide. To keep the relevance of the project, therefore, selection of the specific project areas should be carefully done. Particularly, such area should be selected where climate change issues have already become obvious and the agricultural and aquacultural production systems are yet adapted to, whereby the same approach can be applied to the other areas in accordance with the actual progress of the climate change in the coastal Mekong delta.

- ✓ *Harmonization with infrastructure development project*: a change of production systems also requires a change of water management. Typically, quite a different water management is required for paddy cultivation and brackish shrimp culture as the former needs freshwater while the latter needs brackish water. To do proper control of brackish water, well-established infrastructure is essential. In this regard, harmonization with other development project such as establishment of sluice gate project, freshwater intake project, and improvement of canal system by, e.g. dredging, should be, if any, pursued.

- ✓ *Environmental issues for shrimp culture*: in the project, shift of production system from paddy to brackish aquaculture is to be addressed where it is applicable. Yet, shrimp culture always entails risk of disease especially when it is done in a large scale intensively. Therefore, before the actual change of the systems, necessary information about disease control and prevention should be collected, analyzed and incorporated into the planning process.

- ✓ *Consideration on supply system for shrimp culture:* When trying to expand a production system of a specific commodity, i.e. shrimp culture, surrounding systems required to such commodity should be also considered. For example, to expand the production area of shrimp culture, supply system of larvae need to be also upgraded or commodity chain, such as collection point, road network, and/or market places, needs to be scaled up.

- ✓ *Application of modern technologies:* to cope with climate change issues, application of new technologies is essential. For example, use of such new rice varieties are useful that are early maturing, saline tolerant, and having characteristics to open flower in morning time when the temperature is still low. Although some technical advancement in rice sector is being carried out by the government of Vietnam, further assistance, especially on technical aspect, can widen the alternatives to be applied in the project. Therefore, combination with other technical assistance should also be considered for application of modern technologies.

PART V

FLOW WATER MANAGEMENT

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 'the Project on Capacity Development for Flow Water Management in Mekong Delta', which centers on capacity development for the relevant government officers in adapting to and coping with climate change in the field of water resources management.

1.2 According to a climate change simulation conducted by IMHEN (MONRE), it is expected that, by the year 2050, sea level increases by 31 cm under climate change scenario A2. As a result, crop yield losses are expected due mainly to an increased saline water intrusion associated with the sea level rise. There are already areas where freshwater is affected by saline water, and no longer conducive to paddy cultivation but to brackish shrimp culture. There are thus some conflicts in such mixed areas between farmers for crop cultivation and the others for shrimp culture. To cope with such problems, the project is proposed to improve flow water management in the coastal areas of Mekong delta.

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 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.

2.6 As is well known, aquaculture production in the Mekong Delta surpasses the production of other regions. On top of this, 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.

2.7 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 (4,350km), and 21st largest in drainage area (795,000 km2). Flood season starts from July and ends in December. 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.

2.8 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

2.9 Mekong River is divided into 2 major tributaries of Tien and Hau (Bassac), flowing into the Vietnamese territory. There are hydrological stations on the tributaries near the boundary with Cambodia. 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. During the driest season of April and May, the total discharge of the 2 stations stays at around 3,000 cum/s only.

2.10 Waterway network in Mekong Delta had been developed for navigation purpose at the beginning period in Nguyen dynasty, 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 main, level 1 – 3. 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. Of the total 90,000 km, main canal shares only about 3,190 km length, and level-1 canal (first class secondary canal) reaches 10,960 km of length. Remaining length is shared by level-2 and level-3 canals.

2.11 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 the Mekong Delta. Observed water level amplitudes in April 2008 indicate about 1 meter fluctuation at the most upstream parts of Mekong Delta, and about 1.5 m to 2.0 m at around mid parts of the Delta, and more than 2.0 m to over 2.5 m at the downstream parts of Mekong Delta;

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 by about 3.0% by year 2050 in the case of A2 scenario (high greenhouse gas emission). Monthly rainfall in October is projected to increase by 15%, more than 20%, and more than 30% by year 2100 for the scenarios B1, B2, and A2 respectively. 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:

- ✓ *Yield loss by temperature rise*: Extremely high temperature during vegetative stage of paddy reduces tiller number and plant height and negatively affects panicle and pollen development. It was estimated that approximately 0.57 ton/ha of yield loss is caused per 1.0 degree Celsius of temperature increase at a range between 31-33 degree Celsius. As a result, present yield of winter-spring paddy at around 4.5-4.9 tons/ha would decrease to 3.8-4.2 tons/ha by 2050, accounting for about 12-18% of yield loss.

- ✓ *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.

- ✓ *Combined loss by saline intrusion and inundation*: Combined loss of saline intrusion in dry season and inundation in rainy season in year 2050 is estimated on average 30% of the annual production of paddy, vegetable, fruits, tree and shrimp, ranging from 20% to 50% by province. In monetary value, it accounts for about 3.6 trillion to 12 trillion VND.

4. DESIGN OF THE PROJECT

4.1 In recent years, saline intrusion has shown a tendency to migrate upstream. Measurement of salinity has been carried out by DONRE. However, the information of salinity is not always provided as useful information for the gate operation, and the information is not used for water management purpose. Accordingly, river/canal basin based water management across many provinces has become increasingly necessary. Yet, at the present, technological knowledge and experience and the management system for the actual water management has not been established. Therefore, there is a need for human resources development in the relevant areas of water resources management and/or flow water management.

4.2 The main responsibility to observe water level and quality in the Mekong Delta lies with MONRE and its related provincial organization, DONRE. They, however, cannot cover small and lower level canal system. Therefore, for the certain purpose of gate operation and/or some particular projects, ad-hoc observation shall be conducted by DARD and its related organizations. However, information gathered by a DARD in the particular province is not shared with another DARD in other province under present situation. For this reason, adequate gate operation is not carried out during salinity intrusion period, and whereby lack of fresh water causes damage to the crops. Therefore, information gathering and sharing on flow water management by MARD and DARD as well as amongst provinces shall be strengthened.

4.1 Overall Goal, Objective, Outputs, Activities, and Input

4.3 The overall goal is that inter-provincial and integrated flow water management system for sustainable agricultural and rural development in adaptation to the climate change is expanded to the coastal Mekong Delta. To this end, the project objectives is that in the project target areas, water resources information management system for flow water including fresh water and saline water is developed and adapted to contribute to sustainable agriculture and aquaculture in adaptation to salinity intrusion caused by climate change.

4.4 To achieve the project objective, there are two major outputs; 1) in the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation, and 2) at both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened.

4.5 Activities are planned as listed below corresponding to the aforementioned each output:

Output (1): In the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation.

1-1 SIWRP determines pilot areas.

1-2 SIWRP analyzes the current situations of relevant organizations in the field of flow water management in the pilot areas.

1-3 SIWRP makes a basic design of observation network, computer systems and information network.

1-4 SIWRP formulates a observation plan of fresh water and saline water.

1-5 SIWRP installs observation equipments.

1-6 SIWRP conducts training courses for observation and observation data processing to the officers of DARDs and IMCs.

1-7 SIWRP formulates observation data storing, managing and sharing.

1-8 SIWRP, DARDs and IMCs conduct observation.

1-9 SIWRP, DARDs and IMCs reflect the observation results to the exiting gate operation.

1-10 MARD, DARDs and SIWRP formulate an integrated flow water management plan including observation plan and gate installation, operation and maintenance plan in the pilot area.

Output (2): At both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened.

2-1 SIWRP analyzes the current situations of flow water management at the national and provincial level.

2-2 SIWRP establishes analysis system for flow water management including fresh water and saline water.

2-3 SIWRP advises MARD on institutional and organizational arrangement for future inter-provincial/ river basin-based flow water management including the system of information sharing among relevant organizations.

2-4 SIWRP establishes training systems for the effective and integrated flow water management including fresh water and saline water management.

4.6 As the project requires highly technical conduct, technical assistance and related inputs may be required from donor country(ies) along with the self-support of Vietnamese government toward the same end. In principle, deployment of experienced experts are required for both long term and short term position from the donor(s); those who are responsible in designing of the entire project framework, provision of technical guidance, and coordinating with agencies concerned, through which technical transfer is to be made to counterpart personnel involved in the implementing process of the project.

4.2 Implementing Agency and Steering Committee

4.7 In the project, Southern Institute of Water Resources Planning (SIWRP) functions as the implementing agency. SIWRP has total 90 permanent staffs including 1 assistant professor, 3 doctors, 6 postgraduates, 16 masters, 50 engineers, and 10 bachelors. Field of study and number of year of experience are: thirty-year experience in surveys/investigation and hydrological and water resources determination, twenty-year experience in water quality analysis, twenty-eight-year experience in application of mathematic models in water resources assessment, fifteen-year experience in application of GIS in natural resources development mapping, twenty-five-year experience in land and water resources development planning, fifteen-year experience in master development planning, and so on.

4.8 As for the proposed institutional arrangement, Joint Coordinating Committee (JCC) should be established at central level in Hanoi, which is composed of MARD, MoNRE, and JICA. As general water resources management plan is subject to the approval from MoNRE, MoNRE should also be a part of the JCC. The JCC is responsible to authorize the direction of the project and coordinate the project activities to be in line with the government policy. For example, proposed change of water resources management plan should be submitted to the JCC, at which the plan should be approved.

4.9 At regional level, Project Implementing Committee (PIC) shall be established in participation with responsible institutes in water resources management. The PIC is responsible in monitoring and improvement of project activities. The actual monitoring and observation of hydro-meteorological condition and the gate operation based on the collected hydro-meteorological information in provincial level under MARD are conducted by Water Resources Management Company/ Irrigation and Drainage Management Company (IMC). Therefore, improved systems are to be disseminated through current hydro-meteorological observation and gate operation system.

4.10 In addition, the two parties, SIWRP and donor experts, coordinate with and get support from other agencies: provincial peoples' committee that represents water resources division of DARD and hydro-meteorology division of DoNRE, Vietnam Academy of Water Resources (VARW) including Southern Institute for Water Resources Research (SIWRR), University of Water Resources, Cuu Long River Basin Organization, and Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP). The institutes provide technical guidance and help establish a set of improved flow water management system oriented to climate change adaptation, e.g. adaptation to saline intrusion.

4.3 Project Implementation Schedule and Cost

4.11 This Project is carried out in a five-year period, which is divided into three phases. In phase I, pilot areas are determined based on the latest status of climate change issues especially saline intrusion. After that, current situations of relevant organizations in the field of flow water management in the pilot areas are analyzed, a basic design of observation/ monitoring stations and networks, computer systems and information networks are developed, an observation plan of fresh water and saline water movement is formulated, observation data storing, managing and sharing plan is formulated, and observation equipments and network/information systems are installed, training courses for observation and observation data processing to the officers of DARDs and IMCs are conducted.

4.12 In phase II, observation and monitoring of fresh water and saline water movement, processing observed data, storing, managing and sharing acquired data are conducted by DARDs and IMCs. Also, observation data is utilized to existing gates operation. In this phase II, training systems for effective and integrated flow water management including fresh water and saline water management are also established. In phase III, based on the previous activities, integrated flow water management plan including observation/ monitoring plan and gate installation and operation plan in the pilot areas is formulated. Further, institutional and organizational arrangement for future inter-provincial and river basin based flow water management including the system of information sharing among relevant organizations is advised to MARD.

4.13 Project costs is categorized into donor side and Vietnamese side, and further divided into expert, materials/equipment, training, and others. As a summary, total project cost for the 5 year project duration comes to US$ 5,763,000 composed of US$ 5,435,000 by donor and US$ 328,000 for counterpart fund.

CONTENTS (FLOW WATER MANAGEMENT)

EXECUTIVE SUMMARY
CONTENTS
ABBREVIATIONS
LIST OF TABLES
LIST OF FIGURES

CHAPTER 1 INTRODUCTION V-1-1
1.1 Rationale of the Project V-1-1
1.1.1 National Plans V-1-1
1.1.2 National Target Program to Respond to Climate Change (NTP-RCC) V-1-2
1.1.3 Action Plan Framework of Rural and Agriculture Sector (2008-2020) V-1-2
1.1.4 Outline of the Mekong Delta V-1-3
1.1.5 Constraints and Difficulties V-1-4
1.2 Outline of the Project V-1-7
1.2.1 Overall Goal, Objective, Outputs, Activities, and Input V-1-8
1.2.2 Implementation Agency V-1-9
1.2.3 Target Groups V-1-10

CHAPTER 2 THE PROJECT AREA AND CLIMATE CHANGE V-2-1
2.1 Salient Features of Project Area V-2-1
2.1.1 Location and Demography V-2-1
2.1.2 Meteorology and Hydrology V-2-3
2.2 Water Resources V-2-5
2.2.1 Discharge and Water Level V-2-6
2.2.2 Relevant Organizations in the Water Sector V-2-9
2.3 Expected Climate Change based on Simulation Analysis V-2-14
2.3.1 Temperature V-2-15
2.3.2 Rainfall V-2-17
2.3.3 Sea Level Rise V-2-19
2.3.4 Mekong River Flow Regime Prediction (MRC) V-2-19
2.4 Expected Impact by and Adaptation to Climate Change V-2-22
2.4.1 Impact on Crop Production by Saline Intrusion under CC V-2-22
2.4.2 Impact on Crop Production by Flood under CC V-2-25

CHAPTER 3 DESIGN OF THE PROJECT V-3-1
3.1 Issues Identified V-3-1
3.1.1 Government Officers' Perception on Climate Change V-3-1
3.1.2 Villagers' Perception on Climate Change V-3-2
3.1.3 Saline Intrusion as Main Issue Considered in this Project V-3-5
3.1.4 Current Issues V-3-6
3.1.5 Future Issues caused by Socio-economic Development V-3-9
3.2 Project Components V-3-9
3.2.1 Capacity Development Project for Flow Water Management in Mekong Delta V-3-11
3.2.2 Early Flood Warning System Improvement Program V-3-12
3.2.3 Early Saline Intrusion Warning System Establishment Program V-3-13

3.3 Proposed Technical Assistances and Inputs for the Project V-3-14
3.3.1 Technical Assistances Required V-3-14
3.3.2 Inputs Required V-3-15
3.4 Preparatory Project Evaluation V-3-16
3.4.1 Evaluation by Five Criteria V-3-16
3.4.2 Consideration on Poverty, Gender, and Environmental Issues V-3-18
3.5 Institutional Arrangement for Project Implementation V-3-18
3.5.1 Implementation Agency V-3-18
3.5.2 Proposed Project Steering Committee... V-3-22
3.5.3 Proposed Project Site V-3-23
3.6 Project Implementation Schedule and Cost.. V-3-23
3.6.1 Project Activity Schedule under Output 1... V-3-24
3.6.2 Project Activity Schedule under Output 2... V-3-24
3.6.3 Project Cost V-3-24
3.7 Project Design Matrix (PDM) and Plan of Operation (PO) V-3-26

CHAPTER 4 RECOMMENDATIONS... V-4-1

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
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) Company
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
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
NCB	National Competitive Bidding
NPK	Nitrogen, Phosphate, Potassium
NPV	Net Present Value
O&M	Operation and Maintenance
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
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 21,054 (TTB)
US$ 1.00	=	82.11 Japanese Yen (TTB)
VND 1.00	=	0.0039Yen

VIETNAM FISCAL YEAR

January 1 to December 31

LIST OF TABLES

Table 1.1.1 Past Trend in Climate and Water Level in Mekong Delta V-1-4
Table 1.1.2 Simulated Trend in Climate and Water Level in Mekong Delta......................... V-1-4
Table 2.1.1 Land and Demography of the Project Area as compared with Other Areas V-2-2
Table 2.2.1 Responsibilities of Key Agencies in the Water Sector V-2-9
Table 2.3.1 Monthly Average Discharges at Kratie Simulated under Different Scenarios . V-2-20
Table 2.4.1 Damage Index for Saline Water Intrusion V-2-22
Table 2.4.2 Damage Index for Flood Inundation V-2-25
Table 3.1.1 Issues with Priority Order related to Climate Change identified by 7 Provinces V-3-1
Table 3.1.2 Priority Order of the Issues related to or caused by Climate Change................ V-3-1
Table 3.1.3 Climate Change Issues Identified in the Problem Trees of Each Commune V-3-3
Table 3.1.4 Climate Change Respondents Observed.. V-3-3
Table 3.1.5 Major Damages or Losses Caused by Climate Change..................................... V-3-4
Table 3.1.6 Saline Intrusion at Farmers' Field or Canals Nearby.. V-3-4
Table 3.1.7 Saline Prone Area of Currently Paddy Area Expected in 2050 (ha).................. V-3-6
Table 3.5.1 Table Number of Officers in each Division of SIWRP V-3-21
Table 3.6.1 Summary of Project Cost, US$ V-3-25

LIST OF FIGURES

Figure 1.1.1 Ca Mau Peninsula composed of 3 Provinces.. V-1-6
Figure 1.2.1 Overall Goal, Objective, and Outputs of the Project.. V-1-8
Figure 1.2.2 Government Agencies related to the Proposed Project and Target Group.........V-1-11
Figure 2.1.1 Population and Land Area by Province in the Mekong Delta V-2-2
Figure 2.1.2 Population Density (Left) and Population Growth Ratio (Right) by Province in the Mekong Delta and by Region in Vietnam V-2-3
Figure 2.1.3 Average Monthly Air Temperature at Major Locations in Mekong Delta.......... V-2-3
Figure 2.1.4 Annual Average Rainfall Counters.. V-2-4
Figure 2.1.5 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month V-2-4
Figure 2.2.1 Map of the Mekong River Basin V-2-5
Figure 2.2.2 Map of the Lower Reaches of Lower Mekong River Basin (After Kratie Station)... V-2-5
Figure 2.2.3 Daily Discharge Data Recorded at Kratie Station from 1985 to 2000 .... V-2-6
Figure 2.2.4 Daily Water Level Data Recorded at Tan Chau Station from 1980 to 2010....... V-2-7
Figure 2.2.5 Daily Water Level Data Recorded at Chau Doc Station from 1980 to 2010 ...... V-2-8
Figure 2.2.6 Daily Discharge at Tan Chau Station and Chau Doc Station.............................. V-2-8
Figure 2.2.7 Summed Daily Discharge for Tan Chau and Chau Doc Stations V-2-9
Figure 2.2.8 Organization chart of Ministry of Agriculture and Rural Development........... V-2-10
Figure 2.2.9 Organization Chart under the Directorate of Water Resources V-2-10
Figure 2.2.10 Organization chart of the Southern Institute for Water Resources Planning (SIWRP) V-2-11
Figure 2.2.11 An example of Organization Chart of Province V-2-12
Figure 2.3.1 Mean Annul Temperature Rise at Year 2050 in Percentage under Scenario B2V-2-15
Figure 2.3.2 Mean Annul Max. Temperature Change in Mekong Delta with 3 Scenarios ... V-2-15
Figure 2.3.3 Mean Annul Min. Temperature Change in Mekong Delta with 3 Scenarios.... V-2-15
Figure 2.3.4 Mean Annul Temperature Change under Scenario B2 by Province V-2-16

Figure 2.3.5 Mean Annul Temperature Change under Scenario A2 by Province V-2-16
Figure 2.3.6 Mean Monthly Temperature Change in Mekong Delta under B1 .... V-2-16
Figure 2.3.7 Mean Monthly Temperature Change in Mekong Delta under B2 .... V-2-16
Figure 2.3.8 Mean Monthly Temperature Change in Mekong Delta under A2 .... V-2-16
Figure 2.3.9 Annul Rainfall Change at Year 2050 in Percentage under Scenario B2........... V-2-17
Figure 2.3.10 Annual Rainfall Change in Mekong Delta under 3 scenarios V-2-17
Figure 2.3.11 Annual Rainfall Change by Province under Scenario B1 .... V-2-17
Figure 2.3.12 Annual Rainfall Change by Province under Scenario B2 .... V-2-18
Figure 2.3.13 Annual Rainfall Change by Province under Scenario A2 .... V-2-18
Figure 2.3.14 Monthly Rainfall Change in Mekong Delta under Scenario B1...................... V-2-18
Figure 2.3.15 Monthly Rainfall Change in Mekong Delta under Scenario B2...................... V-2-18
Figure 2.3.16 Monthly Rainfall Change in Mekong Delta under Scenario A2...................... V-2-18
Figure 2.3.17 Sea Level Rise of Mekong Coastal Area under 3 Scenarios V-2-19
Figure 2.3.18 Sea Level Rise by Province Under Scenario B1, ... V-2-19
Figure 2.3.19 Sea Level Rise by Province Under Scenario B2 .... V-2-19
Figure 2.3.20 Sea Level Rise by Province Under Scenario A2 .... V-2-19
Figure 2.3.21 Mekong River Discharge at Kratie during Dry Season (A1 and B2) V-2-21
Figure 2.3.22 Mekong River Discharge at Kratie during Rainy Season (A1 and B2)........... V-2-21
Figure 2.3.23 Mekong River Discharge at Kratie during Dry Season with Basin Development Projects V-2-21
Figure 2.3.24 Mekong River Discharge at Kratie during Rainy Season with Basin Development Projects V-2-21
Figure 2.4.1 Salinity Isolines of March for DY 1998 MR Discharge with 30 cm SLR (2050) V-2-23
Figure 2.4.2 Salinity Isolines of April for DY 1998 MR Discharge with 30 cm SLR (2050) V-2-23
Figure 2.4.3 Salinity Isolines of May for DY 1998 MR Discharge with 30 cm SLR (2050) V-2-23
Figure 2.4.4 Salinity Isolines of June for DY 1998 MR Discharge with 30 cm SLR (2050) V-2-23
Figure 2.4.5 Production Loss(%) by Province.. V-2-24
Figure 2.4.6 Production Loss(%) by Province.. V-2-24
Figure 2.4.7 Production Loss(VND) by Province V-2-24
Figure 2.4.8 Production Loss(VND) by Province V-2-24
Figure 2.4.9 Flood Isolines of August for FY2000 MR Discharge with 30 cm SLR (2050) V-2-26
Figure 2.4.10 Flood Isolines of September for FY2000 MR Discharge with 30 cm SLR (2050) V-2-26
Figure 2.4.11 Flood Isolines of October for FY2000 MR Discharge with 30 cm SLR (2050) V-2-26
Figure 2.4.12 Flood Isolines of November for FY2000 MR Discharge with 30 cm SLR (2050) V-2-26
Figure 2.4.13 Annual Production Loss(%) by Province V-2-27
Figure 2.4.14 Annual Production Loss(%) by Province V-2-27
Figure 2.4.15 Annual Production Loss(VND) by Province... V-2-27
Figure 2.4.16 Annual Production Loss(VND) by Province... V-2-27
Figure 3.1.1 Saline Intrusion in 1998 and 2020 based on Simulation V-3-5

Figure 3.1.2 Distribution of the Agricultural Product and the Boundary of Provinces in Ca Mau Peninsula V-3-7
Figure 3.5.1 Organizational Structure of SIWRP V-3-20
Figure 3.5.2 Institutional Arrangement... V-3-22
Figure 3.6.1 Phasing of the Project... V-3-24

MAIN

REPORT

CHAPTER 1 INTRODUCTION

This report is to propose a water flow management project as one of the necessary activities for climate change adaptation in the coastal Mekong Delta. First, a comprehensive project proposal is presented from Chapter 1 to Chapter 3 and then from section 3.3, a specific technical assistance project is proposed aiming to be funded by donors as technical cooperation project.

1.1 Rationale of the Project

1.1.1 National Plans

1) National Development Plan (Agricultural and Rural Development 2011 – 2015)

Overarching national development plan in Vietnam is the Five Year Socio-Economic Development Plan 2011 – 2015, composed of all the development sectors corresponding primarily to the ministerial set-up. Of the plan, the section of Agriculture and Rural Development 2011 – 2015 is the relevant part to the proposed project. The main objective of the agricultural and rural development sector is to achieve sustainable development, improve living conditions of rural population, especially poor people, and properly protect and exploit natural resource and the environment.

The sector elaborates relevant activities in such areas of agriculture, aquaculture, livestock, horticulture, etc. Of them, the agriculture sector development aims at ensuring food security for the nation and exploitation of advantageous commodities for domestic and export demand. Some proposed priority projects include: 1) national food security program, 2) farming pattern shift program, 3) disease control for farming program. Of them, the first 2 programs are quoted below;

National food security program, one of the priority programs, aims at maintaining planned paddy area at 3.8 million ha, investing on water resources development to meet irrigation requirements, conducting research and study to develop improved seeds, enhancing promotion activities to encourage farmers apply advanced technologies into production, and developing post-harvest technology. Also, the program plans to enhance paddy production in the two deltas, form large production area in East-southern region, Central Highland, Northern Midlands and Mountainous region, Mekong Delta, and apply suitable cropping pattern to achieve high output. The paddy production target in 2015 is set at 40 million tons, including export of 4 – 4.5 million tons.

Farming pattern shift program is to promote the production of advantageous crops in the country such as paddy, coffee, cashew, pepper, tea, rubber, tropical fruits and vegetable; enhance value of those crops to improve competitiveness in domestic and international market. The targets under this program are; cereals crop area reaches 8.23 million ha with output 46.3 million tons, in which paddy is 7.0 million ha with the output 40 million tons. Beans and vegetable area is set at 1.09 million ha with output 15 million tons, and on average production per capita is targeted at 161 kg/person/year. Fruit is targeted to increase by 50,000 ha to reach 850,000 ha in year 2015.

In the aquaculture development sector, such development indicators are set; total aquaculture farming area is set to increase from 1,110,000 ha in 2010 to 1,120,000 ha (101%) in 2015, total aquaculture output from 4,800,000 tons to 6,000,000 tons (125%), total catching production from 2,200,000 tons to 2,350,000 tons (107%), and export from US$ 5,000 million to US$ 7,000 million (140%). It is known that the export is targeted to increase by as much as 40% in monetary value by year 2015. In fact, 60% of the aquaculture products are planned to be processed in meeting safety and hygiene standard, for which export is to be facilitated to 200 countries.

The aquaculture development sector aims at upgrading technology, and developing offshore catching. In addition, the sector is to continue development of aquaculture farming in fresh, brackish and saline area, and ensure enough seeds (50 billion shrimp seeds, 25 billion fish seeds). Farming area is to be maintained at 1.12 million ha while the total aquaculture farming output is targeted to increase to 3.65 million tons in 2015 from 2.60 million ton in 2010. Focus is placed on such 3 main raising commodities as tiger shrimp, white-leg shrimp, and catfish.

Though the above Agricultural and Rural Development 2011 – 2015 does not specifically mention about climate change, it is obvious unless otherwise measures are undertaken, such target as 40 million tons production of paddy can hardly be achieved. In addition, aquaculture e.g. brackish shrimp culture is emphasized in the above plan especially from export point of view aside from fresh water catfish. Therefore, the proposed Project to adjust cropping pattern and improve the pattern as well the agricultural system is highly in line with the national development plan.

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

National Target Program to Respond to Climate Change (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 to ensure sustainable development of Vietnam. The standing agency for the NTP-RCC 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.

1.1.3 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) conduct the communication and information program to disseminate knowledge and experiences to enhance people's awareness on climate change impacts, 2) develop human resources and conduct studies to develop and consolidate scientific foundation for providing solutions for climate mitigation and adaptation, 3) develop policy system, integrating climate change in sectoral development program, 4) promote international cooperation in mitigation and adaptation, and 5) carry out priority activities for implementing mitigation and adaptation.

In connection with above 5) priority projects, there are some concrete project 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 water resources sector is highly needed. One of the measures is to be capacity building on water flow management, e.g. to cope with and/or adapt to saline intrusion fresh water management under climate change. Therefore, the proposed Project is highly in line with the above 2 national plans.

1.1.4 Outline of the Mekong Delta

The Mekong Delta (MKD) covers approximately 5.9 million hectares and spans the southern parts of both Cambodia and Vietnam. The Vietnamese territory of the Delta covers approximately 3.9 million hectares, accounting for about 12 percent of the country's land area, and 27 percent of its designated agricultural land. It is composed of twelve provinces and one municipality (Can Tho) and has a population of 18.6 million people (i.e., 22 percent of the population still lives in rural areas and 76 percent of its population derives its primary income from agriculture).

The Vietnamese territory of the MKD can be segmented into three sub-regions based on topographical, economic, demographic, and geological characteristics: (a) an eastern part (east from the Tien River up toward Ho Chi Minh City); (b) a central part (between the Tien River and the Hau River); and (c) a western part (west of the Hau River and toward the Gulf of Thailand).

The eastern part was previously considered to have low agricultural potential, due to its acid sulphate soils; however, recent advances in technology and agronomic practices have converted this area into a very productive horticulture and rice growing area. The central part, considering of rich alluvial soils, has emerged as an important area for horticultural production, experiencing relatively rapid urbanization.

The western part features diverse conditions and agricultural practices have adapted accordingly. This area is comprised of: (a) an upstream flood plain section (Long Xuyen Quadrangle and Bay Nui Region); (b) a mid-stream section (Trans- Basac Depression), with relatively better soil, (from upstream); and (c) a southernmost part (Ca Mau Peninsula) which features persistent shortage of freshwater and the intrusion of saltwater from two directions. The region's average elevation is less than three (3) meters above sea level

The MKD area is a major and growing pillar for Vietnam's agricultural sector, accounting for 40 percent of the country's agricultural GDP, more than half of its expanding agro-food exports, 52 percent of national rice production (and nearly all rice exports), 65 percent of fruit production, and 60 percent of its combined fisheries and aquaculture output. During the past decade, there has been growing industrial investment in the MKD plus gains in tourism development.

contribute to the above development direction of the Mekong Delta.

1.1.5 Constraints and Difficulties

1) Current Issues related to Climate and Sea Level

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 three places: 15 cm over the past three decades—meaning 5 cm of increase per decade. The table below summarizes past trend in climate and water level.

Table 1.1.1 Past Trend in Climate and Water Level in Mekong Delta

Indicator	Trend	Measuring Stations	Period
Temperature	Annual mean: Increased by 0.7 degree Celsius Mean maximum: Increased by 1.0 degree Celsius Mean minimum: Increased by1.0 degree Celsius	Vung Tau, Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Annual Sunshine hours	Decreased by about 500 hours, accounting for 20% of original hours	Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Evaporation	Increased in Vung Tau and Can Tho Decreased in Ca Mau and Rach Gia (Annual value ranges 800-1,400mm)	Vung Tau, Can Tho, Ca Mau, Rach Gia	1978-2009/2010
Rainfall	Increased in Ca Mau, Rach Gia and My Tho Little decreased in Ca Mau, Vun Tao (Can Tho alone increased during 1910-2010)	Can Tho, Ca Mau, Rach Gia , My Tho, Vun Tao	1978-2010
Water level	Increased by 15 cm over 30 years (5 cm per decade)	Vung Tau, Rach Gia, Can Tho	1982-2009/2011

Source: JICA Project Team (2012)

As a result of all those climate changes, there are a number of issues claimed on the ground, although concrete quantitative evidences are not always available. For example, it was pointed out that occurrence of diseases has increased both for crop and aquaculture products, size of fruits has decreased, and paddy received damage by saline water, etc. Typically observed is an issue of saline intrusion along coastal areas. Many farmer households have already shifted from paddy cultivation to shrimp cultivation in such areas where saline contents is considerably high.

On the other hand, in such a delicate area where saline intrusion occurs once in a while, paddy is often damaged by high salinity in canal water. Risk of saline intrusion is also associated with human factors: a delay of gate operation had for example caused loss of paddy approximately 70% of harvest in 8,000ha and 30-70% in about 3,000ha in Tra Vinh province in 2010. So, climate change issues are already urgent issues.

2) Climate Change Prediction

With reference to a climate change simulation by Global Circulation Model (GCM) and the Providing Regional Climates for Impacts Studies (PRECIS)—a regional climate model system, it is expected that the mean annual temperature (1980-1999) would increase by 1.0 degree Celsius by year 2050, of which significance of temperature increase is greater in rainy season when paddy is mainly cultivated. Monthly rainfall in October is now projected to increase by 15%, more than 20%, and more than 20% by year 2100 for the scenarios B1, B2, and A2.

On the other hand, annual rainfall is expected to increase by about 3.0% by year 2050 under A2 scenario (high greenhouse gas emission). With regard to sea level, biggest rise would occur in A2 scenario amongst scenarios B1, B2, and A2, wherein it is expected to increase by 31cm by year 2050 and as much as 103 cm by 2100. The trend is quite exponential up until year 2100 for all the scenarios.

Table 1.1.2 Simulated Trend in Climate and Water Level in Mekong Delta

Indicator	Simulation Result
Annual temperature	- Increase by 1.0 degree Celsius by 2050 (A2, B1, B2) - Increase by 1.4 to 2.7 degree Celsius by 2100(A2, B1, B2)
Monthly temperature	- Increase 1.2 (B1), 1.3 (B2) and 1.4 (A2) degree Celsius by 2050 during rainy season - Increase 0.6 (B1), 0.7 (B2) and 0.8 (A2) degree Celsius by 2050 during dry season
Annual rainfall	- Increase the biggest at A2 scenario at 3.0% by 2050 and 7.0% by 2100
Monthly rainfall	- Decrease during dry season - Increase during rainy season (July and October) - As mean rainfall in October, increase by 15% (B1), 20% (B2), and 30% (A2) by year 2100
Sea level	- Increase by 31 cm by 2050 and 103 cm by 2100 (A2: biggest) - Increase by 28 cm by 2050 and 79 cm by 2100 (B2: medium) - Increase by 27 cm by 2050 and 70 cm by 2100 (B1: least) - Trend of all scenario is exponential until around year 2100
Mekong River Discharge	(Given no development project upstream) - In dry season, remain the same by 2050 as the average discharge during 1991-2000 (B2 and A2), having stronger tendency to increase from beginning to the end of the season. - In rain season, no clear tendency observed, having bigger discharge after September, as compared to the average discharge during 1991-2000
	(Given development project in catchment areas) - In dry season (March to April), increase by 70% from 2,300-2,400 m^3/s during 1991-2000 to 4,000 m^3/s by 2050 due to the effect of hydropower dams that release water during dry season.

Source: JICA Project Team (2012)

3) Constraints and Difficulties in Agriculture and Aquaculture

By the climate change so far having taken place and expected to occur, a range of damages are caused or to be caused. In this section, typical problematic issues are discussed as constraints and difficulties to farmer households on the ground:

a) *Yield loss by temperature rise*: Extremely high temperature during vegetative stage of paddy reduces tiller number and plant height and negatively affects panicle and pollen development. It was estimated that approximately 0.57 ton/ha of yield loss is caused per 1.0 degree Celsius of temperature increase at a range between 31-33 degree Celsius. As a result, present yield of winter-spring paddy at around 4.5-4.9 tons/ha would decrease to 3.8-4.2 tons/ha by 2050, accounting for about 12-18% of yield loss.

b) *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. As mentioned earlier, in addition, loss of paddy by saline intrusion is already a central issue in coastal provinces.

c) *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.

d) *Combined loss by saline intrusion and inundation*: Combined loss of saline intrusion in dry season and inundation in rainy season in year 2050 is estimated on average 30% of the annual production of paddy, vegetable, fruits, tree and shrimp, ranging from 20% to 50% by province. In monetary value, it accounts for about 3.6 trillion to 12 trillion VND.

After all, agricultural and aquacultural production in the coastal Mekong delta is at stake due to climate change so far having happened and expected to occur.

4) Water Use Conflict

In the Mekong Delta, between rice cultivation that requires freshwater and shrimp farming that requires saltwater, there have been local disputes over water use. Referring to the example of Ca Mau peninsula, the shrimp farming part is colored purple in the figure and rice cultivation area is colored white. Then, the red line shows the boundary of the province, blue line shows the main canal to bring about fresh water and green line shows the main canal to bring about salt water.

Shrimp farming is distributed across three provinces of Ca Mau, Bac Lieu and Soc-Trang while cultivation is also distributed in the same three provinces. The problem here is that determination of the opening and closing of the gates to control the fresh water and salt water have been made in units of province, and therefore range affected by the gate operation and the water channel does not match the boundary of the province. In addition, conflicts between upstream and downstream water users may cause serious shortage of freshwater in future.

Figure 1.1.1 Ca Mau Peninsula composed of 3 Provinces, Source: JICA Project Team

Furthermore, it is probable for conflicts to occur between the uses of fresh water with the development of industrial Mekong Delta. It is also just a matter of concern not only water quantity but also water quality issues. That is, in addition to chemical contamination by pesticides and fertilizers associated with agricultural production, waste water treatment due to industrial production is concerned, which is an occurrence of water pollution from inadequate treatment.

Fresh water is also used for domestic use of local residents, not just the possibility of directly affected due to the deterioration of water quality, and the possibility of fish and shellfish that live naturally in the Mekong Delta may be contaminated. Fish and shellfish are farmed widely in Mekong Delta, and consuming them might result n human health damage, one of concerned issues. In addition to the above mentioned constrains, the following issues should be considered:

a) Information gathering in MARD and DARD on water level and salinity is insufficient in terms of location and frequency. Since the collected information is not shared between DARD and MARD, it cannot perform the appropriate gate operation during salt water intrusion taking place in dry season. By this reason, crops such as rice may be damaged resulting from the saline water intrusion and the lack of fresh water. Therefore, there is a need to promote and strengthen their share of collected information related to water resources between DARD and MARD.

b) Between rice cultivation that require fresh water and the shrimp farming that requires salt water, there have been conflicts over the usage of water such as whether the fresh water or the salt water should be taken into canals. To avoid conflicts, it is necessary to carry out more detailed water management in the canals and it would be necessary to install water regulation gates at tertiary waterways and to control water level and quality more precisely.

c) Chemical pollution caused by large volume of pesticides and fertilizers has been a concern in the areas of rice cultivation. There is also concern about effect to the health of farmers from them. In addition, although it is thought that chemicals may have caused negative impact to the rearing environment in shrimp farming, the actual situation of the water quality has not been well examined. Therefore, there is a need for grasping current situation of water quality.

d) As it is written to the national socio-economic development strategy, it is centered on industrialization and processing of agricultural products are expected. It is therefore expected to increase the use of industrial water in future. The water due to the increase of industrial wastewater has been discharged into waterways from factories. It is necessary to drain quickly to the outside of the waterway river. Therefore, it is necessary to properly control the water level in the gate.

e) Deterioration of water quality is of concern in terms of not only agriculture use but also human health. Deteriorated water quality affects aquaculture industry, resulting in human health as a probability. During dry season, a lot of people still depend on canal water for domestic use. The status of water quality is necessary to examine.

5) Current Status and Issues in the Management of Surface water in the Mekong Delta

Water level and salinity observation in the Mekong Delta is under the jurisdiction of MONRE. A mechanism observed in the field is that Provincial Hydro-meteorological Centre conducts the observation, and to National Hydro-meteorological Service via the Southern Regional Hydro-meteorological Centre from Provincial Hydro-meteorological Centre, integrated reporting in the center of the observation data of the national are in place.

Management, operation and maintenance of irrigation canals and dams are under the jurisdiction of MARD. The MARD needs water level and salinity observations as well. Water Resources Management Company under the Irrigation Divisions of DARD at province level carries out such observation to some extent. There is no mechanism to aggregate the observed data by the center with DARD (Water Resources Management Company) at province level.

Furthermore, water levels and salinity levels in a wide area across the provinces has not been shared to date. Water management is done just within each province, whereby the current system of water management does not look at the whole Mekong Delta. The current system for water management is segmented along provincial lines and therefore there is an evident need to develop a sub-regional analytical and planning framework for improved planning, monitoring and coordination in terms of water resources management.

1.2 Outline of the Project

To pursue political targets in agricultural and rural development, this project is proposed with an aim to avoid any losses conceivable by the negative effect of climate change in the future. It is expected that general trend of climate change entails significant impacts to the rural life as forms of saline intrusion, temperature increase, and a lack of freshwater, and skewed weather pattern for example. As a result, there will be such areas where agro-ecological condition may no longer be suitable to the existing commodities.

Generally, those issues can be addressed through structural measures such as construction of sea dykes, sluice gate, and irrigation/drainage canals effectively and thoroughly. Yet, precise timing and consequences of climate change are still in uncertainty and thus it is difficult to put the highest priority to such a large investment projects. To complement structural measures, therefore, this project proposal focuses on non-structural measure, namely capacity development for flow water management in accordance with the occurrence of climate change issues on the ground.

1.2.1 Overall Goal, Objective, Outputs, Activities, and Input

1) Overall Goal

Overall goal of this project is that inter-provincial and integrated flow water management system for sustainable agriculture and rural development is expanded to the coastal Mekong Delta. In other words, surface flow water in the Mekong Delta is well understood and managed through the coordination among relevant organizations to contribute to agricultural production. It also contributes to social and economic development of the region, and furthermore, it contributes to improving the lives of local residents.

2) Objective

Water flow management system developed by SIWRP is utilized for sluice operation for effective freshwater use; the system is composed of three major components; collection of in-situ data on water level and salinity at rivers/canals with proper scientific manner, preparation of water flow management plan based on results of field monitoring and analysis on water level and saline water intrusion, utilization of water flow management plan for actual sluice operation in pilot area(s) and examination of the plan through field monitoring, establishment of water flow management system coupled with training plan.

3) Outputs

To achieve the project objective, total four major outputs are expected;

1) In-situ data on water level and salinity at rivers/canals is collected with proper scientific manner,
2) Water flow management plan is prepared based on the results of field monitoring and analysis on water level and saline water intrusion,
3) Water flow management plan is utilized for actual sluice operation in pilot area(s) and examined so as to prevent saline intrusion and take freshwater effectively, and
4) Water flow management system coupled with training plan is established based on the results of the examination.

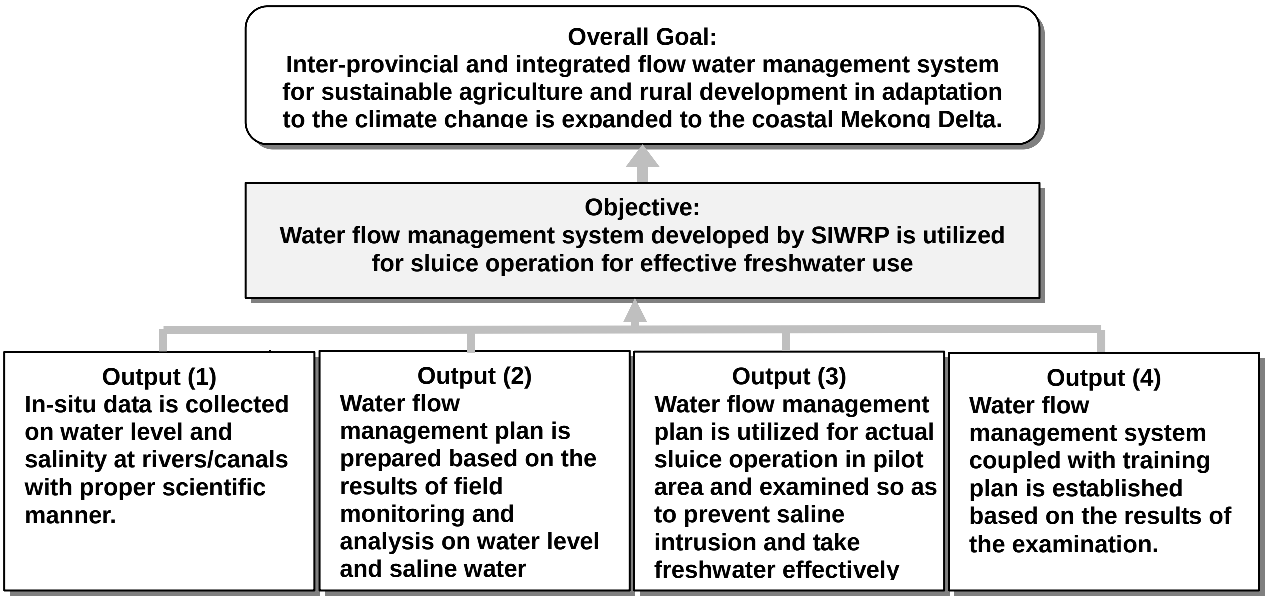


Figure 1.2.1 Overall Goal, Objective, and Outputs of the Project

4) Activities

Output (1); In-situ data are collected on water level and salinity at rivers/canals with proper scientific manner.

1-1. SIWRP determines pilot area for monitoring; there shall be sluices for pilot operation.

1-2. SIWRP selects monitoring point of water level and saline content along canal/river.

1-3. SIWRP examines discharge in canal/river so as to prepare discharge-rating-curve at different tidal levels.

1-4. SIWRP decides monitoring interval for water level and saline content.

Output (2); Water flow management plan is prepared based on results of field monitoring and analysis on water level and saline water intrusion.

2-1. SIWRP conducts computer analysis on water flow and saline intrusion based on observed data in the pilot area.

2-2. SIWRP conducts feed-back from computer analysis to field observation; parameters of the computer analysis will be adjusted.

2-3. SIWRP conducts model simulation on sluice operation in the pilot area and prepare sluice operation plan

2-4. SIWRP prepares water flow management plan based on in-situ observations monitoring on water level and saline contents, and sluice operation plan with simulation results.

Output (3); Water flow management plan is utilized for actual sluice operation in pilot area and examined so as to prevent saline intrusion and take freshwater effectively.

3-1. SIWRP conducts sluice operation together with DARD and Water Resource Management Company in the pilot area

3-2. SIWRP examines water flow management plan and review/revise it.

Output (4); Water flow management system coupled with training plan is established based on the results of the examination.

4-1. SIWRP prepare for plan of water flow management system in Mekong delta

4-2. SIWRP prepares a training plan for water flow management.

5) Inputs

As the project requires highly technical conduct, technical assistance and related inputs may be required from donor country(ies) along with the self-support of Vietnamese government toward the same end. In principle, deployment of experienced experts are required for both long term and short term position from the donor(s); those who are responsible in designing of the entire project framework, provision of technical guidance, and coordinating with agencies concerned, through which technical transfer is to be made to counterpart personnel involved in the implementing process of the project.

1.2.2 Implementation Agency

Institutional setting related to agricultural and rural development in Mekong delta area is shown in Figure 1.2.2. In principle, Ministry of Agriculture and Rural Development (MARD) is the primary institute that governs the entire sector of agriculture, fishery, forestry, livestock and aquaculture including water resources development and management for the sector use. At national and regional level, there are a number of research and development institutions that are focused on specific subjects.

The Southern Institute for Water Resources Planning (SIWRP) under MARD is proposed as the main implementation agency for this project. SIWRP is an institution of water resources planning whose primary function is to develop water resources plans for the sustainable development of river basins and the environment with proper regulation and utilization for the socio-economic development of provinces in the south of Vietnam. In the project, SIWRP is also expected to be an administrative body coordinating with related agencies and institutions as to propose improved water flow management suited to such areas where impact of climate change is apparent and to promote new water flow management systems where applicable.

1.2.3 Target Groups

The main objective of the project is to enhance the capacity on water resources information management system for flow water including fresh water and saline water. Therefore, target group of the project is technical officers in charge of water resources management including observation of hydro-meteorological data and gate operation in DARDs, DoNREs, and Water Resources Management Companies.

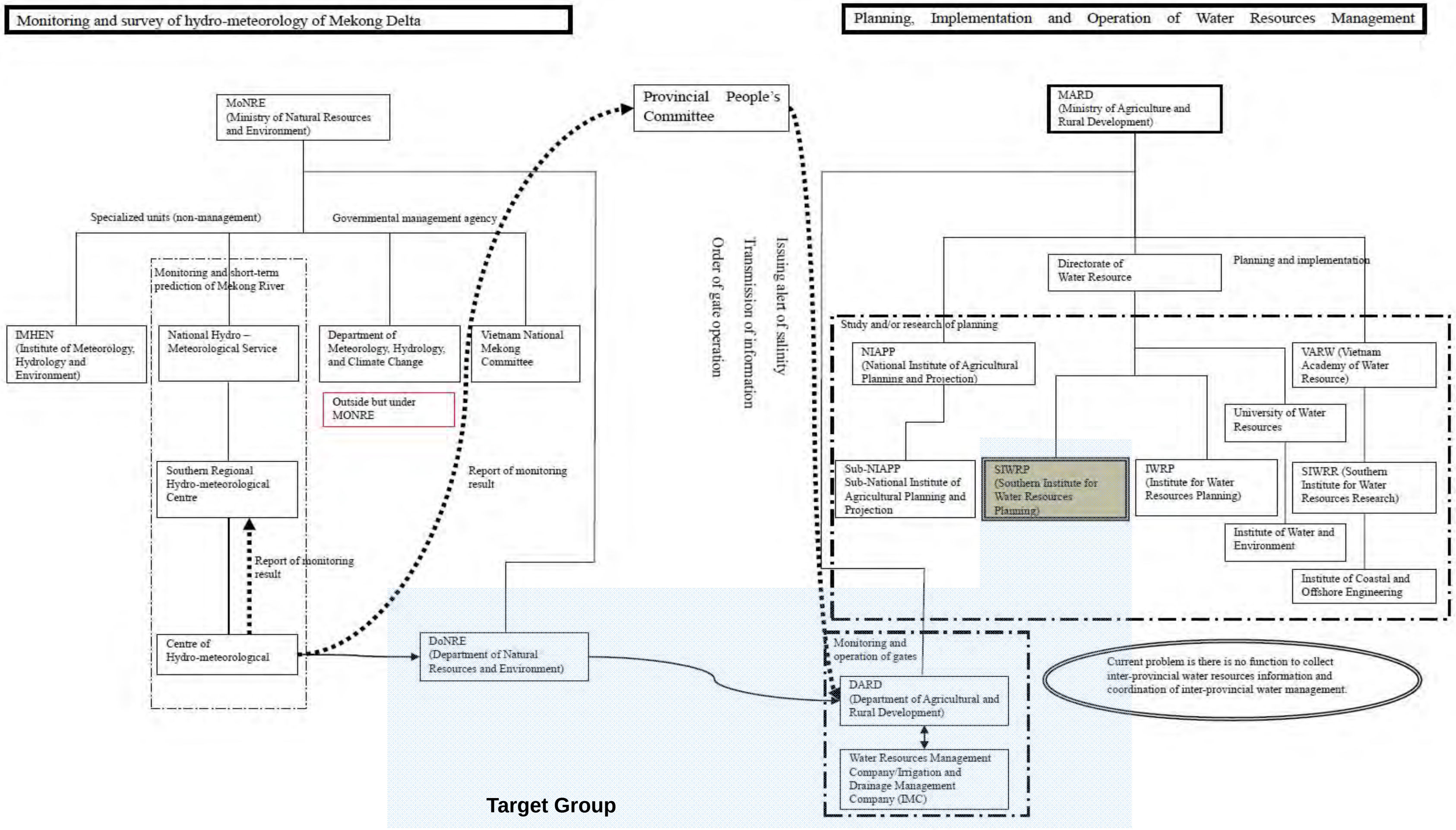


Figure 1.2.2 Government Agencies related to the Proposed Project and Target Group

CHAPTER 2 THE PROJECT AREA AND CLIMATE CHANGE

2.1 Salient Features of Project Area

Agriculture in the Mekong Delta is quite diversified. So-called “rice bowl” of rice production area is featured by strategic combinations of paddy, fruit trees, and aquaculture depending on specific conditions of agro-ecological environment in the Delta. One of those diversified farming systems is repeated production of paddy: two to three times of paddy productions a year. As moving to coastal area, brackish shrimp culture starts dominant, and even paddy-shrimp rotational cultivation is practiced. This sub-chapter discusses the salient features in the Project area as well as for the Mekong Delta by large.

2.1.1 Location and Demography

1) Spatial Settings

The Project area, 7 coastal provinces, is located along the coastal line of the Mekong Delta as is called. The delta falls in the most southern part of Vietnam, bordering on Cambodia at its upstream, or north-western, side. The Delta area lies immediately to the south-west of Ho Chi Minh City, roughly forming a triangle stretching from My Tho in the east to Chau Doc 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 degrees 20 minutes to 11 degrees 00 minutes (237 km) in north latitude and from 103 degrees 50 minutes to 106 degrees 45 minutes (290 km[1]) 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) Area, Population and Population Density

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 region in Vietnam. In addition, Figure 2.1.1 shows the area and population by province in the Mekong Delta, while Figure 2.1.2 depicts population density that also compares the population density with other 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 24,631 km^2 equivalent to about 61% of the total Mekong Delta area. Population density arrives 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. High population density implies high carrying capacity of the land endorsed with high productivity.

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

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

growth ratio of whole Mekong Delta arrives at 0.42% close to that of the Project area. On the other hand, most of the population growth ratios of other regions surpass that of Mekong Delta. Only those of North Central and Central Coastal area are the exception. Nation-wide 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 ratio of the Project area as well as for the Mekong Delta may be attributed to high out-migration trend of the people. As indicated in the most right column of Table 2.1.1, net-migration for the Project area is as high as -10.1 % and that of Mekong Delta is -8.4%. It may be suggested that the population in the Mekong Delta are now moving out to urban and industrial areas, e.g. Ho Chi Min city as well as to an industrial area of Binh Duong province located north from Ho Chi Minh city.

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)

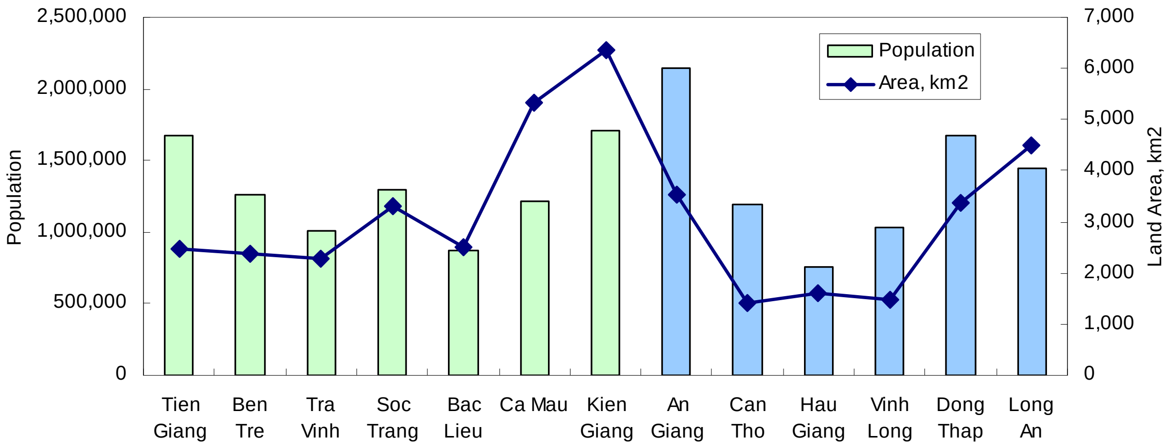


Figure 2.1.1 Population and Land Area by Province in the Mekong Delta

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

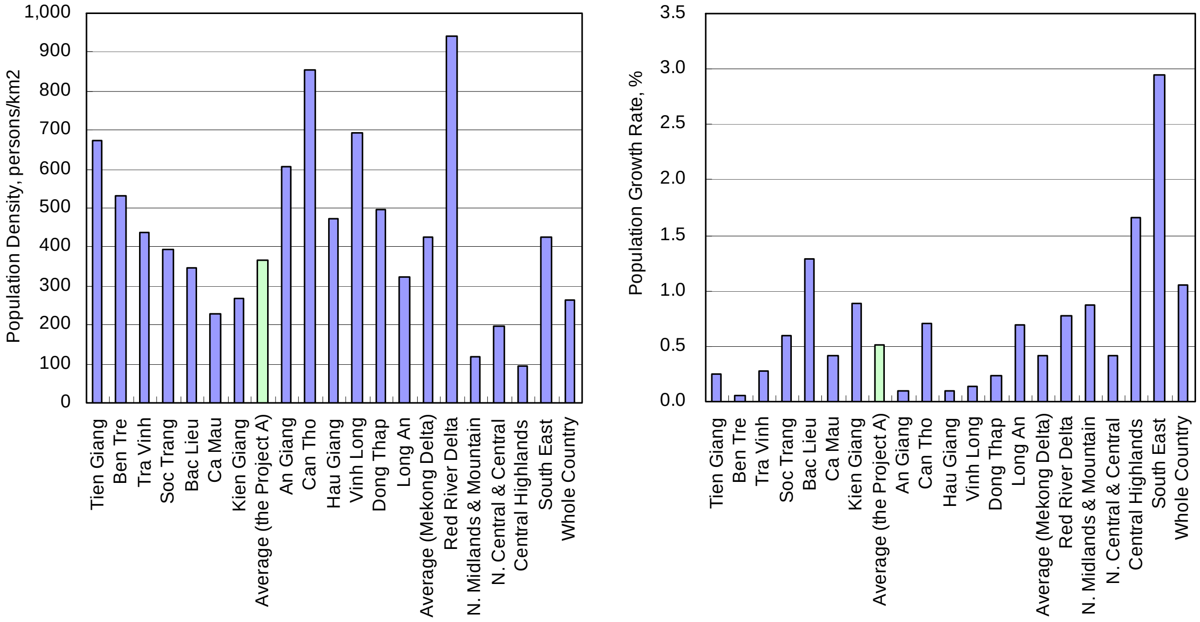


Figure 2.1.2 Population Density (Left) and Population Growth Ratio (Right) by Province in the Mekong Delta and by Region in Vietnam

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

2.1.2 Meteorology and Hydrology

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 2.1.3); 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.

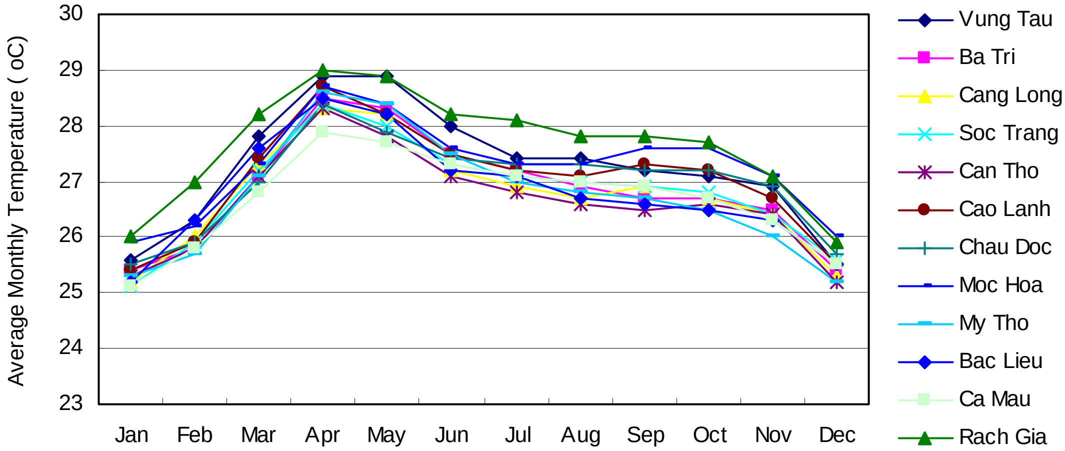


Figure 2.1.3 Average Monthly Air Temperature at Major Locations in Mekong Delta

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 average monthly air temperature at the same place. 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. 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 varies from 1,300 mm to as much as 2,300 mm dependent on the place.

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 2.1.4.

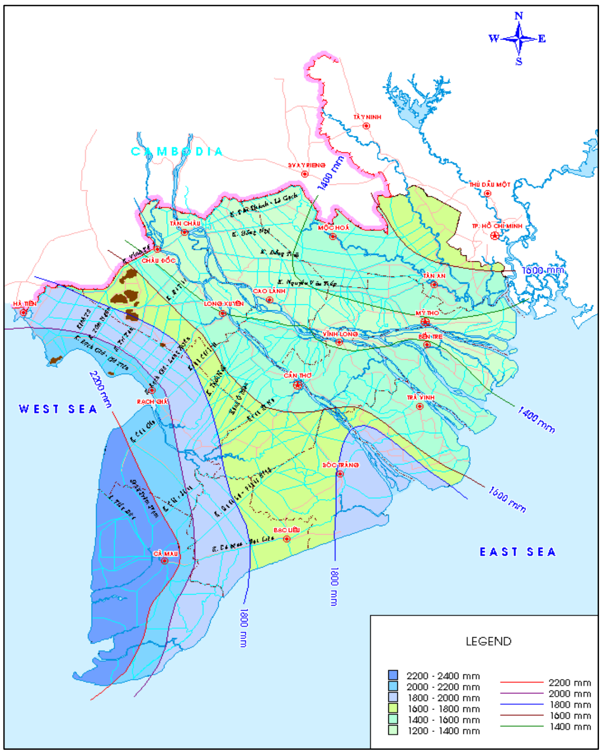


Figure 2.1.4 Annual Average Rainfall Counters
Source: SIWRP

A rainfall data probability analysis shows that a total amount of the annual rainfall in the Mekong Delta with 75% probability ranges between 1,200 and 1,400 mm or sometimes more. The highest rainfall at 75% probability shows up along western peripheral of Ca Mau - Rach Gia area with over 1,800 – 2,000 mm; while the lowest one is observed at Go Cong in Tien Giang province with only 900 – 1,000 mm.

Figure 2.1.5 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 remains only about 10%.

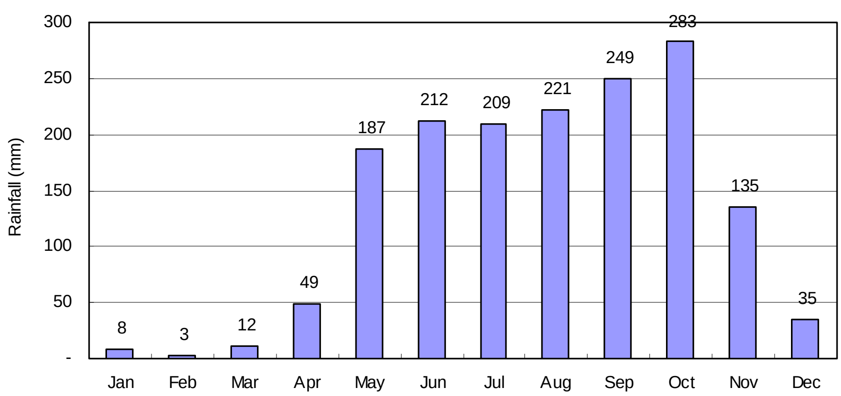


Figure 2.1.5 Major 18 Stations' Monthly Average Rainfall in Mekong Delta, mm/month
Source: Southern Institute for Water Resources Planning

2.2 Water Resources

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 (4,350km), 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'.

It is a major trans-boundary river, originating in the Tibetan Highlands with an altitude of over 5,000m. The Mekong flows through gorges in Lancang area in China's Yunnan Province, and then passes through Myanmar, Laos, Thailand, Cambodia and then finally Vietnam.

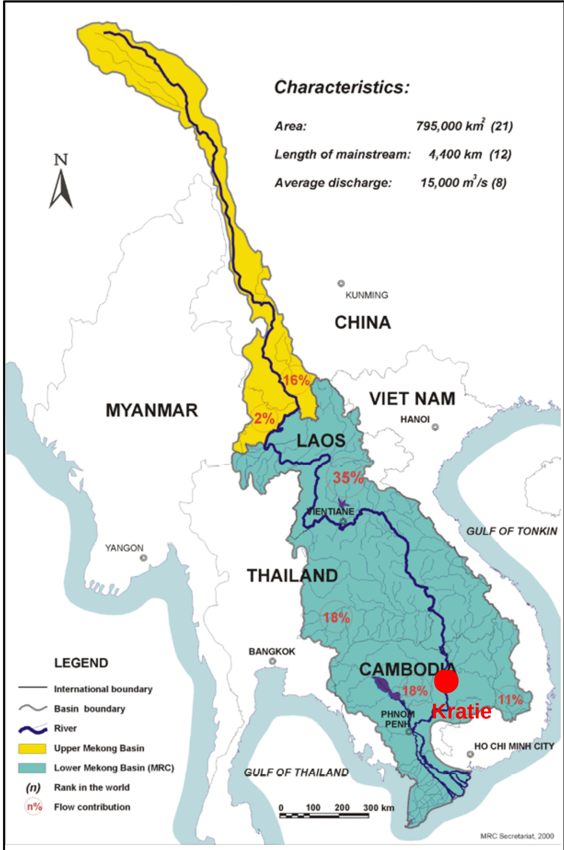


Figure 2.2.1 Map of the Mekong River Basin
Source: MRC, 2000

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.

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.

Figure 2.2.2 Map of the Lower Reaches of Lower Mekong River Basin (After Kratie Station)

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].

2.2.1 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.

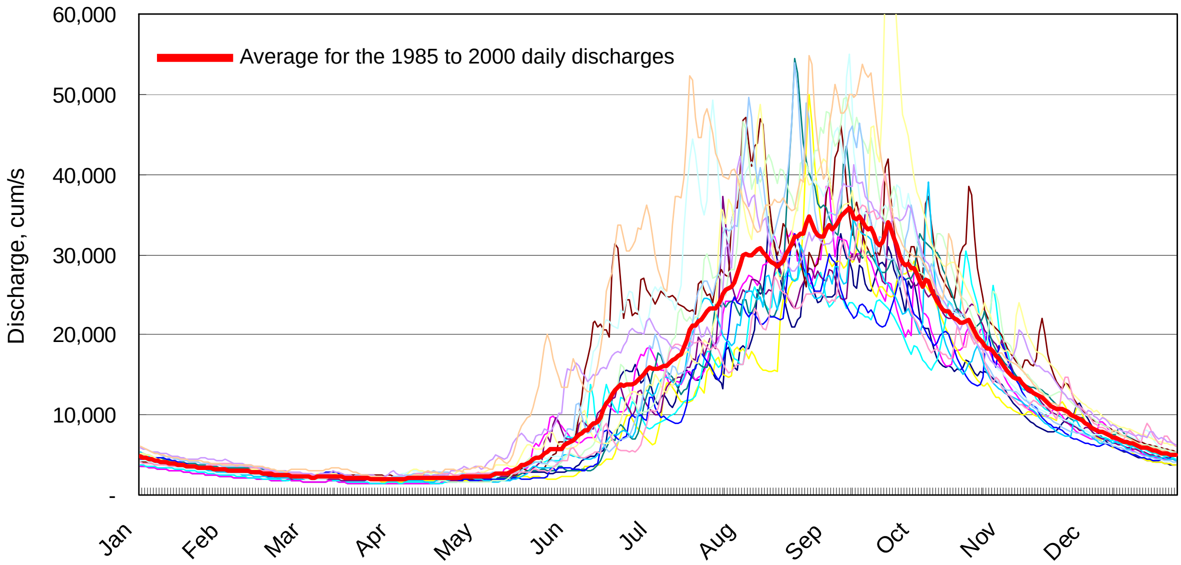


Figure 2.2.3 Daily Discharge Data Recorded at Kratie Station from 1985 to 2000

Source: Mekong River Commission

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

[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 2.2.3 shows 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 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 2 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 as aforementioned. 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 2.2.4 and Figure 2.2.5 show the water levels at Tan Chau and Chau Doc stations respectively for a period of 31 years from 1980 – 2010. Water level stays very low in April and May; the average daily water level goes down to lower than 0.5 meter AMSL at Tan Chau station in April and that of Chau Doc to lower than 0.4 meter AMSL while from May the water level starts rising towards the peak of the flood season, which is October. In October, the average water level reaches as high as about 4.0 meter at Tan Chau station and about 3.5 meter at Chau Doc station.

It is said by hydrologists as; 1) a low flood when the flood peak in Tan Chau is less than 4.0 m, 2) moderate floods when the flood peak is between 4.0 and 4.5 m, and high floods when the flood peak is more than 4.5 m. In the 31 years from 1980 to 2010 shown in the figures, there were 9 years that the water level went up more than 4.5 m. The maximum water level occurred in 2000, which reached 5.04 m.

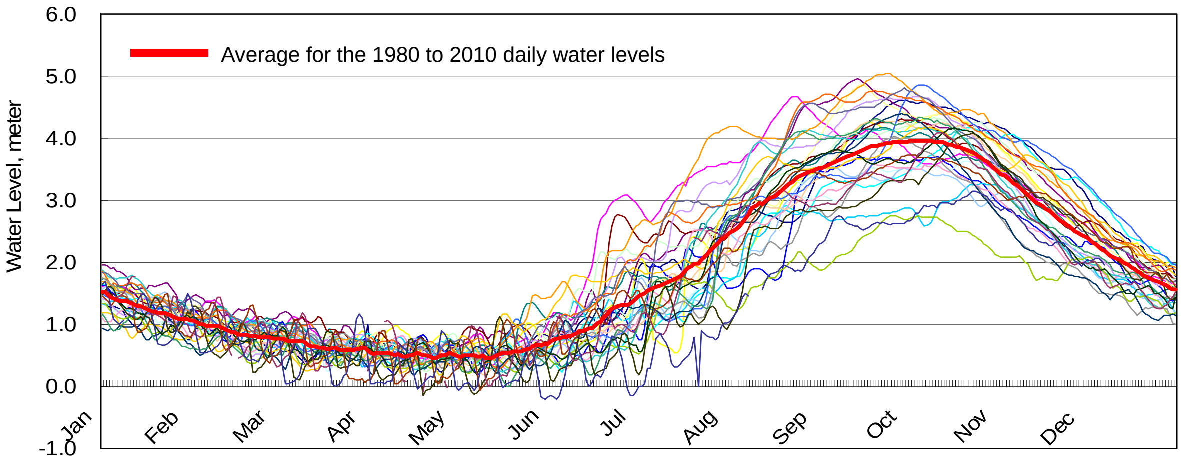


Figure 2.2.4 Daily Water Level Data Recorded at Tan Chau Station from 1980 to 2010

Source: Mekong River Commission

Note; Thick line shows the average of the water level from 1980 to 2010.

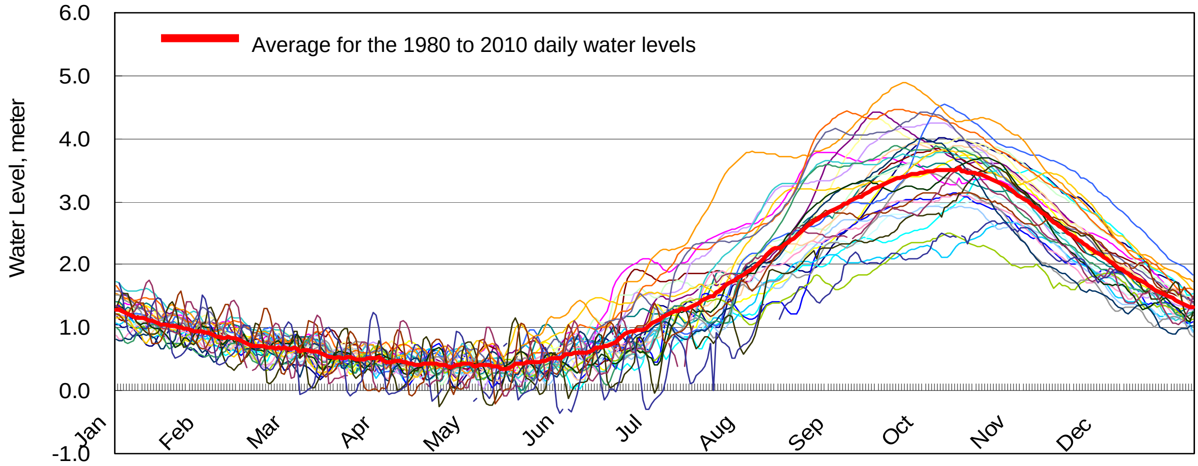


Figure 2.2.5 Daily Water Level Data Recorded at Chau Doc Station from 1980 to 2010

Source: Mekong River Commission

Note; Thick line shows the average of the water level from 1980 to 2010

Figure 2.2.6 shows the discharges for the both stations and Figure 2.2.7 shows the summated discharges for the 2 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.

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. As demonstrated in the hydrographs in Figure 2.2.7, 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.

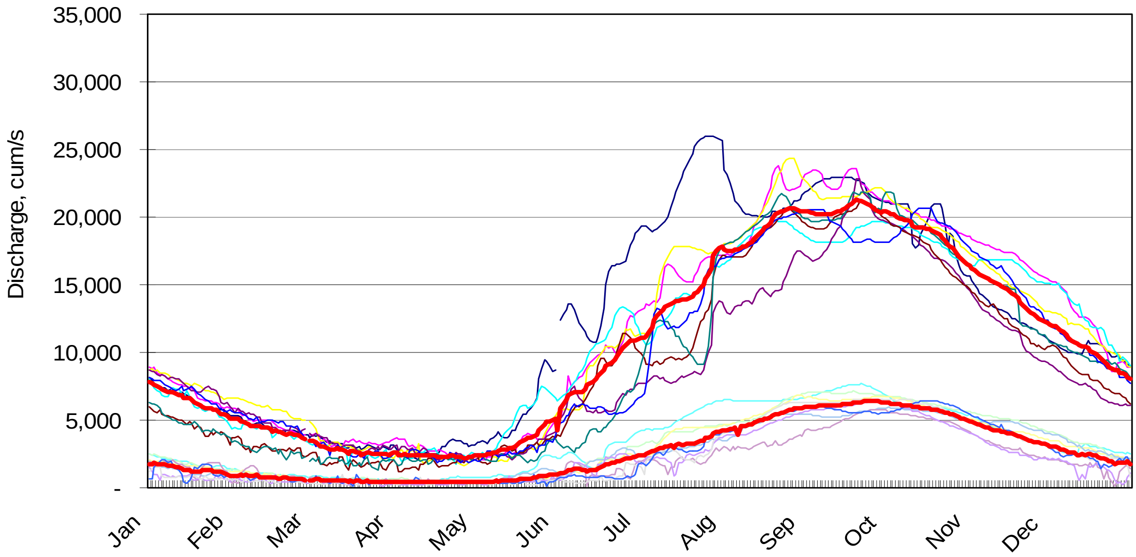


Figure 2.2.6 Daily Discharge at Tan Chau Station and Chau Doc Station

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 shows respective average discharge.

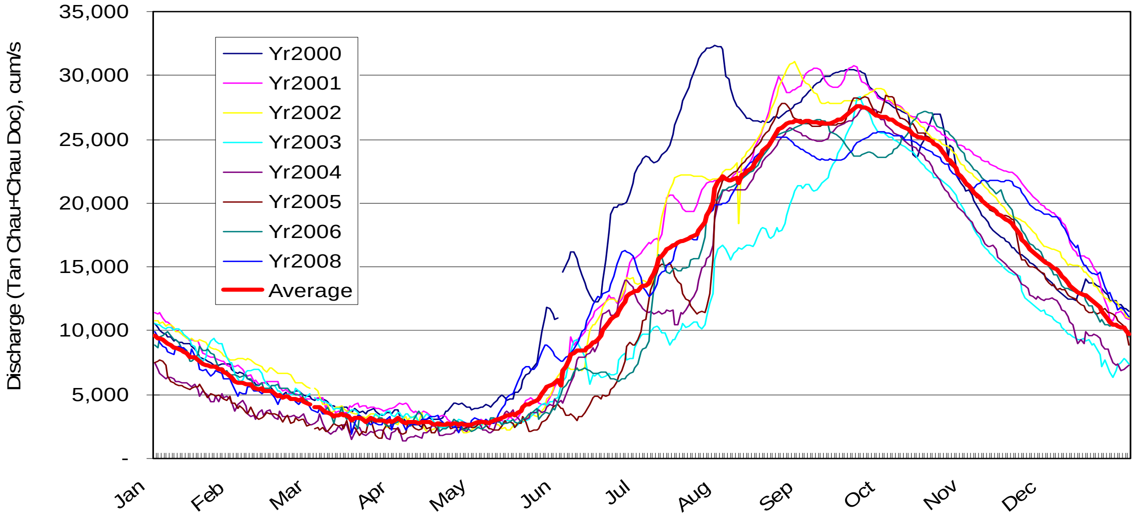


Figure 2.2.7 Summed Daily Discharge for Tan Chau and Chau Doc Stations

Source: Mekong River Commission, Note; Bold line show the average discharge.

2.2.2 Relevant Organizations in the Water Sector

1) Central Level

The primary responsibility for the broad planning and management of the water resources of Vietnam rests with the Ministry of Natural Resources and Environment since its creation in early 2003. The Ministry of Agriculture and Rural Development still retains some responsibilities for water management, although how the state management functions are shared is not clear at present. However, MARD maintains control of large scale, inter-provincial and multi-purpose water resources works.

Notwithstanding the key roles played by MONRE and MARD, a number of government agencies other than those ministries also have an influence in making decisions that affect the water sector. The following table shows the various ministries and other agencies at the central level having responsibilities in the water sector:

Table 2.2.1 Responsibilities of Key Agencies in the Water Sector

Responsibility	Ministry / Agency
State management of water resources	MONRE
Irrigation	MARD
Drainage	MARD
Flood protection	MARD
Rural and small towns water supply	MARD
Watershed management (forest land)	MARD
Land use management (agricultural land)	MARD
International coordination of water resource management	Mekong Basin: Vietnam National Mekong Committee, chaired by MARD, inter-ministry membership Red River Basin: No arrangements presently in place
Urban water supply and drainage	Ministry of Construction
Hydro-meteorological, surface, groundwater, water quality and other water resources data collection	MONRE (lead role) MARD
Water quality	MONRE (lead role), MARD, Ministry of Health and Others
Hydropower, operation of reservoirs	Ministry of Industry MARD (operation of major reservoirs during flood season)
Budget, planning, investment allocation and coordination of international assistance	Ministry of Finance Ministry of Planning and Investment
River channels and water transportation	Ministry of Transport
Drinking water standards and regulation	Ministry of Health

Source: Ministries mandate documents

2) Ministry of Agriculture and Rural Development

The organization and structure of Agricultural sector in general refers to the diagram below:

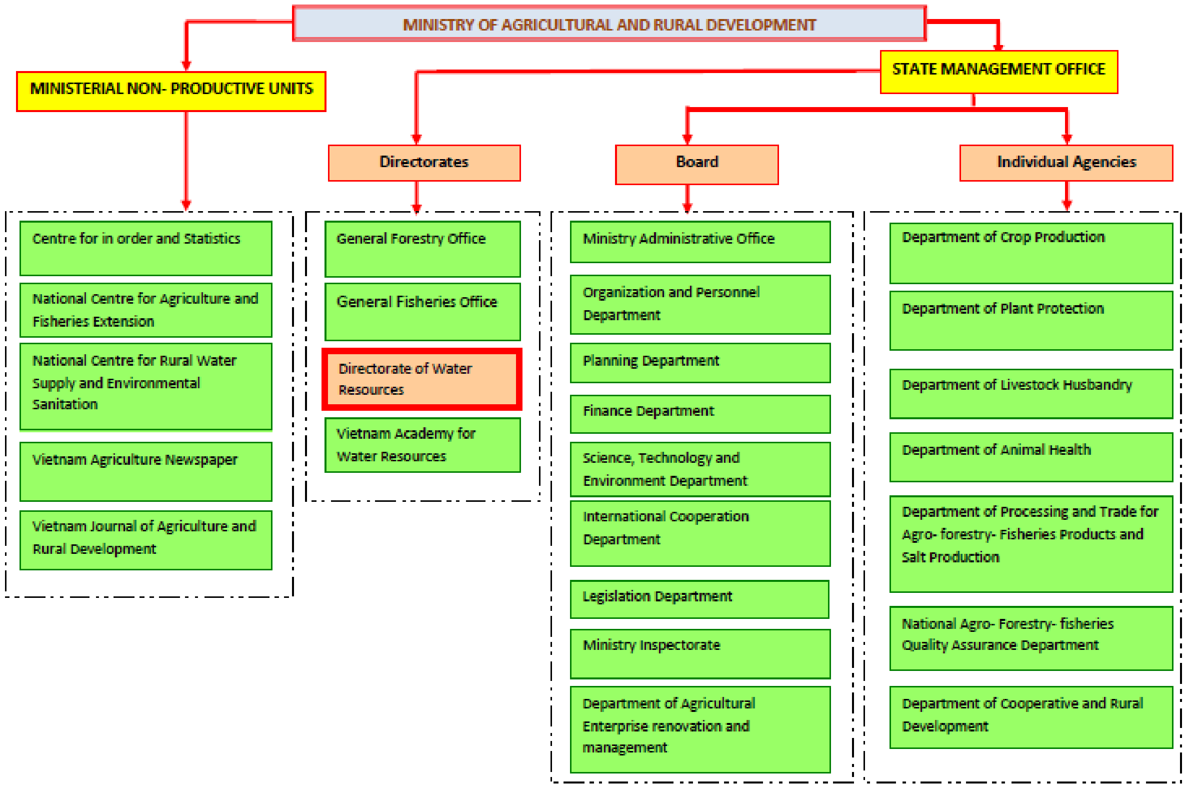


Figure 2.2.8 Organization chart of Ministry of Agriculture and Rural Development

This overall structure provides a very strong administrative mandate for provinces and districts which results in some concerns for water management in such areas where the hydrologic unit boundaries seldom coincide with the administrative boundaries. This feature is common to virtually all countries, however the rather rigid administrative structure mentioned above for Vietnam has traditionally made it difficult to introduce cross-provincial boundary water management arrangements.

Various laws, decrees, decisions and circulars issued over recent years have emphasized the importance and logic of the hydrologic unit for water resources management rather than administrative boundaries. However, it was not until the passage of the Law on Water Resources, which came into effect on 1 January 1999, for which

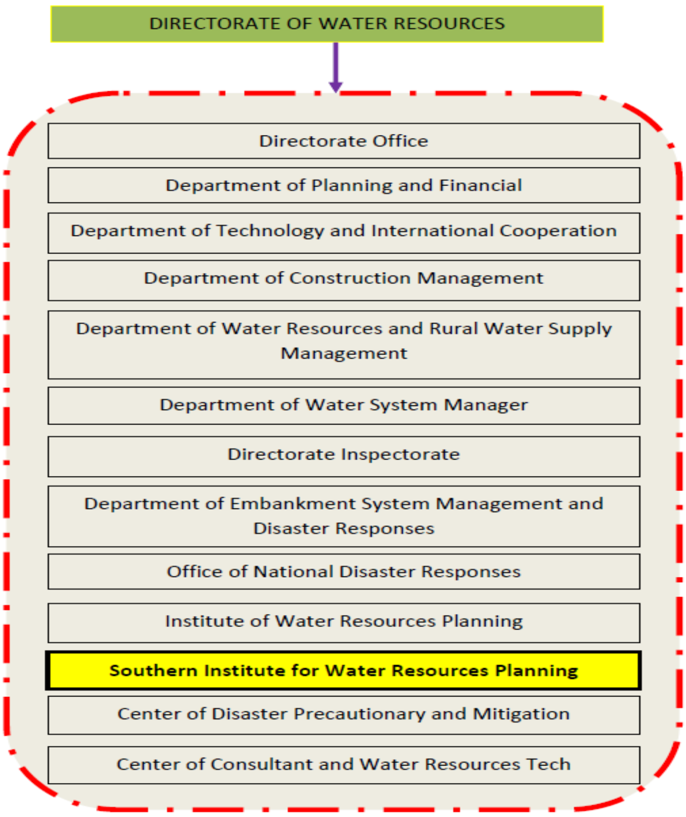


Figure 2.2.9 Organization Chart under the Directorate of Water Resources

the legal basis and structure was provided to enable this to occur.

In the MARD, Directorate of Water Resources is the main actor for water resources management. Figure 2.2.9 shows the organizations and the structure under the Directorate of Water Resources. Under the Directorate, Southern Institute for Water Resources Planning (SIWRP) has function of study and research of water resources planning, whose structure is shown in the following chart;

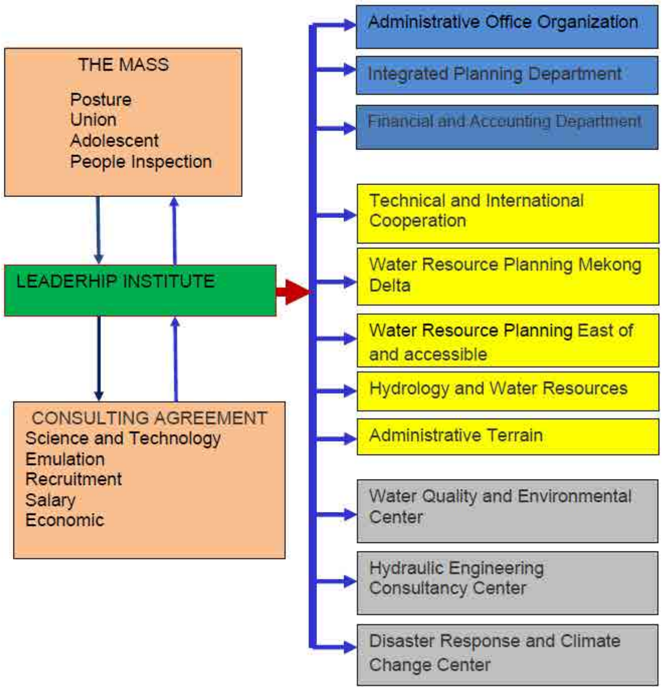


Figure 2.2.10 Organization chart of the Southern Institute for Water Resources Planning (SIWRP)

3) Provincial Level

Each province has a Provincial Department of Agriculture and Rural Development (DARD) which operates under provincial funding and administration but with technical links to MARD. Most DARDs supervise a number of autonomous enterprises that develop and manage water resources for the Provincial People's Committee (PPC). This comprises a very strong set of administrative and technical arrangements for water management at provincial level.

Much of the management responsibility for irrigation infrastructure has been transferred to Irrigation and Drainage Management Companies (IMCs)/ Water Resources Management Companies (WRMCs). It is estimated that over 65% of irrigation in Vietnam is now managed this way, and it is certainly the case for most of the irrigation infrastructure in the Mekong Delta. These companies are expected to run as autonomous self-financing enterprises in accordance with recent government decrees. However, they are still under the supervision of the PPC and are hardly self-financing.

The IMCs/WRMCs operate and maintain water distribution systems which include canals and gates down to the point at which water is delivered to a “district”. This interface with the farmers is called the “District Station” and it concentrates on managing contracts between the IMC/WRMC and the farmer cooperatives or commune level groups in regard to water supply. Irrigation and drainage activities at the commune level are overseen by the Commune People’s Committee. In effect, the necessary operations are undertaken by the commune irrigation team, or water user association (WUA), which receives water from the District Station, distributes it to farmers and acts as the interface with the District Station.

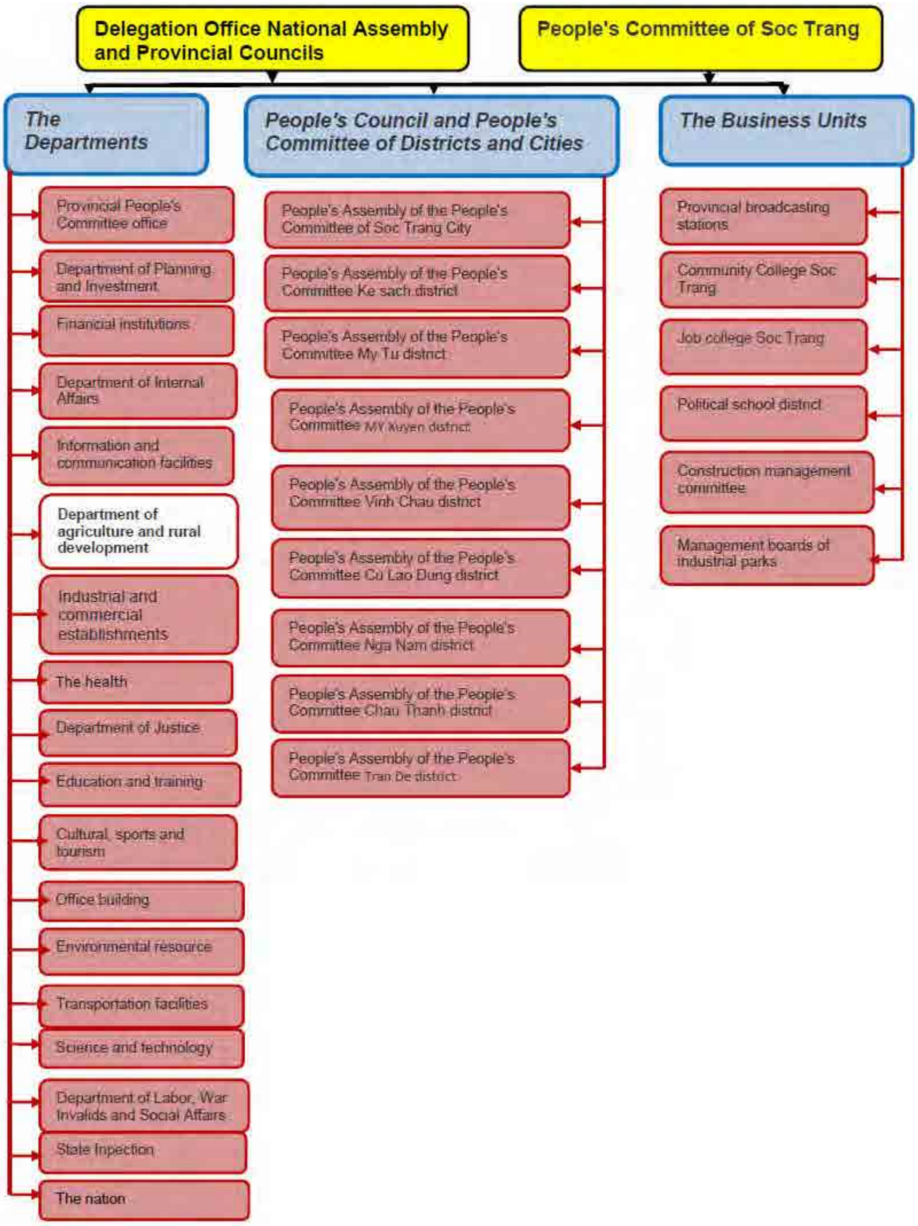


Figure 2.2.11 An example of Organization Chart of Province

4) Interagency Coordination

4.1) National Water Resources Council

The National Water Resources Council (NWRC) was established as a high-level advisory and coordination body under a Prime Minister's Regulation, dated 28 June 2001. This regulation specifies the functions, responsibilities and powers of the NWRC and its Office. Its Chairman is a Deputy Prime Minister. Representation on the Council includes all agencies with water management functions.

The Council's major purpose, by its legal mandate and membership, is to promote integrated water resource management through advice to Government on such things as policies and strategies, approval of river basin plans and major water resource development projects, advice regarding the resolution of water sector conflicts and international aspects of water resource development. It also provides a mechanism for improved coordination among the various ministries and other agencies that have responsibilities for aspects of water resource management in Vietnam.

The NWRC is at an early stage of operation and it is being supported by donor assistance from ADB and the governments of Australia and the Netherlands. It has identified a number of key issues to be addressed in the short term, including the development of a national water sector strategy for Vietnam to facilitate a more integrated and coordinated approach to water resource management across the entire sector.

4.2) Cuu Long River Basin Organization

Under the Law on Water Resources, all the river basins in Vietnam have become designated unit for water resource planning and management. These rover basin organizations have no authority or state management functions as specified by the Law on Water Resources. The Cuu Long River Basin Organization for Mekong Delta basin was formally established by Ministerial Decision in mid-2001. The RBO is composed of two parts, namely a Council and a supporting office or secretariat. All provinces in the river basin are represented on the council, together with high level officials from other ministries and agencies with water resources responsibilities.

4.3) Community, NGOs and Other Stakeholders Participation

In Vietnam hundreds of NGOs both nationally and internationally are operating. The involvement of the water sector is being addressed by a number of these NGO. Domestic NGOs are providing an active role in consultancy service for the water sector including participating in planning, appraisal and supervision of large scale projects. They also make advisory recommendations to facilitate the Government's decision making process.

Many NGOs are registered under the Fatherland Front or under an association of NGOs as research based organizations that also provide services within such areas as capacity building, social economic survey and environmental assessment. Some NGOs act as mass organizations that serve very useful functions in conducting urgent collective tasks such as dyke repair or mitigating flood damage. At provincial or lower level, activities of NGOs are also very useful in the collection of community concerns about water services and presentation of a picture of grass roots problems for higher level consideration and resolution.

International NGOs are also contributing support and assistance for the improvement and strengthening of the water sector services by providing grants for construction of small scale water works like pumping stations, small reservoirs for irrigation, improvements of sea dyke, irrigation canal system, water supply and mini hydro power projects. The efforts of these NGOs normally concentrate in mountainous areas or in areas of critical conditions like Northern and central mountainous and remote provinces, but not much in Mekong Delta area.

4.4) Private Sector Participation

Community in many parts of Vietnam, particularly in mountainous and remote areas have had self – investment and used their own labor for the construction of canals, management of small water structures for irrigation, drainage or electrical generation, embankments of small dams for flood regulation and fisheries. Some households, under assignment by the local authorities, operate water works in their locality. However, private sector participation in water resources management is very limited.

While the private sector is limit in size a tendency has become evident that it is growing and will ensure a much wider range of activity in different types of work in the future. This could include self management of small scheme hydraulic structures, provision of water delivery services and collecting water fee, rehabilitation of these works, provision of labor force and skilled workers to implement water works, supplying goods and accessories in water related sectors, provision of technological application and training services.

Small private organizations, consulting centers and private groups are emerging in many parts of the country especially at the central, provincial and municipal level. They provide various types of technical education and training services leading to application to water sector activities, for example computer application, languages training and identification of potential water works. At central and provincial level computer application, information technologies and application of water related software are in the main conducted by the private sector.

4.5) International Relations for Water Resource Management

The Mekong is the longest river in south-east Asia. It drains from high country in China and Myanmar, and enters into the lower basin at the common Myanmar – Laos – Thailand border. The so-called 'lower basin' covers some 600,000 sq.km and includes parts of four countries – Thailand, Laos, Cambodia and Vietnam. While the river carries huge volumes of water in the wet season, the flows in the dry season are such that the competing needs of water for all four countries could present both water quantity and quality problems in the future and could well be a limiting factor in development plans of all the countries.

The Mekong River Commission (MRC) was created in its present form with the signing of the historic 'Agreement on Cooperation for the Sustainable Development of the Mekong River Basin' in April 1995. Signatories are the Kingdoms of Cambodia and Thailand, the Lao People's Democratic Republic and the Socialist Republic of Vietnam. The MRC's principal role is to coordinate and promote 'cooperation in all fields of sustainable development, utilization, management and conservation of the water related resources of the Basin'. Three permanent bodies administer the MRC: 1) Ministerial Council responsible for policy development and decision-making; 2) Joint Committee responsible for implementing Council's policies and decisions; and 3) Secretariat responsible for providing technical advice and administrative services to the council and the Joint Committee.

Not covered by the agreement, but essential for effective MRC operations, is the four National Mekong Committees (NMC's) that coordinate MRC activities in each member country. The Vietnam National Mekong Committee (VNMC) was established and its role and functions were defined by a government decree in December 1995. The VNMC is the organization that connects internal water management issues in the Mekong Delta and Central Highlands with the initiatives within the MRC.

The VNMC's role is to bring the government's attention on a range of issues with the aim of soundly developing and protecting the water resources of the Mekong Basin, but particularly, within the Vietnam component of the basin. As Vietnam is the most downstream country in the lower basin, it depends largely on good water resources management being practiced by the other countries if resources of acceptable quantity and quality are to pass downstream into the provinces of the delta.

Accordingly, it is important that Vietnam take a strong role in the MRC arena to ensure equity and fairness in sharing the overall resources of the basin. At present the VNMC is chaired at minister level and reports directly to the Prime Minister. This has ensured that international water matters can be addressed quickly at the highest level.

2.3 Expected Climate Change based on Simulation Analysis

IMHEN under MONRE had carried out a climate change simulation in 2010 by using Global Climate Model (GCM) and published those simulation results in November 2010. The resolution of GCM was 250 x 250 km, and IMHEN further carried out climate change simulation by using PRECIS model. PRECIS model provides a high resolution climate change regional simulation. IMHEN undertook 3 climate change scenarios of A2, B1 and B2, and presents all the results in the published literatures e.g. Impact of Climate Change on Water Resources and Adaptation Measures.

IMHEN does not mention which scenario out of the A2, B1 and B2 should be applied in Vietnam, and this is because it is dependent upon which development pass the world should undergo, e.g. economic oriented development or environmental friendly oriented development and also pursuing globalization or otherwise localization. This issue cannot be pertinent to Vietnam only but to the whole world. Therefore, the IMHEN does not specify which scenario is the best for Vietnam, but very often the results of the B2 scenario have been referred to in many cases. This may be simply because the results of B2 fall somewhat in between the results of A2 and B2. Following are the summaries of the climate change prediction carried out by IMHEN as well as some simulation results under climate change:

2.3.1 Temperature

Figure 2.3.1 shows isolines of mean annual temperature rise at year 2050 under climate change 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.

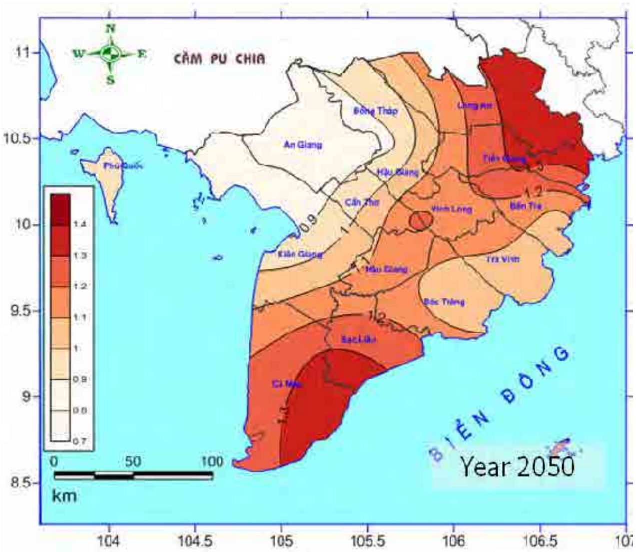


Figure 2.3.1 Mean Annul Temperature Rise at Year 2050 in Percentage under Scenario B2

Figure 2.3.2 to Figure 2.3.5 show change of mean annual temperature, mean annual maximum temperature, and mean annual minimum 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. As the figure shows, 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 °C in year 2050 for the 3 scenarios and by 1.4 °C to as much as 2.7 °C in year 2100 depending on the scenario.

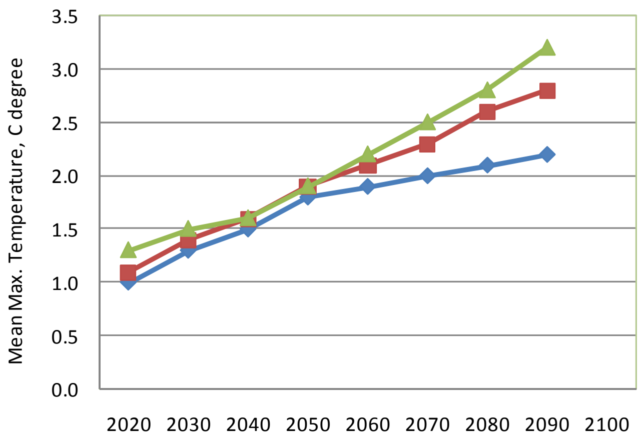


Figure 2.3.2 Mean Annul Max. Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS

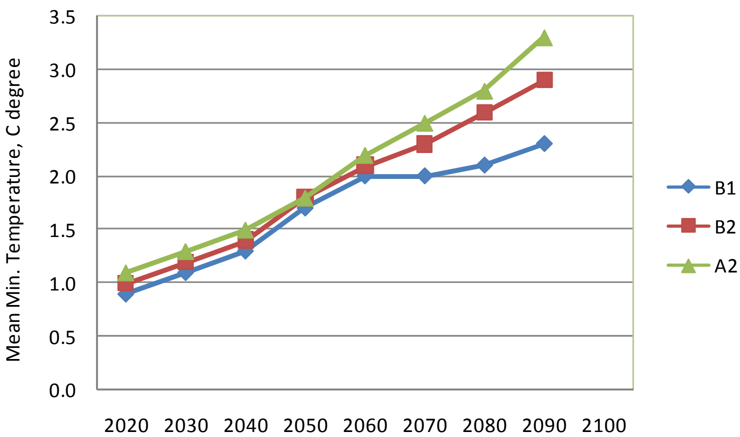


Figure 2.3.3 Mean Annul Min. Temperature Change in Mekong Delta with 3 Scenarios, Source; PRECIS

For the mean annual maximum temperature, the increase is more than that of mean annual temperature. It shows already more than 1 °C increase in year 2020 against the average temperature for the period of 1980 and 1999, nearly about 2 °C increase in 2050 and then 2.2 °C to 3.2 °C increase in 2090. The mean annual minimum temperature shows almost same trend of mean annual maximum temperature.

Figure 2.3.4 shows the mean annual temperature change for scenario B2. It shows almost linear increase trend toward 2100. The increase is about 0.8 ^{o}C to 1.4 ^{o}C by year 2050 and 1.6 ^{o}C to 2.6 ^{o}C by year 2100 depending on the place. Mean annual temperature under scenario A2, high greenhouse gas emission scenario, has exponential increase trend as shown in Figure 2.3.5. The increase by year 2050 reaches 0.9 ^{o}C to 1.4 ^{o}C and 2.1 to 3.3 by year 2100. Lowest increase shows up in Kien Giang while the highest increase is seen at Ca Mau, followed by Tien Giang, and Bac Lieu.

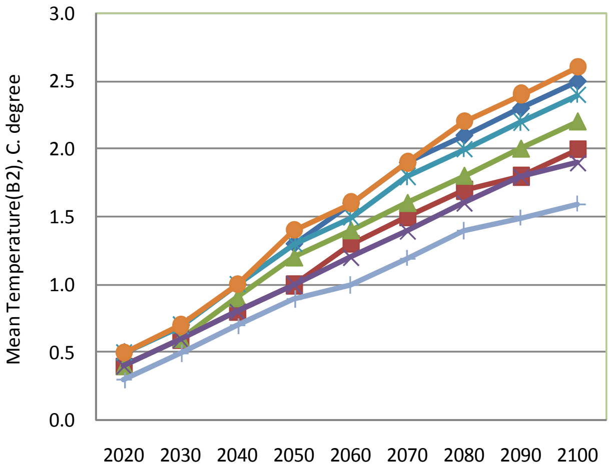


Figure 2.3.4 Mean Annul Temperature Change under Scenario B2 by Province, Source; PRECIS simulation

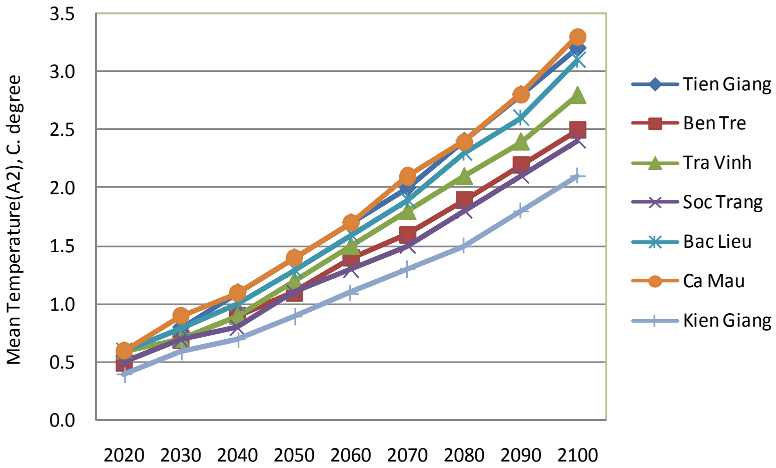


Figure 2.3.5 Mean Annul Temperature Change under Scenario A2 by Province, Source; PRECIS simulation

Figure 2.3.6 to Figure 2.3.8 show monthly temperature change for Mekong Delta under scenario B1, B2 and A2 by year. Temperature tends to increase more during rainy season than dry season. In the rainy season, at year 2050 expected temperature increase is to be about 1.2 ^{o}C, 1.3 ^{o}C and 1.4 ^{o}C for the scenarios B1, B2 and A2. At year 2100, the increase will be about 1.6 ^{o}C, 2.5 ^{o}C, and 3.2 ^{o}C respectively. One thing unique tendency is that there is a drop during the rainy season temperature increase, which shows up in August.

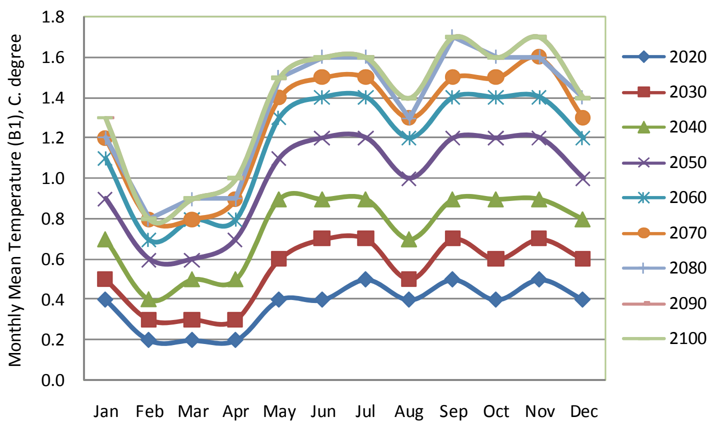


Figure 2.3.6 Mean Monthly Temperature Change in Mekong Delta under B1, Source; PRECIS simulation

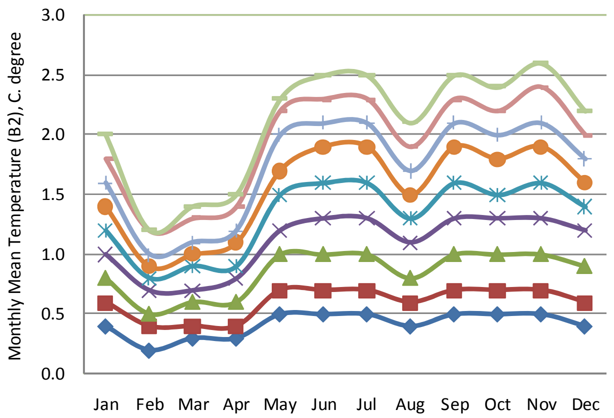


Figure 2.3.7 Mean Monthly Temperature Change in Mekong Delta under B2, Source; PRECIS simulation

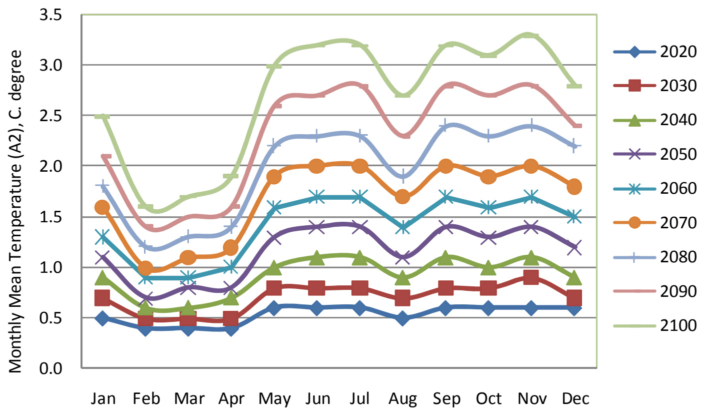


Figure 2.3.8 Mean Monthly Temperature Change in Mekong Delta under A2, Source; PRECIS simulation

During dry season, temperature increase is not much especially between February and April. The increase at year 2050 is about 0.6 ^{o}C, 0.7 ^{o}C, 0.8 ^{o}C for the scenario B1, B2 and A2 respectively. At year 2100, the increase becomes more as about 0.9 °C, 1.4 °C, and 1.7 °C for the scenario B1, B2, and A2 respectively. Trend of increase ratio by year is somewhat different by scenario as; less increase ratio toward 2100 for the scenario B1, even increase ratio toward 2100 for the scenario B2 and greater increase ratio toward 2100 for the scenario A2.

2.3.2 Rainfall

Figure 2.3.9 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.

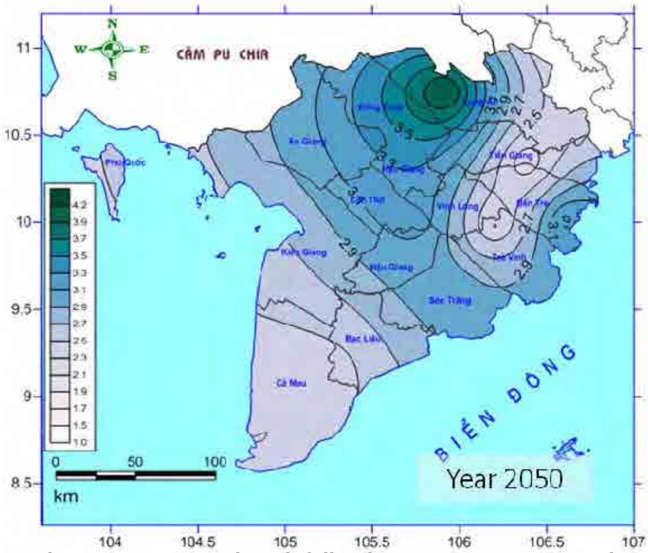


Figure 2.3.9 Annul Rainfall Change at Year 2050 in Percentage under Scenario B2

Figure 2.3.10 shows the simulated overall annual rainfall change of Mekong against the average rainfall between 1980 and 1999 under 3 Scenarios of B1, B2 and A2. The rainfall is predicted to increase for all the 3 scenarios with a general trend that the higher green gas emission the scenario is the more the rainfall takes place and vice versa. Scenario A2 shows the highest rainfall increase as about 3% at year 2050 and over 7% at the 2100. For the B1 scenario, low green gas emission scenario, the increase trend is smaller than the others and the increase ratio after 2070 is very little.

Figure 2.3.11 to Figure 2.3.13 show the annual rainfall change by province under scenario B1 (top), scenario B2 (down left) and scenario A2 (down right). Overall trend of the increase is of course similar to those of increases indicated in Figure 2.3.11. The highest rainfall increase can be seen in Ben Tre, followed by Soc Trang, Bac Lieu and Kien Giang while the lowest increase shows up in Tien Giang. Difference between the provinces comes to about 1 % only at year 2050 and it becomes about 1.5 %, 2.0 % and 3.0% for the scenarios of B1, B2 and A2.

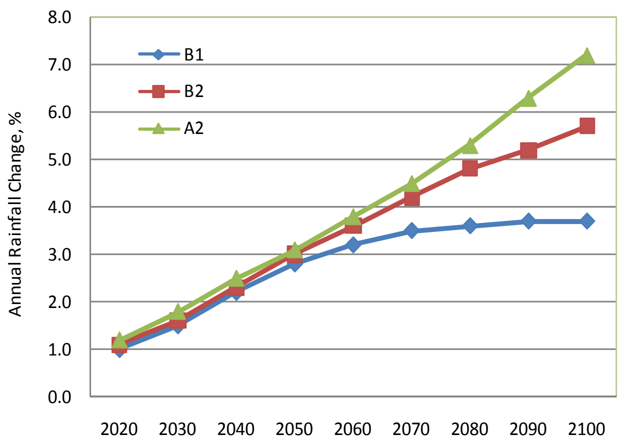


Figure 2.3.10 Annual Rainfall Change in Mekong Delta under 3 scenarios, Source; PRECIS simulation

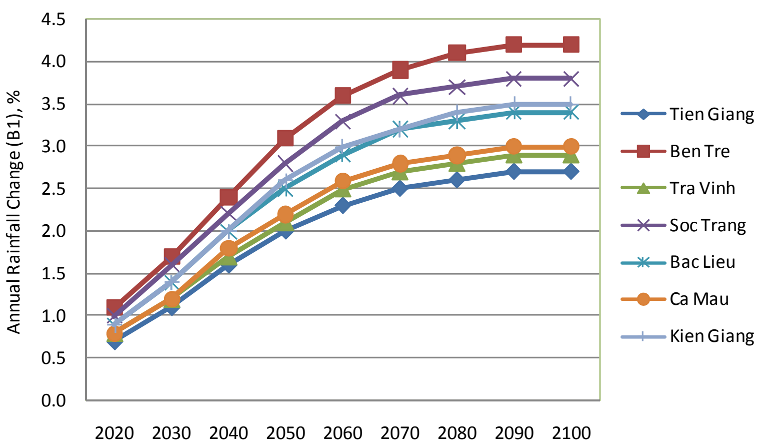


Figure 2.3.11 Annual Rainfall Change by Province under Scenario B1, Source; PRECIS simulation

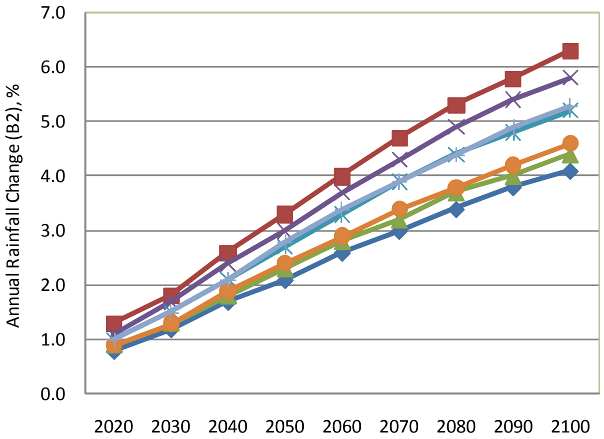


Figure 2.3.12 Annual Rainfall Change by Province under Scenario B2, Source; PRECIS simulation

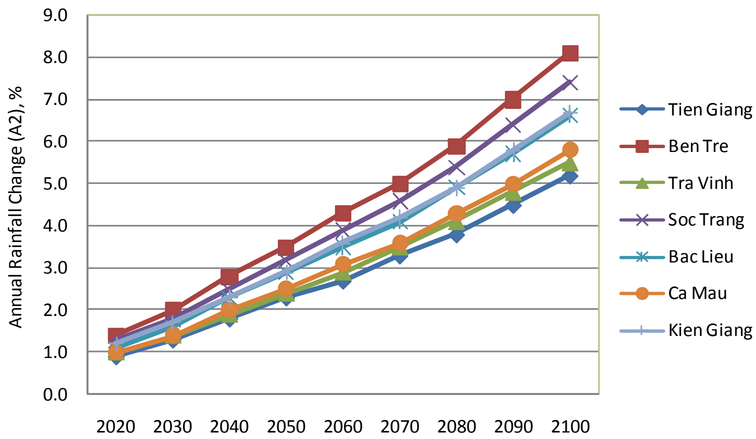


Figure 2.3.13 Annual Rainfall Change by Province under Scenario A2, Source; PRECIS simulation

Figure 2.3.14 to Figure 2.3.16 show monthly rainfall change for the 3 scenarios of B1, B2 and A2 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 20%, 30% and nearly about 40% at year 2100 for the scenarios of B1, B2 and A2 respectively.

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 15%, more than 20% and more than 30% at year 2100 for the 3 scenarios respectively. It can be said in future, it is projected that the rainfall tends to increase especially at the end of rainy season.

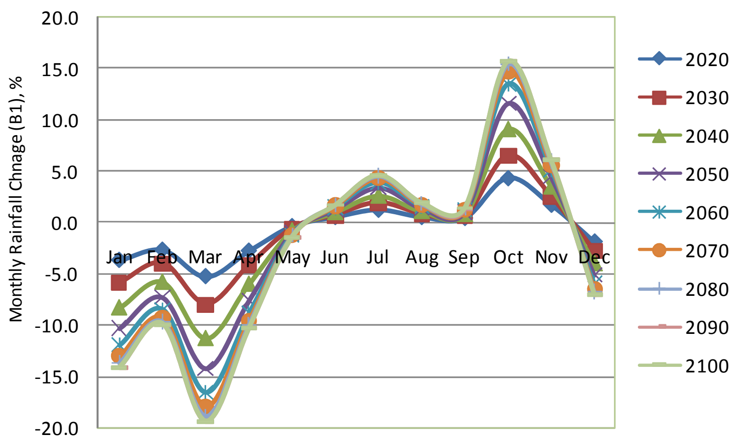


Figure 2.3.14 Monthly Rainfall Change in Mekong Delta under Scenario B1, Source; PRECIS simulation

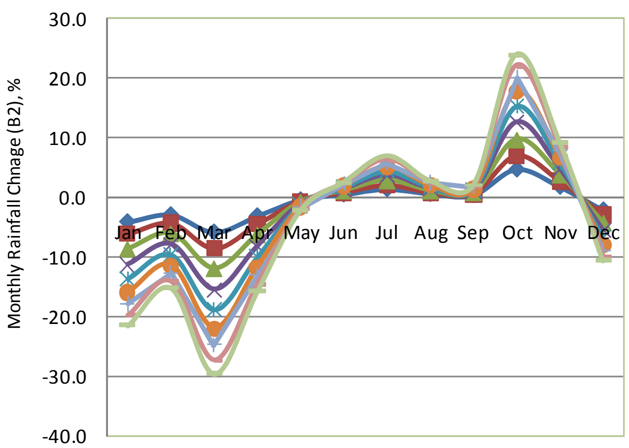


Figure 2.3.15 Monthly Rainfall Change in Mekong Delta under Scenario B2, Source; PRECIS simulation

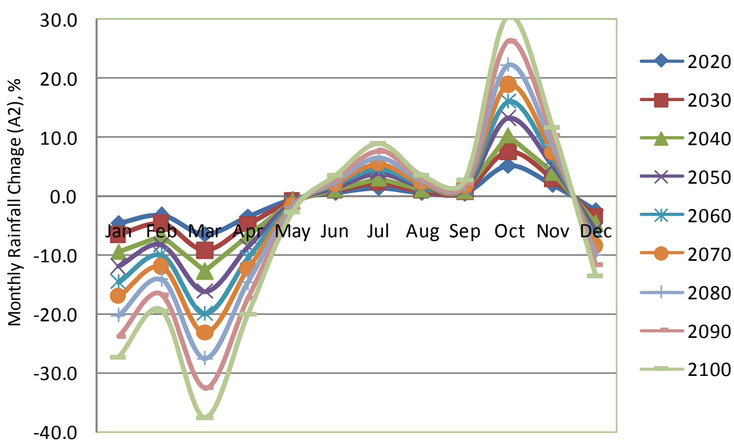


Figure 2.3.16 Monthly Rainfall Change in Mekong Delta under Scenario A2, Source; PRECIS simulation

2.3.3 Sea Level Rise

Figure 2.3.17 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 seas 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 2.3.18 to Figure 2.3.20 show sea level rise by province for the 3 scenarios respectively. Sea level rise by province does not differ much and the difference between provinces is 5 cm even at the year 2100.

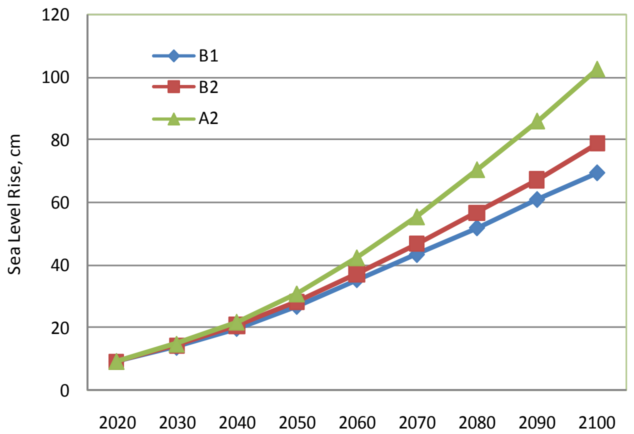


Figure 2.3.17 Sea Level Rise of Mekong Coastal Area under 3 Scenarios, Source; PRECIS simulation

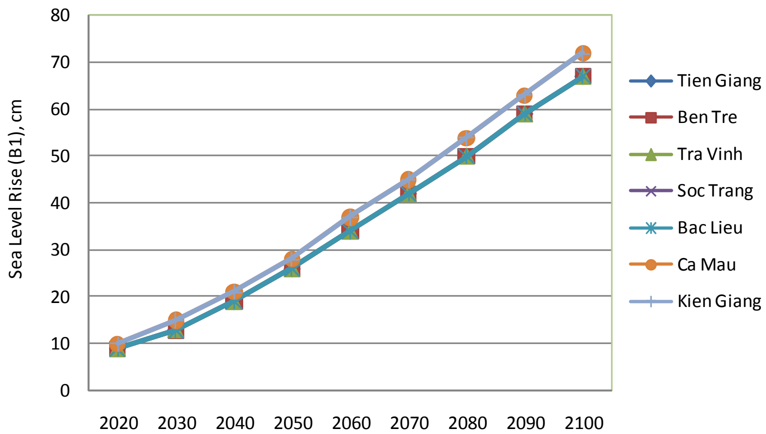


Figure 2.3.18 Sea Level Rise by Province Under Scenario B1, Source; PRECIS simulation

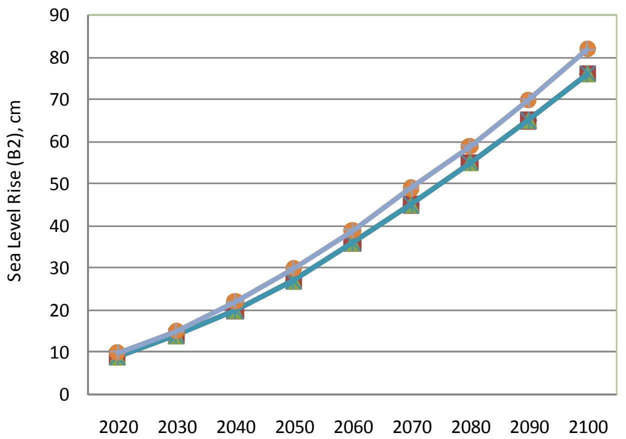


Figure 2.3.19 Sea Level Rise by Province Under Scenario B2, Source; PRECIS simulation

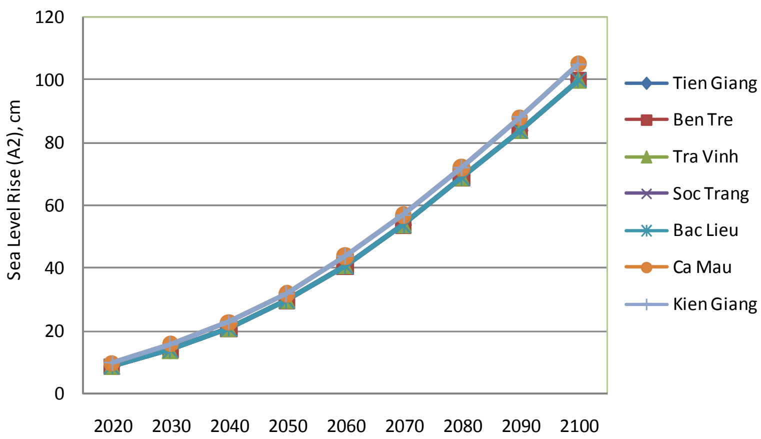


Figure 2.3.20 Sea Level Rise by Province Under Scenario A2, Source; PRECIS simulation

2.3.4 Mekong River Flow Regime Prediction (MRC)

Mekong River Commission (MRC) has carried out simulation on the future Mekong River discharge under climate change Scenarios of B2 and A1. Besides, the Commission carried out additional simulation taking into account various number of basin development projects in estimating the future Mekong discharge. Table 2.3.1 with Figures 2.3.21 to 2.3.24 summarize the monthly average discharges at Kratie station by every 10 years till 2050 under scenarios B2 and A1, and those ones considering water resources development projects till 2020 and also till 2050 in comparison with discharges of year 1998 (driest year), average of 1985 – 2000, and average of 1991 – 2000. From those table and figures, following are expected;

1) With respect to dry season as shown in Figure 2.3.23, discharge not considering future water resources development projects becomes bigger from the beginning till the direst season (end of

March) than the average discharge between 1991 and 2000. Then, the simulated discharges tend to be almost same as the average discharge of 1991 - 2000. Looking at the rainy season discharge not considering the development projects as shown in Figure 2.3.22, the simulated discharges do not show clear tendency of being bigger or being less than the 1991 – 2000 average discharge till the peak period of mid-September. However, after having reached the peak in around mid-September, simulated discharges tend to surpass the average discharge.

2) With respect to the future discharge considering the water resource development projects in the catchment, the dry season’s discharge shows very much increase trend. As illustrated in Figure 2.3.21, the simulated discharge during the driest periods of March and April comes to about 4,000 m^3/s while the average discharge between 1991 and 2000 is only 2,300 – 2,400 m^3/s. This implies that there might be a possibility that should the future development in the catchment be realize as planned, the dry season discharge after Kratie station could increase by as much as 70% (from around 2,350 to 4,000 m^3/s). The reason why it increases so much is the effect of hydropower dams which releases much amount of stored water during dry season for power generation.

3) For the rainy season discharge considering the planned development projects in the catchment shown in Figure 2.3.24, the simulated ones tend to be smaller than the average discharge from 1991 to 2000 during the course of ascending towards the peak, and then sometime after the peak period of mid-September, the discharges are revered, i.e., simulated ones now tend to be bigger than the average. This most probably means that hydropower dams considered in the simulation work to store the rainy season Mekong River discharge while ascending the hydro-curve, and once it has reached the peak, the dams start discharging the stored water for generating power.

4) On the Scenarios A1 and B2, there is not much difference between the two simulation results. In some years, discharge simulated under Scenario A1 may be bigger than that of Scenario B2 while vice versa takes place in other years. Note that simulated discharges in October tend to sharply increase in all the Scenarios A1, B2, and those cases considering planned water resources development projects in the catchment. This tendency seems to correspond to the increase of rainfall at the end of rainy season, October (refer to Figures 2.3.14 – 2.3.16).

Table 2.3.1 Monthly Average Discharges at Kratie Simulated under Different Scenarios

Month	Past Record (average)			Scenario B2 (average)				Scenario A2 (average)			
	1998	1985-2000	1991-2000	2011-2020	2021-2030	2031-2040	2041-2050	2011-2020	2021-2030	2031-2040	2041-2050
Jan	3,724	3,793	4,077	4,398	4,858	5,627	4,702	4,556	5,268	5,364	5,064
Feb	3,140	2,694	2,943	2,994	3,377	3,700	3,144	3,039	3,445	3,837	3,500
Mar	2,236	2,161	2,337	2,343	2,417	2,751	2,301	2,350	2,610	2,828	2,574
Apr	2,560	2,189	2,420	1,848	2,304	2,662	2,143	2,233	2,299	2,432	2,594
May	3,057	3,988	4,303	3,399	6,976	4,996	3,459	3,897	5,707	3,151	5,450
Jun	6,286	11,472	11,602	11,360	10,931	10,788	9,803	12,161	14,330	10,526	13,791
Jul	17,040	21,222	23,418	22,297	21,245	21,097	16,571	17,681	22,251	23,923	24,983
Aug	23,472	31,173	33,138	30,760	27,829	34,238	29,045	31,101	29,557	37,908	32,662
Sep	31,178	32,587	35,236	30,994	37,302	40,168	33,430	30,134	34,934	39,331	39,117
Oct	17,946	21,851	22,296	23,942	25,013	27,121	25,180	26,081	24,822	27,586	25,435
Nov	11,585	11,927	12,209	13,986	13,892	16,983	14,111	13,984	14,282	15,726	14,840
Dec	7,569	6,471	6,784	7,595	8,461	9,500	7,792	8,059	8,490	9,080	8,428

Month	Past Record			Basin Development 2020, B2				Basin Development 2050, B2			
	1998	1985-2000	1991-2000	2011-2020	2021-2030	2031-2040	2041-2050	2011-2020	2021-2030	2031-2040	2041-2050
Jan	3,724	3,793	4,077	4,695	4,800	5,212	4,767	4,658	4,762	5,150	4,745
Feb	3,140	2,694	2,943	3,795	4,086	4,036	3,878	3,806	4,085	4,048	3,887
Mar	2,236	2,161	2,337	3,499	3,618	3,697	3,499	3,592	3,730	3,835	3,634
Apr	2,560	2,189	2,420	3,541	3,891	3,926	3,727	3,638	3,936	4,011	3,803
May	3,057	3,988	4,303	4,597	7,647	6,224	4,957	4,637	7,460	5,976	5,017
Jun	6,286	11,472	11,602	10,754	11,587	10,713	9,704	10,293	11,215	10,272	9,141
Jul	17,040	21,222	23,418	19,857	19,161	18,864	14,829	19,028	18,201	18,153	14,118
Aug	23,472	31,173	33,138	27,870	24,994	31,156	25,789	26,956	24,225	30,233	24,776
Sep	31,178	32,587	35,236	28,498	34,781	38,305	30,582	27,693	33,932	37,443	29,450
Oct	17,946	21,851	22,296	22,400	22,783	25,870	23,279	21,780	22,112	25,328	22,720
Nov	11,585	11,927	12,209	12,827	12,570	16,135	13,025	12,688	12,270	15,830	12,853
Dec	7,569	6,471	6,784	7,023	7,767	8,614	7,119	6,884	7,538	8,286	6,921

Source: Mekong River Commission

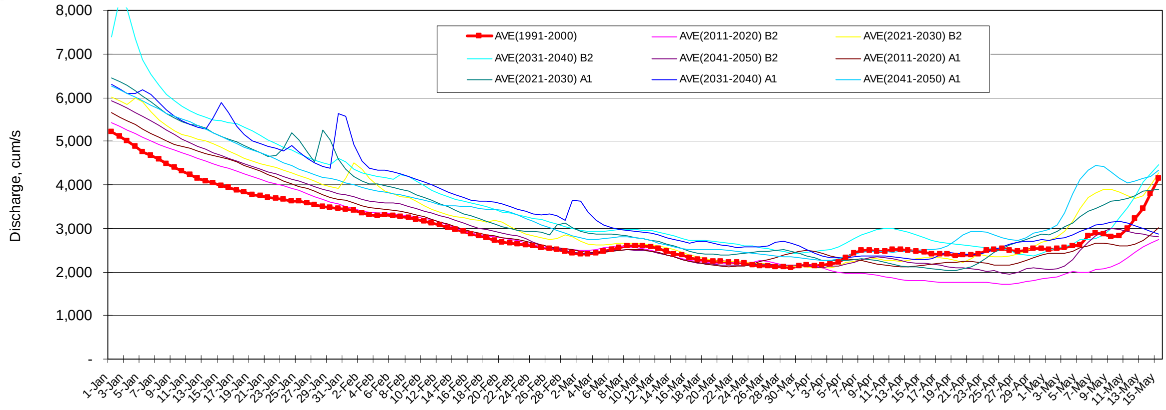


Figure 2.3.21 Mekong River Discharge at Kratie during Dry Season (A1 and B2)

Source: Mekong River Commission

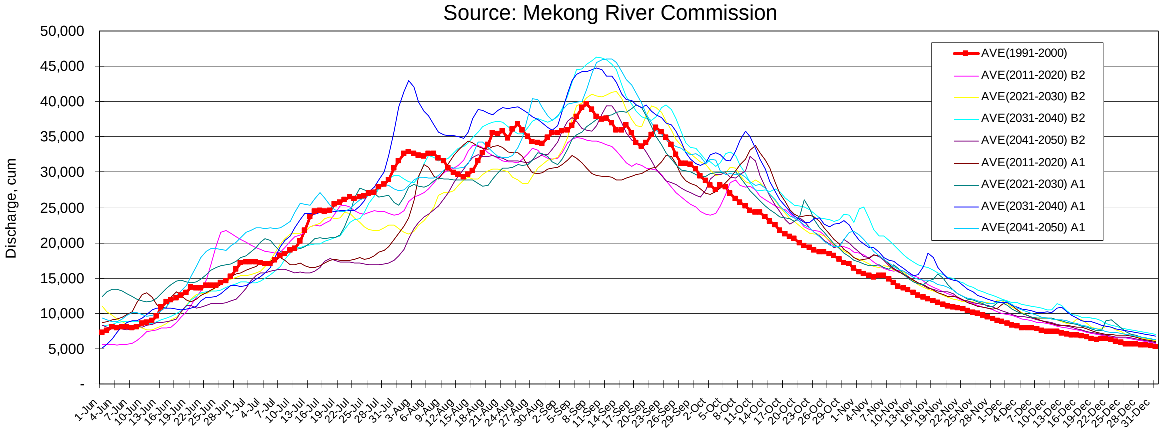


Figure 2.3.22 Mekong River Discharge at Kratie during Rainy Season (A1 and B2)

Source: Mekong River Commission

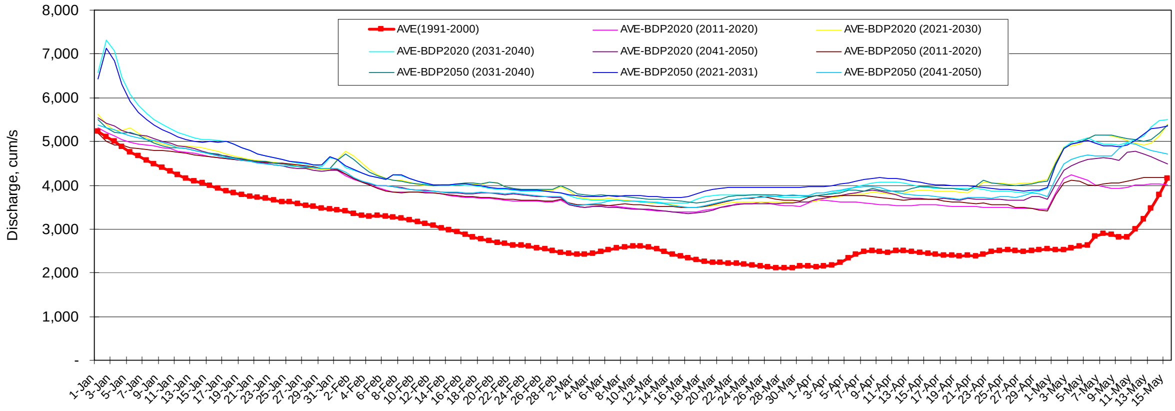


Figure 2.3.23 Mekong River Discharge at Kratie during Dry Season with Basin Development Projects

Source: Mekong River Commission

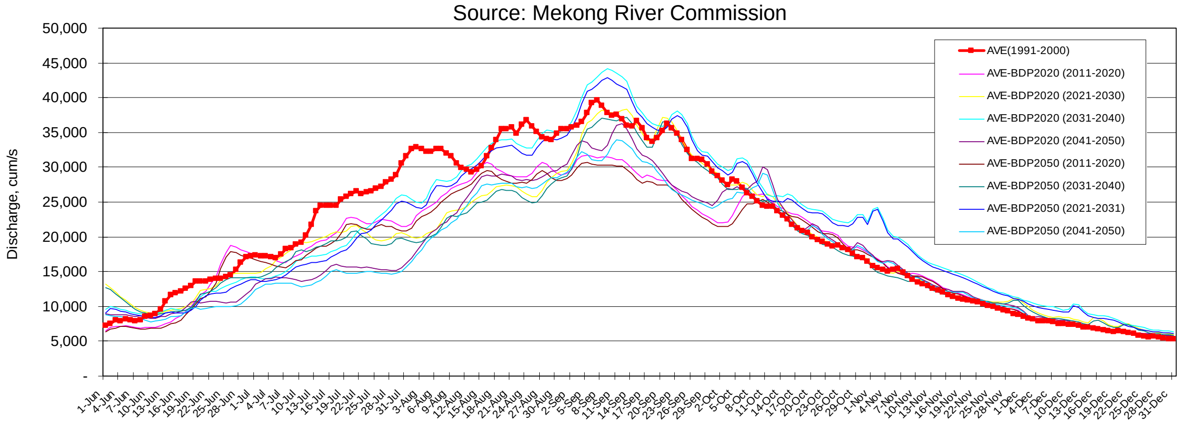


Figure 2.3.24 Mekong River Discharge at Kratie during Rainy Season with Basin Development Projects

Source: Mekong River Commission

2.4 Expected Impact by and Adaptation to Climate Change

Climate change prediction in future was summarized in the previous sections, and this sub-section summarizes expected impacts to be caused by future climate change taking into account sea level rises, Mekong River future discharge, etc. Sanding impacts are to show up on such crops as paddy, fruit, vegetables, etc. under saline intrusion coupled with sea level rise. Also, sea level rise works in the direction of increasing flood damage.

2.4.1 Impact on Crop Production by Saline Intrusion under CC

Saline intrusion simulation was carried out for; 1) cases with the driest year's Mekong River discharge (1998), and 2) cases with projected discharges by MRC including 1991-2000 average discharge. Sea level rises have also been taken into account, e.g., 12 cm, 17 cm, 30 cm, 50 cm and 100 cm corresponding to relevant years and different climate change scenarios.

1) Damage Indexes under Saline Intrusion

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. Table 2.4.1 summarizes the relationships taken into the assessment of damage loss under saline intrusion.

Table 2.4.1 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: Ayers & Wescot (1989), FAO, modified by JICA Study Team

2) Yield Loss and Damages by Saline Intrusion

Figure 2.4.1 to Figure 2.4.4 show 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. These figures indicate;

- ✓ Most of the coastal areas are affected by large extent of saline intrusion except for Kien Giang province where there are already many saline prevention sluice gates in operation.
- ✓ The province most affected is Ca Mau as expected, excluding a small area located in western-mid area where paddy fields are well protected by saline prevention sluice gates.
- ✓ Looking at the figures by month, it is obvious that the salinity level hits the peak in April, and with the onset of rainfall from May, it starts descending.

Figure 2.4.5 and Figure 2.4.6 show the change in production/area in terms of percentage by province. Likewise, Figure 2.4.7 and Figure 2.4.8 indicate the change (damage) in terms of monetary value by province. As shown in these figures, 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.

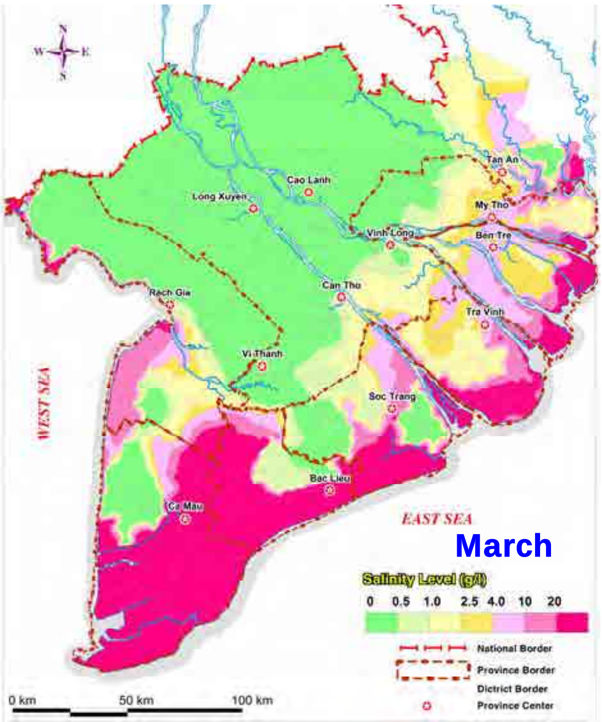


Figure 2.4.1 Salinity Isolines of March for DY 1998 MR Discharge with 30 cm SLR (2050)

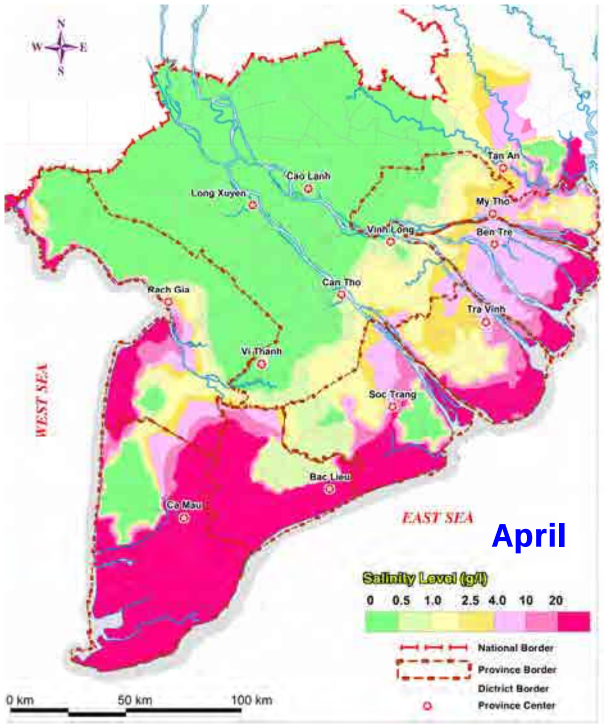


Figure 2.4.2 Salinity Isolines of April for DY 1998 MR Discharge with 30 cm SLR (2050)

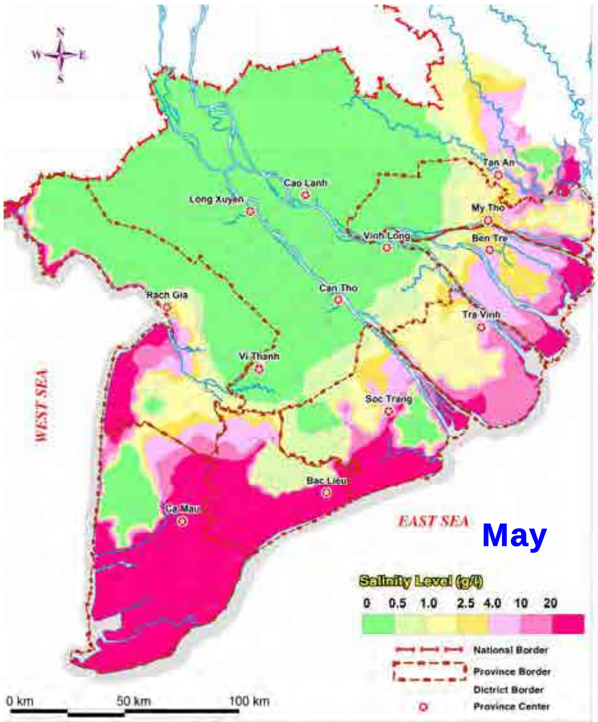


Figure 2.4.3 Salinity Isolines of May for DY 1998 MR Discharge with 30 cm SLR (2050)

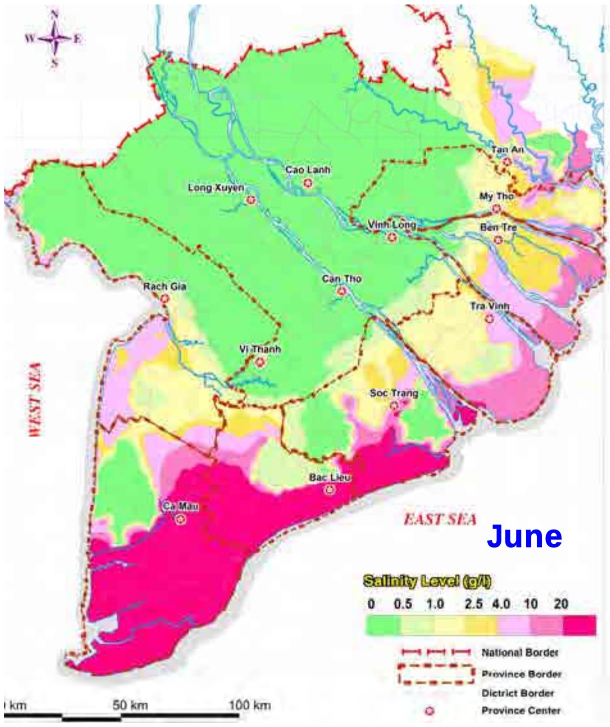


Figure 2.4.4 Salinity Isolines of June for DY 1998 MR Discharge with 30 cm SLR (2050)

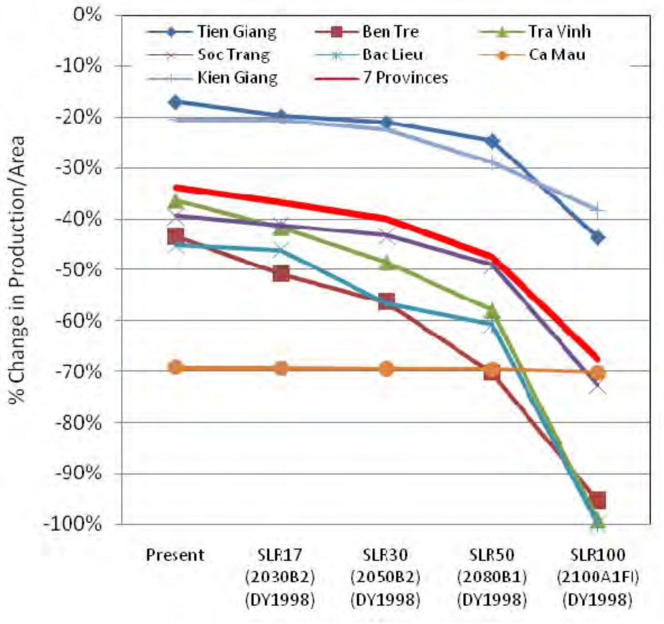


Figure 2.4.5 Production Loss(%) by Province

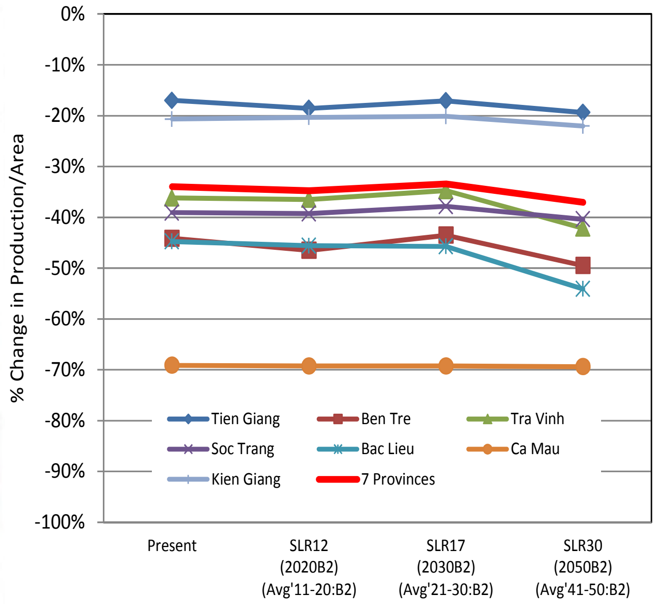


Figure 2.4.6 Production Loss(%) by Province

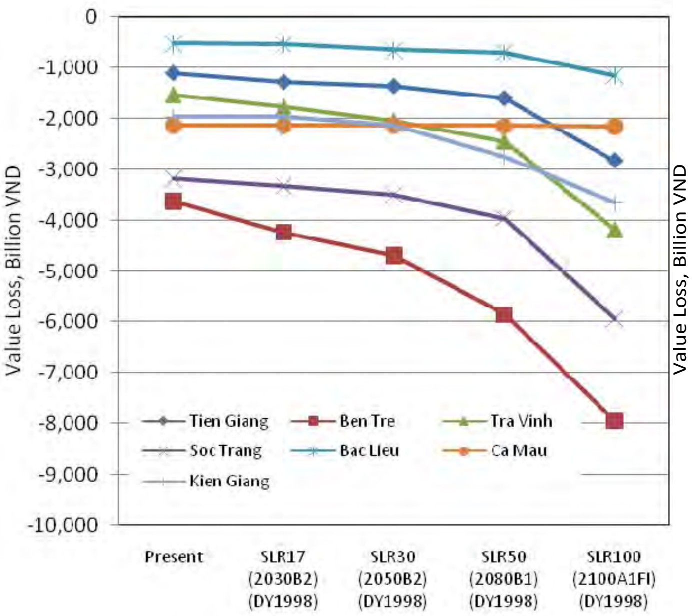


Figure 2.4.7 Production Loss(VND) by Province

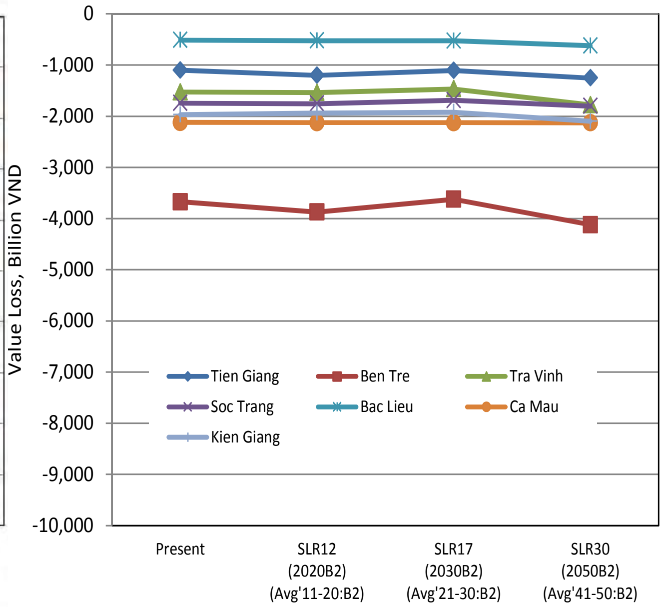


Figure 2.4.8 Production Loss(VND) by Province

2.4.2 Impact on Crop Production by Flood under CC

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 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 flood. Table 2.4.2 shows the damage indexes in percentage corresponding to inundation depth;

Table 2.4.2 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: IAS, SIWRP, and interview by the Study Team

2) Yield Loss and Damages by Flood Inundation

Figure 2.4.9 to Figure 2.4.12 show the isolines of flood inundation by month 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 figures indicate;

1) 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 provinces. 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 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) Looking at the figures by month, it may be said that the inundation hits the peak in September in upstream provinces such as An Giang and Dong Thap provinces while in the coastal provinces the peak is a bit delayed, showing up in October. 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 2.4.13 and Figure 2.4.14 show the change in production/area in terms of percentage by province. Likewise, Figure 2.4.15 and Figure 2.4.6 indicate the change (damage) in terms of monetary value by province. As shown, 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.

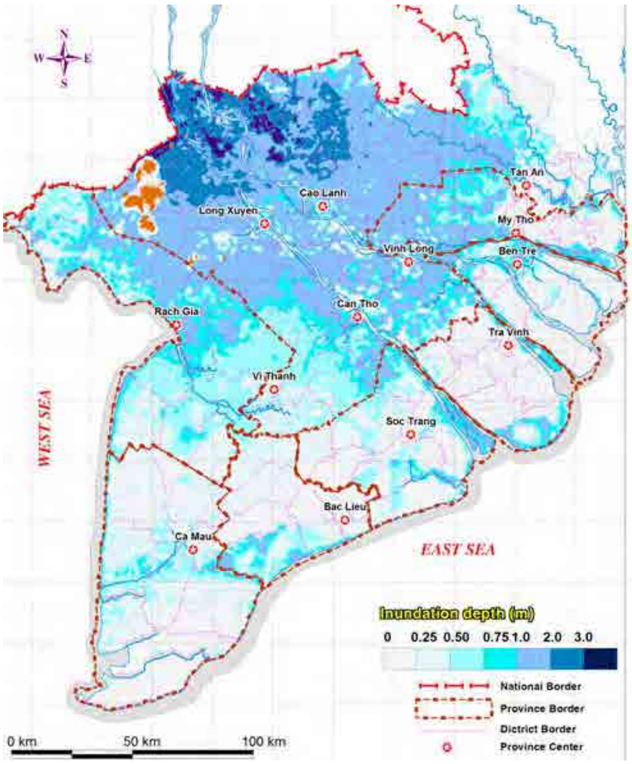


Figure 2.4.9 Flood Isolines of August for FY2000 MR Discharge with 30 cm SLR (2050)

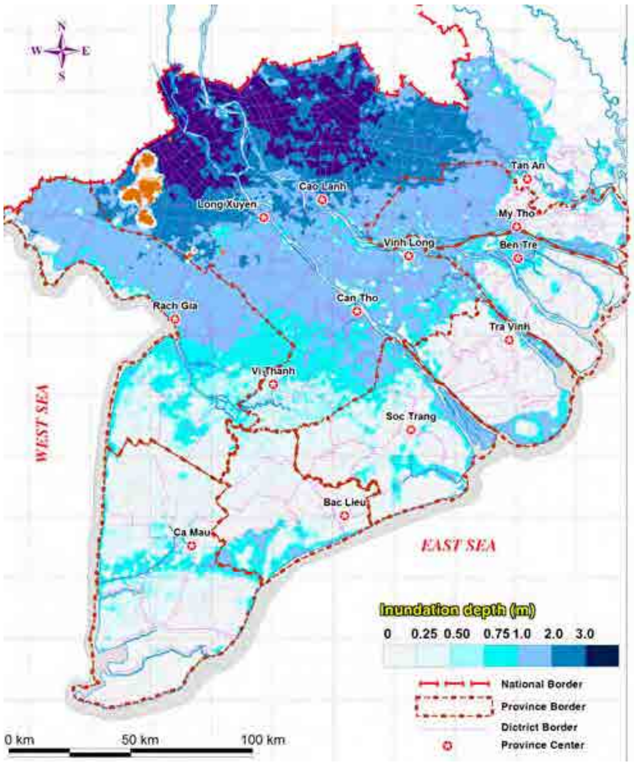


Figure 2.4.10 Flood Isolines of September for FY2000 MR Discharge with 30 cm SLR (2050)

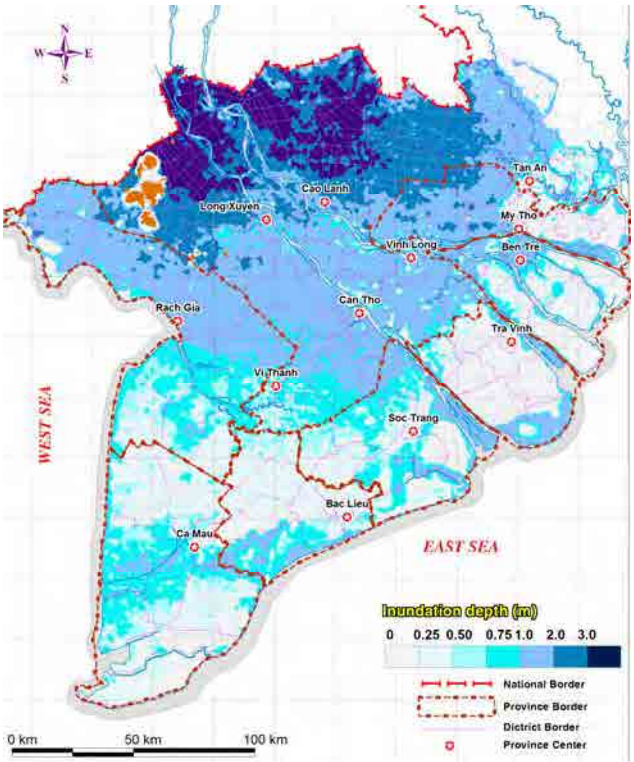


Figure 2.4.11 Flood Isolines of October for FY2000 MR Discharge with 30 cm SLR (2050)

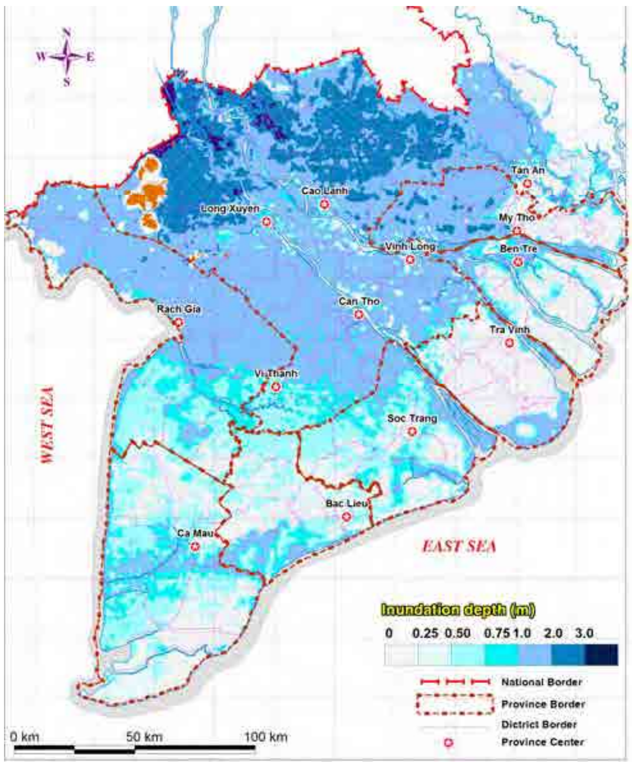


Figure 2.4.12 Flood Isolines of November for FY2000 MR Discharge with 30 cm SLR (2050)

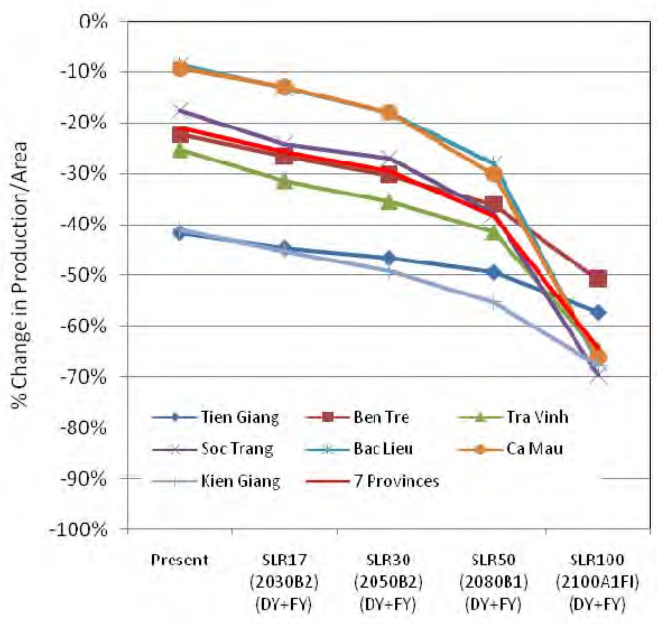


Figure 2.4.13 Annual Production Loss(%) by Province

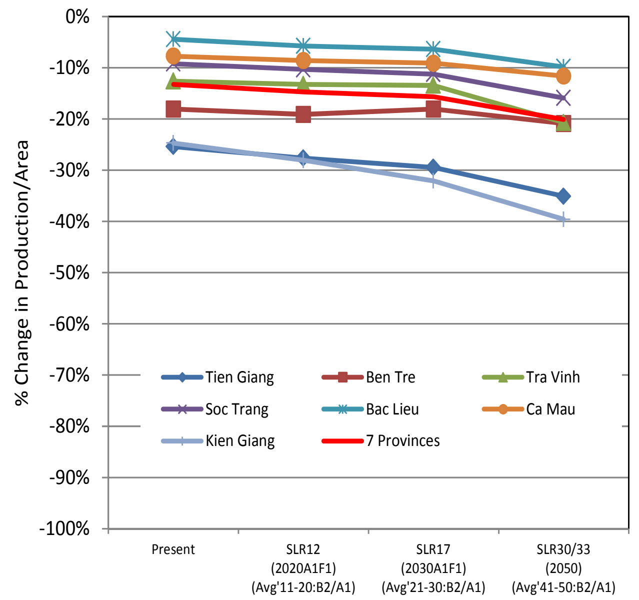


Figure 2.4.14 Annual Production Loss(%) by Province

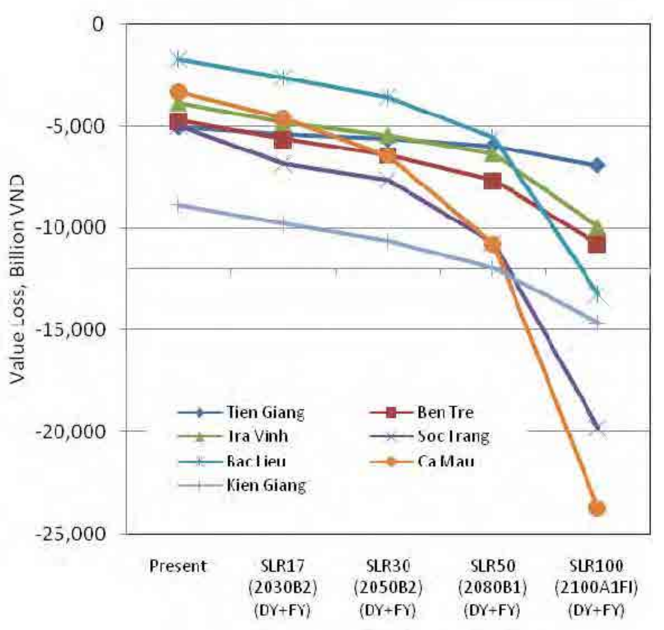


Figure 2.4.15 Annual Production Loss(VND) by Province

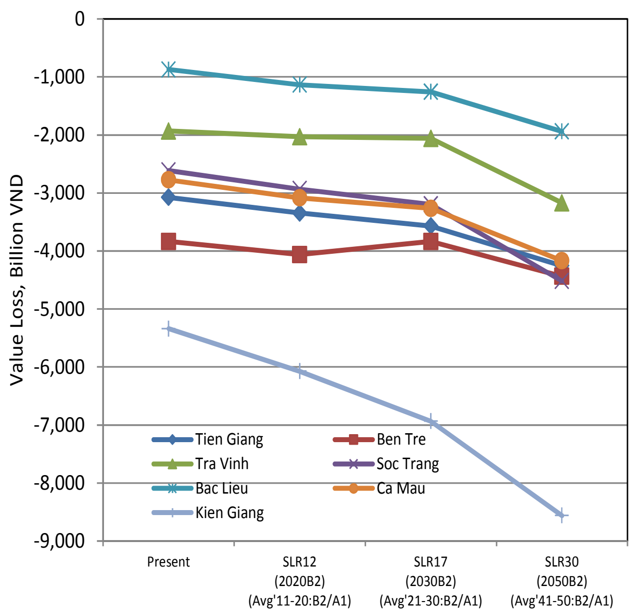


Figure 2.4.16 Annual Production Loss(VND) by Province

CHAPTER 3 DESIGN OF THE PROJECT

3.1 Current and Up-Coming Issues Identified

In the JICA Study (Climate Change Adaptation in Mekong Delta), issues related to climate change had been identified by 1) government officers and 2) villagers, aside from the results of computer simulations. This sub-section addresses the issues identified by those stakeholders as follows;

3.1.1 Government Officers' Perception on Climate Change

Table 3.1.1 summarizes the issues by province and by priority order from the top to the bottom of the table. Issues identified by all the provinces were saline intrusion and seashore-line erosion inducing sea dyke breach, and those issues identified by most of the provinces were flood and/or inundation, lack of fresh water in conjunction with saline intrusion, and drought.

Rainfall pattern change, e.g. uneven distribution and falling at wrong time, were identified by 3 provinces of Bac Lieu, Ca Mau and Kien Giang. Storm (tornado) was identified by 3 provinces of Ben Tre, Ca Mau and Kien Giang. Two provinces such as Ca Mau and Kien Giang listed forest fire as the top priority. Bac Lieu province listed 'inundation' as the top priority issue while other provinces in most cases listed saline intrusion or drought. Bac Lieu centre, located near sea, is easily affected by tidal effect and when accompanied with heavy rainfall, the center is inundated. Thus, the Bac Lieu province listed the inundation issue as their top priority.

Table 3.1.1 Issues with Priority Order related to Climate Change identified by 7 Provinces

No.	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
1	Saline intrusion	Saline intrusion	Drought, saline intrusion, lack of fresh water	Saline intrusion	Inundation	Sea-level rise (saline intrusion, erosion, lack of fresh water)	Drought
2	Sea dyke breach	Lack of fresh water	Shoreline erosion	Shoreline erosion	Welfare of farmers	Temperature rise (drought, forest fire)	Saline intrusion
3	Shoreline erosion	Shoreline erosion	Flood-tide increasing (sea dyke breach)	Lack of fresh water	Infrastructure for production	Storm and tropical low pressure	Forest fire
4	Flood	Livelihood and health of farmers	Epidemic disease for fruits and livestock	Inundation	Shoreline erosion	Depletion of ground water resource	Sea-level rise
5	Inundation	Decreasing of mangrove forest		Biological diversity reduction	Saline intrusion	Rainfall pattern (uneven distribution)	Shore line erosion
6	Change of the ecosystem	Storm/ Tropical low pressure		Crop production system	Production of agriculture, forestry, fishing		Inundation (flood)
7	Drought			Drought	Rainfall pattern (at the wrong time)		Storm - Tornado
8							Rainfall pattern (uneven distribution)

Source: JICA Project Team, based on the 1-day workshop held on October 27, 2011

Those issues are divided into 2 groups: those directly affected or caused by climate change, and those associated with but not directly caused by climate change. Following table summarizes the priority of the issues; i.e. for the first group, saline intrusion being the first priority, followed by drought and/or lack of fresh water, erosion and damage of sea dyke, frequent storm, inundation and flood, rain in dry season, and forest fire.

Table 3.1.2 Priority Order of the Issues related to or caused by Climate Change

Priority	Issues directly caused by CC	Issues associated with CC
1	Saline intrusion	Ecosystem change
2	Drought, Lack of fresh water	Livelihood change
3	Erosion, Damage of sea dyke	Worsening of public health
4	Frequent Storm	Damage of infrastructure

5	Inundation, Flood	Decrease of mangrove forest area
6	Rainfall in dry season (rainfall pattern change)	
7	Forest fire (associated with temperature rise and drought)	

Source: JICA Project Team, based on the 1-day workshop held on October 27, 2011

3.1.2 Villagers' Perception on Climate Change

1) Problem Analysis

To identify climate change issues at village level, a series of workshops were carried out in six communes: two communes in Ben Tre Province, and one commune in each of Tra Vinh, Soc Trang, Bac Lieu, and Ca Mau province. In the workshop, "Problem Analysis" method was employed. To the core problem set as "life is difficult," several causal issues were identified through participatory approach. Following are the major findings in the problem analysis regarding climate change issues, which are also shown in Table 3.1.3:

a) Drought is one of the most common issues related to the climate change. Five communes out of the six communes listed the problem of drought in the problem trees. Only shrimp farmers in Soc Trang Province did not mention the problem of drought. On the detail of the trees, there is some different consciousness between farmers. Farmers in Ben Tre Province put the issue of 'irrigation system is not working' under the 'drought', but farmers in Ca Mau Province did not mention irrigation problem; instead they put the issue of 'drought period becomes longer' as the reason for the drought problem. This means that paddy farmers in Ben Tre Province think the drought problem being as irrigation problem, whereas paddy and shrimp farmers in Ca Mau Province think the drought problem is directly related to the climate change.

b) Inundation is the main problem for the farmers in Phuoc Long commune in Bac Lieu Province. This is because other communes did not mention the problem of inundation except for Thuan Dien commune. There is no 'Heavy rain' issue as their problem in other five communes, however it was found in the problem tree of Bac Lieu Province. Furthermore, Phuoc Long commune in Bac Lieu Province is located in an inland area of Ca Mau Peninsula. Flood often happens in inland areas because of heavy rainfall and also flooded water comes from northern areas. From this point of view, farmers in Phuoc Long commune face inundation problem more seriously than other communes.

c) Vinh Hai commune in Soc Trang Province suffers from an influence of tide. According to their problem trees, farmers in this commune put the 'Flood tide' as one of their direct causes of the core problem. Flood tide means that inundation takes place worse influenced by high tide. Flood tide is common problem in this commune. Also, they mentioned that there are sea dykes, yet high tide overflows these dykes during storms. This indicates that the influence of flood tide is getting more serious for the people in this costal commune.

d) Saline intrusion gives impact mainly on the paddy farmers in Ben Tre and Tra Vinh Provinces. Saline intrusion is also one of the most common climate change issues in these communes. Four communes listed up the problem of saline intrusion in the problem trees. However, it seems that shrimp farmers in Ca Mau Province and Bac Lieu Province are not negatively influenced by saline intrusion because the problem of saline intrusion has never come up in the problem trees. There are possibly two reasons. One reason is that paddy production is more affected by saline intrusion while shrimp production rather takes advantage of the saline intrusion. They need brackish water for the shrimp culture. Hence, shrimp farmers in Ca Mau did not think saline intrusion as their problem. The other reason is that saline water has not reached Vinh Hai commune in Ca Mau and Phuoc Long commune in Bac Lieu Province.

e) Table 3.1.3 Climate Change Issues Identified in the Problem Trees of Each Commune

Commune	Thuan Dien	An Binh Tay	Huyen Hoi	Vinh Hai	Phuoc Long	Tran Thoi	Nos.
Province	Ben Tre	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	
Drought	●	●	●		●	●	5
Inundation	●				●		2
Flood tide	●			●			2
Heavy rain	●				●		2
Saline intrusion	●	●	●	●			4

Source: JICA Project Team, based on the Problem Analysis

2) Villagers Perception on Climate Change by Questionnaire Survey

a) Type of Climate Changes Observed

In a questionnaire survey which was conducted after the workshop, it was asked what kind and what degree of climate change respondents observed in the past few decades; the answers were summarized in Table 3.1.4. Of a total of 367 respondents, the observation the most frequently pointed out was "(prolonged) high temperature" receiving 84 responses or 23% of the total number of responses. The second most prevalent observation was "unusual rain" including two antagonistic patterns of too prolonged or increased rainfall and decreased rainfall (72 responses, 20%).

Then, the third popular observation was saline intrusion having 58 responses (16%). To be sure, this issue did not prevail in all the communes but concentrated only in An Binh Tay and Thuan Dien both in Ben Tre Province, suggesting the saline intrusion as a location specific issue. The forth one was general "weather change" or "irregular climate," which provably represents the unsynchronized weather with ordinal seasons (54 responses, 15%) constituting temperature and precipitation. Other observations suggested include: flood/ high water level (26 responses, 7%), increase in disease/ insect (20 responses, 5%), and drought (19, 5%).

Table 3.1.4 Climate Change Respondents Observed

District	High Temperature (prolonged)	Unusual Rain (prolonged/ increase/ decrease)	Saline Intrusion	Weather Change/irregular climate	Flood/High Water Level	Increase in Disease/insect	Drought	Water Pollution	Change of Season (dry-wet)	Not Particular	Others	Total
Thuan Dien	23	17	26	9	10							85
An Binh Tay	16	11	22	1		6	6					62
Huyen Hoi	10	8	1	13		5	4	1		6		48
Vinh Hai	6	5	1	4	1	1	1		2			21
Phuoc Long	19	22	2	9	5	8	6	4	5	1	4	85
Tran Thoi	10	9	6	18	10		2	10			1	66
Total	84	72	58	54	26	20	19	15	7	7	5	367
	23%	20%	16%	15%	7%	5%	5%	4%	2%	2%	1%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)

Note: Based on a multiple answering and open-ended question

b) Damages or Losses in Agriculture and Aquaculture Caused by Climate Change

Respondents of the questionnaire survey claimed some damages caused mainly by climate change on their own reality. As shown in Table 3.1.5, there were a total of 462 valid responses. The most frequent issue was "damage to coconuts" including the reduced size of coconut fruits and also fallen fruits by strong wind (211 responses, 46% of the total number of responses). The second most common issue was "decreased production" associated with any kind of commodities (not specified). This issue (57 responses, 12%) was observed only in An Binh Tay and Thuan Dien of Ben Tre province.

Negative impact in aquaculture was also addressed; damage to shrimp (51) accounts for 11% of the total number of responses. Then, increased disease and insects were also given 50 responses (11%);

increased temperature tends to harness viruses, pathogenic bacteria, and insects—farmers claim. Damage to paddy was claimed by 3 communes, sharing altogether 4%. Farmers in Thuan Dien claimed particularly about loss of seedlings (7 responses, equivalent to 2%). It sounds realistic considering the fact that plants easily receive damages especially at the early stage.

Table 3.1.5 Major Damages or Losses Caused by Climate Change

District	Damage to Coconut	Decreased Production	Damage to Shrimp	Increased Disease/insect (common)	Yield Loss (common)	Damage to Paddy	Loss of Seedling	Others	Total
Thuan Dien	42	26		19			7	5	99
An Binh Tay	38	31		11		7		1	88
Huyen Hoi	30			6	18	3		6	63
Vinh Hai	21		5		1			2	29
Phuoc Long	41		24	14	7	8		7	101
Tran Thoi	39		22		10			11	82
Total	211	57	51	50	36	18	7	32	462
	46%	12%	11%	11%	8%	4%	2%	7%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)
Note: Based on a multiple answering and open-ended question

c) People's Observation on Saline Intrusion

Table 3.1.7 shows the respondents' observation on any change in the condition of saline intrusion at their field or canals nearby. Of a total of 183 valid responses, 132 respondents, or 72% of the total number of respondents, answered "yes" that they have observed some changes on saline intrusion. Among total 39 valid responses that specified what actually happened in their field or around, 11 responses (28% of the total number of responses) answered either of "prolonged" and/or "increased."

To add with, saline intrusion has become "erratic (6 responses, 15%)" and "early starting (2 responses, 5%)". In this survey, a total of 30 responses (77%) were given generally to negative connotations: "increased", "prolonged", "erratic", and "early starting". By location, there were 4 communes where change in the situation (yes) is dominant. Specifically in Thuan Dien, 41 responses were given to "yes", while only one response was "no". On one hand, the number of responses given to "no" was dominant in Huyen Hoi and Vinh Hai, though the numbers given to each answer were not so different.

In the meantime, there were a total of nine responses given to "decreased", which was due to the installation of sluice gates and/or increased rain. While saline intrusion per se is increasing to a wider extent, totally different situation can be created by artificial manipulations location by location. It suggests that location specific conditions of saline intrusions are intermixed by area.

Table 3.1.6 Saline Intrusion at Farmers' Field or Canals Nearby

District	Yes	No	Total	Prolonged	Increased	Decreased	Erratic	Early starting	Total
Thuan Dien	41	1	42	8					8
An Binh Tay	26	5	31	2					2
Huyen Hoi	13	16	29	1		7		1	9
Vinh Hai	9	11	20		2				2
Phuoc Long	19	11	30		6	2			8
Tran Thoi	24	7	31		3		6	1	10
Total	132	51	183	11	11	9	6	2	39
	72%	28%	100%	28%	28%	23%	15%	5%	100%

Source: Questionnaire Household Survey, JICA Study Team (2012)
Note: Based on a multiple answering and open-ended question

3.1.3 Saline Intrusion as Main Issue Considered in this Project

As is discussed above, there are a number of issues associated with climate change: yield loss by temperature rise, direct damage by saline intrusion, and destruction by inundation, all of which are already in place and simulated to be much severer in the future in terms of area affected and also frequency of severe situation. Among all, Figure 3.1.4 shows a situation of saline intrusion in 1998 when it became severest once in recent years (left) as well as an expected one in 2020 based on simulation model (right). As shown in the figure (left), saline intrusion had spread wide range of areas along the coastal provinces at a saline content level 20g/L or more (red color) in 1998. As a result, vast areas of paddy field were affected. Thus, the saline intrusion is already a pressing issue in these areas, which is expected once in a while.

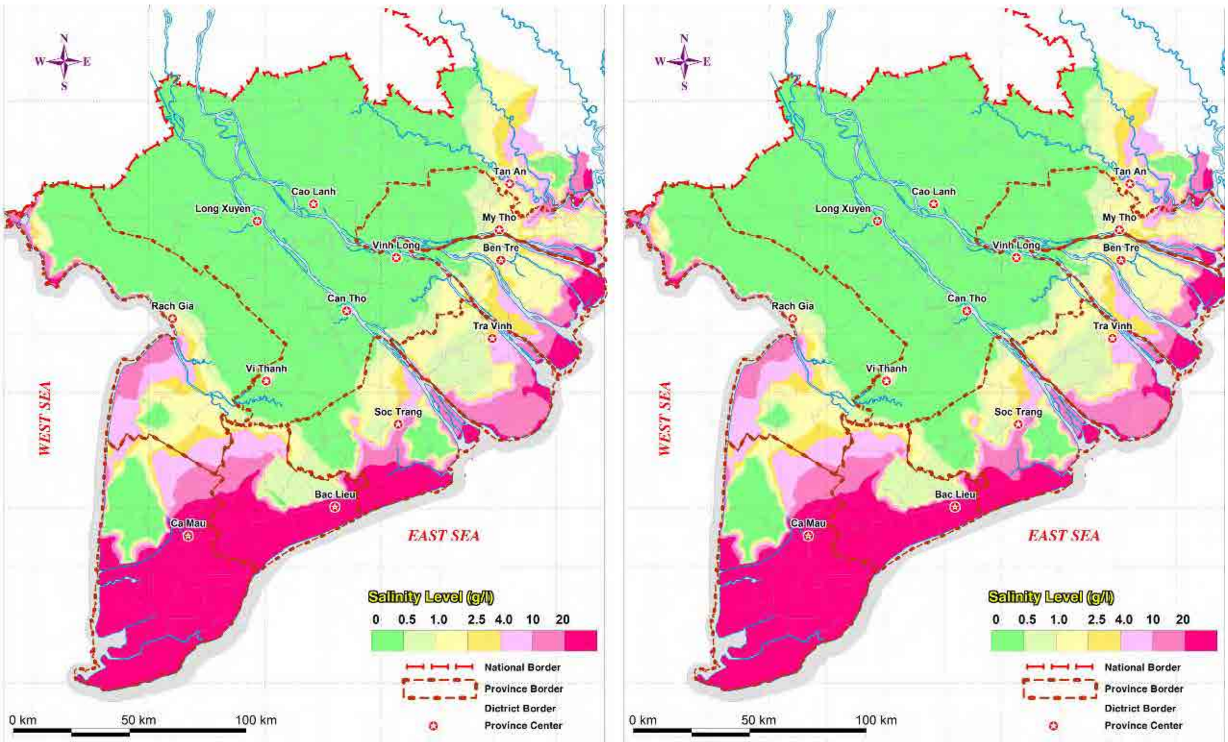


Figure 3.1.1 Saline Intrusion in 1998 and 2020 based on Simulation

Source: JICA Project Team (2012)

Furthermore, saline intrusion is also expected to be as severer as or much severe than 1998 by 2020. As shown in the figure (right), the severest situation in recent years would, expectedly, be the normal situation in the future, suggesting that implementation of possible measures should be put in place, or otherwise large extent of damage to such commodities as paddy, vegetables, fruits, and also shrimps are to take place.

Based on the simulation analysis above, it is expected that some of currently “paddy-paddy” cropping areas would be situated as saline-prone areas in the future. As shown in Table 3.1., a total of 126,168 ha is expected to be non-suitable area for paddy cultivation due to saline intrusion, which accounts for 14% of the area that is now under any kind of paddy cultivation systems, such as paddy, paddy-paddy, and paddy-aquaculture. Of a total of 126,168 ha, 30,616 ha (24%) is expected to be at a level which should be converted to brackish aquaculture –paddy system and 95,552ha (76%) is for brackish aquaculture.

Furthermore, even for such areas where paddy-based systems can be continued, 117,031 ha or 15% of the said area is expected to expose to a risk of saline water at a level 4-10g/L either February or June. Thus, some countermeasures to control the salinity at the filed level are required.

Table 3.1.7 Saline Prone Area of Currently Paddy Area Expected in 2050 (ha)

Land Use	No Change			Change to			Grand Total
	Without Risk	With Risk	Total	Bracksih-Paddy	Brackish Aqua	Total	
	< 4g/L both in Feb&Jun	4-10g/L in either Feb or Jun		>10g/L in Feb <10g/L in Jun	>10g/L both in Feb & Jun		
Paddy	28,768	21,257	50,025	8,801	28,221	37,022	87,048
Paddy (1 crop)	47,722	27,365	75,087	12,535	25,334	37,869	112,956
Paddy (2 crop)	333,068	45,053	378,121	7,815	36,355	44,170	422,291
Paddy (3 crop)	207,820	18,931	226,750	1,455	3,314	4,769	231,519
Paddy and annual crops	741	1,767	2,508	10	2,327	2,337	4,845
Paddy-Fresh aqua	17,236	91	17,327	0	0	0	17,327
Paddy-Fish	13,918	2,567	16,484	0	0	0	16,484
Paddy Total	**649,272**	**117,031**	**766,303**	**30,616**	**95,552**	**126,168**	**892,471**
	85%	15%	100%	24%	76%	100%	
	73%	**13%**	**86%**	**3%**	**11%**	**14%**	**100%**

Source: JICA Project Team based on Sub-NIAP (2012)
Note: Saline-prone area is categorized based on the saline content designated in the table

3.1.4 Current Issues

In recent years, saline intrusion has shown a tendency to migrate upstream. Accordingly, river basin based water management across many provinces has become increasingly necessary. The concept of river basin based water management was introduced by the Water Resources Act which was established on 1 January 1999. But, at the present, technological knowledge and experience and the management system for the actual water management has not been established. Therefore, there is a need for human resources development for the related area.

Regarding the saline intrusion in dry season of year 2011, a delay of confirmation for the concentration of saline water caused a delay of closing operation of gates for saline intrusion in Tra Vinh province. Consequently, there was serious damage to the crops and loss of crops was over 70% in 8,000 ha within the province. Measurement of salinity has been carried out by DONRE. But, the information of salinity is not always provided as useful information for the gate operation, and the information is not used for water management purpose. And further, human resources necessary for these matters have hardly been developed yet.

Between rice cultivation that needs fresh water and shrimp farming that needs saltwater, there have been conflicts over water usage in some areas of Mekong coastal area. To avoid conflicts, it is necessary to carry out more detailed water management within a canal system. And the detailed observations of water level and water quality and the installation of the water control gates are necessary towards level canals.

Chemical pollution caused by large volume of pesticides and fertilizers may be a concern in the areas of rice cultivation. There is also concern about damage to the health of farmers from them. In addition, it is thought that the chemical pollution might have caused mass outbreaks of disease and death in shrimp farming. There is also concern about that the deterioration of water quality may affect not only the fishing industry and fisheries such as shrimp farming, but also health of public who consume them, as well as the health of residents who use water for life. However, the actual situation of the deterioration of water quality has not been elucidated, and therefore there is a need for clarification of the actual situation of deteriorating water quality.

1) Water conflict between fresh water rice cultivation and salt water shrimp farming

There is a water conflict between fresh water demand for rice cultivation and salt water requirement for shrimp farming. In order to avoid such conflict, it needs to manage water in canal system carefully, to observe water level and water quality in detail and to install water control gates in the lower level canals to control the water in detail. However, the main responsibility to observe water level and quality in the Mekong Delta lies with MONRE and its related provincial organization, DONRE.

They maintain around forty permanent monitoring stations in the Mekong Delta. These monitoring stations cannot cover small and lower level canal system. Therefore, for the certain purpose of gate operation and/or some particular projects, ad-hoc observation shall be conducted by DARD and its related organizations. But, this information gathering has not enough period and frequency because of lack of budget and equipments.

Furthermore, information gathered by a DARD in the particular province shall not be shared by another DARD in other province. For that reason, adequate gate operation is not carried out during drought season and salinity intrusion period, and whereby lack of fresh water causes damage to the crops, e.g. saline damage to rice cultivation shall take place. Therefore, information gathering and sharing on water resources by MARD and DARD as well as amongst provinces shall be strengthened.

On the water conflict between salt water shrimp farming and fresh water rice cultivation, there is an the example in Ca Mau Peninsula, as shown in the figure below. The purple part is shrimp farming, while the white part shows rice cultivation. Then, the red broken line shows the boundary of the province; the blue line shows the fresh water intake main canal; and the green line shows the salt water intake main canal. Shrimp farming is distributed across three provinces named Ca Mau Province, Bac Lieu Province and Soc Trang Province. Rice cultivation is also distributed across the same three provinces. The problematic issue is that the area affected by the gate operation is not the same as the area of provinces.

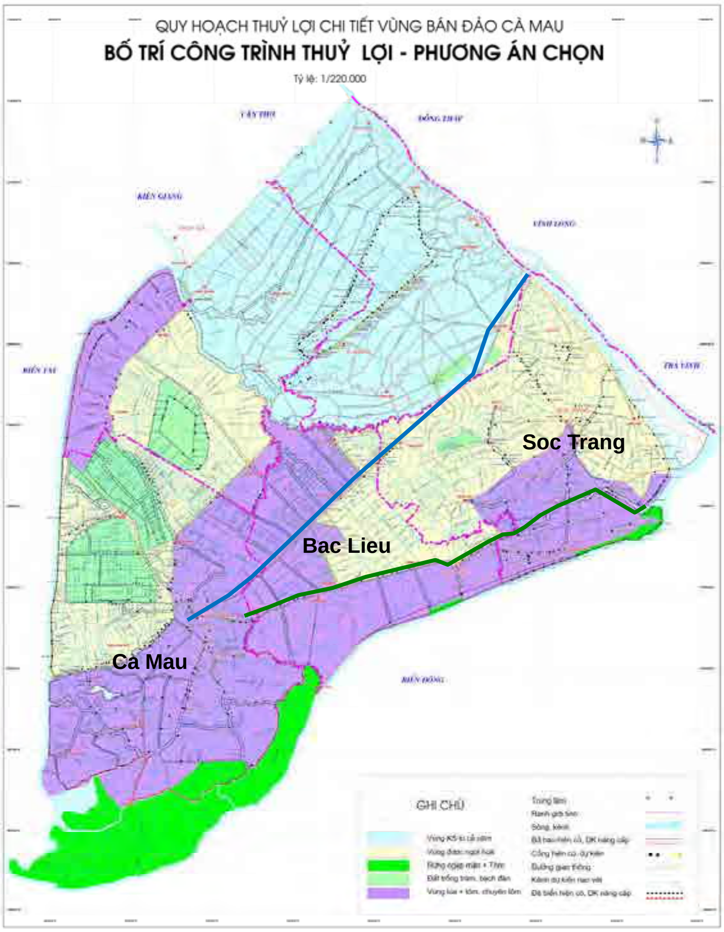
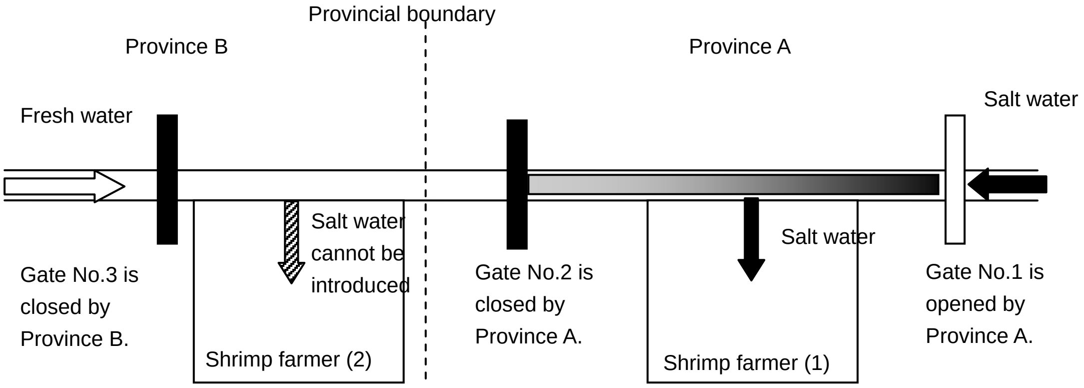


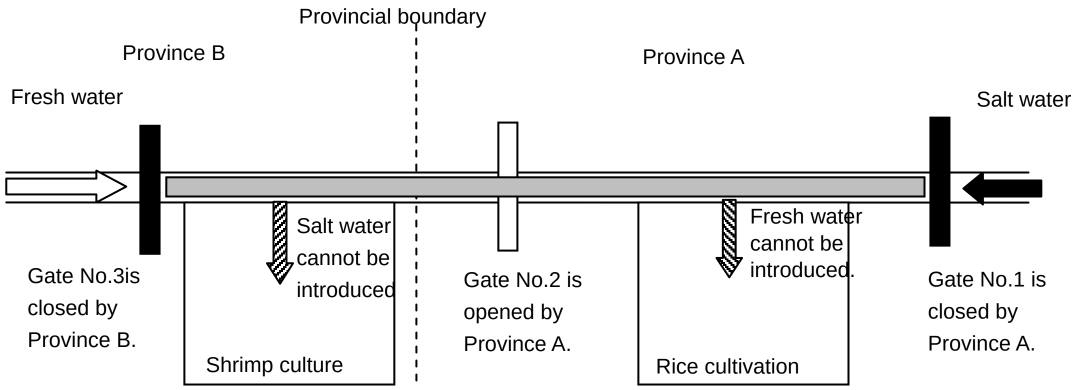
Figure 3.1.2 Distribution of the Agricultural Product and the Boundary of Provinces in Ca Mau Peninsula (Source: The Study Team)

As shown in the figure of example (1) below, in order to introduce sufficient salt water to shrimp farmer (1), the gate No. 1 is opened by province A in which the shrimp farmer is located and the gate No.2 is closed. And shrimp farmer (2) also needs salt water, so that province B closes the gate No.3. H, the gate No.2 is closed, so that shrimp farmer (2) cannot introduce salt water to their shrimp pond.

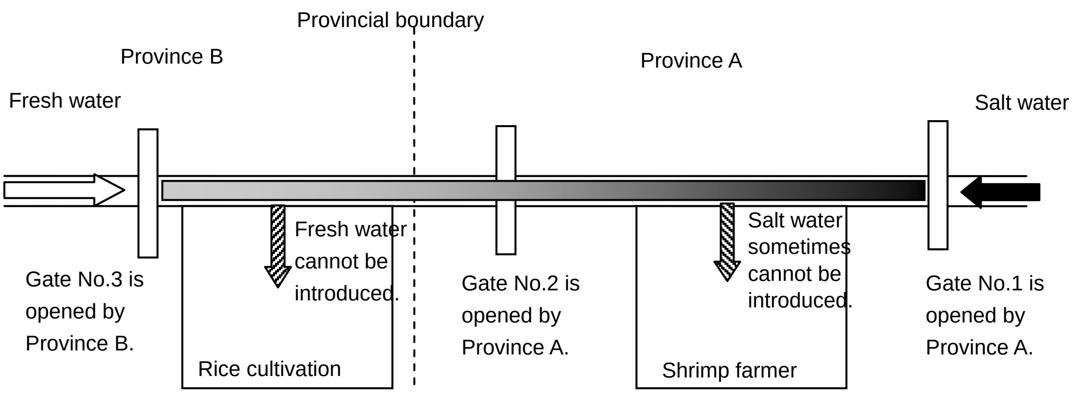
In addition, as shown in the figure of Example (2), rice cultivation located in the province A needs fresh water, so the gate No.1 is closed and the gate No.2 is opened by province A. But, if shrimp farmer located in province B needs salt water at the same time, province B may close the gate No.3. Then, the rice cultivation cannot obtain enough fresh water and the shrimp farmer located in province B cannot obtain salt water.



Example (1)



Example (2)



Example (3)

Further, as shown in example (3), if there is a shrimp farmer located in province A which needs salt water, province A may open the gate No.1. Rice cultivation located in the province B requires fresh water, so province B opens the gate No.3. However, if the gate No.2 in province A remains opened, salt water may come up and the rice cultivation in province B cannot introduce enough fresh water. Furthermore, if the salinity intrusion is not strong, the gate No.2 should be closed, otherwise the shrimp farmer may not introduce enough salt water.

As shown in above mentioned examples, canal system extends over some provinces and variety of crops or products are different, for that reason, there is a case that single province cannot decide the appropriate gate operation and also real-time salinity measurement shall be conducted and be reflected to the gate operation.

3.1.5 Future Issues caused by Socio-economic Development

In addition, following problems may be considered which is caused due to the economic and social development.

1) Chemical pollution caused by large volume of pesticides and fertilizers has been concerned in the areas of rice cultivation. And there is also concern about damage to the health of farmers from them. In addition, it is thought that the chemical pollution has caused mass outbreaks of disease and death in shrimp farming to some extent. In addition, there is concern that the deterioration of water quality may affect not only the fishing industry and fisheries such as shrimp farming, but also health of residents who use water for life. However, the actual situation of the deterioration of water quality has not been elucidated, and therefore there is a need for clarification of the actual situation deteriorating water quality.

2) As it is also written in the Economic Development Strategy 2011-2015 of Vietnam, the industrialization that centers on processing of agricultural and marine products is expected, there is a possibility that the increased use of water for industrial use will take place in the future. Then, the industrial discharge needs to be quickly drained to the outside of the waterway river water. Therefore, it is necessary to properly control the water level in the canals with a help of control gates.

3.2 Project Components

In this section, proposed project components are described as: 1) Capacity Development Project for Flow Water Management in Mekong Delta, 2) Capacity Development Project for Early Flood Warning System in Mekong Delta, and 3) Capacity Development Project for Early Drought and Saline Intrusion Warning System in Mekong Delta. Simplified Project Design Matrix (PDM) of each project component is attached in the following pages.

Of the 3 components, the most outstanding one is the ‘Capacity Development Project for Flow Water Management in Mekong Delta’. The main objective of this project is to strengthen the water resources planning capacity and the monitoring and information sharing capacity for the future installation of SCADA system in fresh water and salt water mixed area in the Mekong Delta. Under this objective, there are 4 outputs which are expected to be attained by the end of the project as follows;

1) In-situ data on water level and salinity at rivers/canals is collected with proper scientific manner,

2) Water flow management plan is prepared based on the results of field monitoring and analysis on water level and saline water intrusion,

3) Water flow management plan is utilized for actual sluice operation in pilot area(s) and examined so as to prevent saline intrusion and take freshwater effectively, and

4) Water flow management system coupled with training plan is established based on the results of the examination.

For the output (1), following activities are required;

1-1. SIWRP determines pilot area for monitoring; there shall be sluices for pilot operation.

1-2. SIWRP selects monitoring point of water level and saline content along canal/river.

1-3. SIWRP examines discharge in canal/river so as to prepare discharge-rating-curve at different tidal levels.

1-4. SIWRP decides monitoring interval for water level and saline content.

For the Output (2); following activities are required;

2-1. SIWRP conducts computer analysis on water flow and saline intrusion based on observed data in the pilot area.

2-2. SIWRP conducts feed-back from computer analysis to field observation; parameters of the computer analysis will be adjusted.

2-3. SIWRP conducts model simulation on sluice operation in the pilot area and prepare sluice operation plan

2-4. SIWRP prepares water flow management plan based on in-situ observations monitoring on water level and saline contents, and sluice operation plan with simulation results.

For the Output (3), which is 'water flow management plan is utilized for actual sluice operation in pilot area and examined so as to prevent saline intrusion and take freshwater effectively';

3-1. SIWRP conducts sluice operation together with DARD and Water Resource Management Company in the pilot area

3-2. SIWRP examines water flow management plan and review/revise it.

For the Output (4); following activities are required

4-1. SIWRP prepare for plan of water flow management system in Mekong delta

4-2. SIWRP prepares a training plan for water flow management.

3.2.1 Capacity Development Project for Flow Water Management in Mekong Delta

Project Title	**Capacity Development Project for Flow Water Management in Mekong Delta**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
Target Groups	Officer of SIWRP						
Implementing Agency	SIWRP, DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To enhance the capacity of flow water management in Mekong Delta

Rationale: Flow discharge from upstream to Mekong Delta is observed at two stations of Tan Chau and Chau Doc by observing water level. But, the relation between water level and discharge, H-Q rating curve, is not accurate because of the backwater effect. Furthermore, water level or flow rate in canals or channels for irrigation are not observed, so that current situation of flow rate and water use is not grasped. Regarding saline intrusion, salinity data is not acquired frequently. It is observed in two (2) periods at the tidal peak in a month following lunar calendar and it takes very long time to test the salinity in a laboratory. One period covers only around three (3) days. Saline intrusion occurs in a balance between fresh water supply from upstream of river and salt water pushed up by tide from the sea. Therefore, if the amount of fresh water from upstream is smaller than ordinary one in dry season, the balance shall be lost and saline water goes up deeply before the normal period and damage by saline intrusion shall be caused. Hydro-meteorological data such as water level, rainfall and salinity are observed and collected by the Centre of Hydro-meteorological under the Ministry of Natural Resources and Environment (MONRE), but these data are not supplied to DARD and SIWRP under the Ministry of Agriculture and Rural Development (MARD) with free of charge. And Department of Agriculture and Rural Development (DARD) in provinces is conducting measurements of salinity by themselves, but this data is not standardized to be used for analysis.

	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
Project Implementation													

Expected Outputs	**Development Indicators**
• Capacity of establishing flow water management plan shall be enhanced. • Capacity of analyzing eutrophication and planning of eutrophication control shall be enhanced. • Capacity of detailed analysis and planning of water quantity and quality in fresh water and saline water mixing area shall be enhanced. • Capacity of flood runoff and inundation analysis and early flood warning shall be enhanced by using satellite images, remote sensing data and real time data. • Capacity of low flow runoff analysis and saline intrusion analysis and drought and saline intrusion warning shall be enhanced by using satellite images, remote sensing data and real time data.	• Water management plan by using detailed observation data in Mekong Delta. • Eutrophication control plan in a pilot area. • Detailed plan of water quantity and quality in a pilot fresh water and saline water mixing area. • Early flood warning system • Early drought and saline intrusion warning system.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
• To utilize Doppler current meter, real time water gauge and salinity sensor to enhance capacity of planning for water resources management. • To enhance capacity for analysis of eutrophication and eutrophication control planning. • To enhance capacity for detailed analysis of water quantity and quality and water resources management planning in fresh water and saline water mixing area. • To utilize satellite images, remote sensing data and real time data to analyze flood runoff and flood inundation and to establish early flood warning system. • To utilize satellite images, remote sensing data and real time data to analyze low water runoff and saline intrusion and to establish early drought and saline intrusion warning.	5.1 million USD Experts assignment, Equipment, Logistics, Trainings, Etc.	MARD, Donors

Project Risk:
No specific project risks are expected.

Environment Assessment (C): This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no particular social and environmental concerns are foreseeable.

3.2.2 Early Flood Warning System Improvement Program

Project Title	**Early flood warning system improvement program**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
				○			○
Target Groups	Officer of SIWRP						
Implementing Agency	SIWRP, DARD, MARD						
Potential Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To enhance the capacity of flood management in Mekong Delta

Rationale: Flow discharge from upstream to Mekong Delta is observed at two stations of Tan Chau and Chau Doc by measurement of water level. The relation between water level and discharge, H-Q rating curve, is not accurate because of the backwater effect of Mekong River. Furthermore, water level or flow rate in canals or channels for irrigation have not yet been observed, so that current situation of flow rate and water use is not grasped until now. Regarding flood inundation, water spread area and its water level are not acquired frequently. Sometimes satellite images are supplied from Mekong River Commission or MoNRE but real time situation cannot be obtained and handled by regional government and relating organizations. Numbers of sluices are installed at confluences of canals and rivers in Mekong delta. These sluices can drain flood water coming from hinterlands when outside water level of river becomes lower than inside water level by opening gates; flood water can be stopped at sluices when outside river water level becomes higher than inside water level by closing gates. For the sake of effective gate operation for flood prevention purposes, real time information on flood water level will be quite useful; each province can operate their sluices with the most appropriate method. Furthermore, information of water level reduction is also useful for preparation of paddy seedling and land plowing of winter spring paddy and other farming practices in the Mekong Delta. Hydro-meteorological data such as water level, rainfall and salinity are observed and collected by the Centre of Hydro-meteorological under the Ministry of Natural Resources and Environment (MONRE), but these data are not supplied to DARD and SIWRP under the Ministry of Agriculture and Rural Development (MARD) with free of charge. Data supply and real time information sharing are proposed.

Project Implementation	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
	■	■	■	■	■								

Expected Outputs	**Development Indicators**
• Early warning system in the program area • Flood warning network system map • Real time measurement system of river flow • Base map of program	• Early warning system is established • General early warning system map is prepared and data and simulation are synchronized • Real time monitoring system is established • Base map of program is prepared

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
• To establish early warning system • To layout flood inundation warning networks on the map • To analyze flood expansion • To measure flood water level, flow velocity of rivers, real time water level of rivers • To obtain remote sensing rainfall data	• Total cost is 5.9 million • Experts: 4.9 million • Equipment and other cost: 1.0 million	MARD, Donors

Project Risk: The main ministry for water resources management in Vietnam is the Ministry of Natural Resources and Environment (MONRE). MARD is managing water resources as a water user side for agricultural and rural development purpose. In the Mekong Delta, MONRE is in charge of basic meteorological and hydrological information collection and management. MARD and DARD conduct hydrological observation only for the purpose of water use such as irrigation. This project is formulated from the viewpoint that MARD and DARD shall need to obtain inter-provincial hydrological and flood data and share them on the basis of the expected future situation of expansion of flood inundation. However, the information owned by MONRE is supposed to be shared to MARD and DARD. If it is not shared, basement of information is not used for the project. Therefore, the framework of the project should be reconsidered.

Environment Assessment (C): This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no particular social and environmental concerns are foreseeable.

3.2.3 Early Saline Intrusion Warning System Establishment Program

Project Title	**Early Saline Intrusion Warning System Establishment Program**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		○	◎	●			
Target Groups	Officer of SIWRP						
Implementing Agency	SIWRP, DARD, MARD						
Potential Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To enhance the capacity of saline water management in Mekong Delta

Rationale: Flow discharge from upstream to Mekong Delta is observed at two stations of Tan Chau and Chau Doc by measurement of water level. The relationship between water level and discharge, H-Q rating curve, is not accurate because of the backwater effect of Mekong River. Furthermore, water level or flow rate in canals or channels for irrigation have not yet been observed, so that current situation of flow rate and water use is not grasped until now. Regarding saline intrusion, salinity data is not acquired frequently for a purpose of data base formulation. The practice at present is that observation is conducted at two (2) times a month at the tidal peaks in a month following lunar calendar and it takes very long time to test the salinity in a laboratory. One time observation can cover only three (3) days between before and after the observation day. Saline intrusion occurs in a balance between fresh water supply from upstream of river and salt water pushed up by tide from the sea. Therefore, if the amount of fresh water from upstream is smaller than ordinary one in dry season, the balance will be lost, consequently, saline water goes up deeply in comparison with normal period and damage by saline intrusion will be caused. Hydro-meteorological data such as water level, rainfall and salinity are observed and collected by the Centre of Hydro-meteorological under the Ministry of Natural Resources and Environment (MONRE), but these data are not supplied to DARD and/or SIWRP under the Ministry of Agriculture and Rural Development (MARD) with free of charge; and then, Department of Agriculture and Rural Development (DARD) in provinces is conducting measurements of salinity by themselves, but this data is not standardized to be used for analysis.

Project Implementation	2013	2014	2015	2016	2017	2018	2019	2020	2022	2024	2026	2030	2050
			▬	▬	▬	▬	▬						

Expected Outputs	**Development Indicators**
・ Early warning system in the program area ・ Saline intrusion warning network system map ・ Data base of runoff and saline intrusion ・ Real time measurement system of river flow ・ Base map of program	・ Early warning system is established ・ General early warning system map is prepared ・ Data and simulation are synchronized ・ Real time monitoring system is established ・ Base map of program is prepared

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ To establish early warning system ・ To layout saline intrusion warning networks on the map ・ To analyze low water runoff, saline intrusion ・ To measure salinity level, flow velocity of rivers, real time water level of rivers ・ To obtain remote sensing rainfall data	・ Total cost is 7.0 million ・ Experts: 5.6 million ・ Equipment: 1.1 million ・ Training & activities: 0.3 million	MARD, Donors

Project Risk: The main ministry for water resources management in Vietnam is the Ministry of Natural Resources and Environment (MONRE). MARD is managing water resources as a water user side for agricultural and rural development purpose. In the Mekong Delta, MONRE is in charge of basic meteorological and hydrological information collection and management. MARD and DARD conduct hydrological observation only for the purpose of water use such as irrigation. This project is formulated from the viewpoint that MARD and DARD shall need to obtain inter-provincial hydrological and water quality data and share them on the basis of the expected future situation of expansion of saline intrusion. However, the information owned by MONRE is supposed to be shared to MARD and DARD. If it is not shared, basement of information is not used for the project. Therefore, the framework of the project should be reconsidered.

Environment Assessment (C): This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no particular social and environmental concerns are foreseeable.

3.3 Proposed Technical Assistances and Inputs for the Project

Among those project components aforementioned, priority components are compiled as a proposal of specific project under the title 'The Project on Capacity Development for Flow Water Management in Mekong Delta' to be funded by any donor. This Project is specifically designed as a potential technical-assistance project. The project is so recommended to be a model project that can be a basis of further application of the activities in the future if forecasted climate-change issues became critical in other areas.

That is, fundamental purpose of this technical assistance project called 'The Project on Capacity Development for Flow Water Management in Mekong Delta' is to enhance water resources information management system for flow water including fresh water and saline water, by which agricultural and aquacultural systems can be smoothly adapted to force coming climate change.

3.3.1 Technical Assistances Required

This Project aims to develop water resources information management system for flow water including fresh water and saline water and to contribute sustainable agriculture and aquaculture in adaptation to salinity intrusion caused by climate change in the selected areas of coastal Mekong Delta. Therefore, the project contains two aspects of capacity development. One is the technical aspect to conduct observation of flow water, share observation result and use it for better gate operation. The other one is the institutional and organizational aspect for river basin based and inter-provincial based flow water management. These are related to the two outputs which are expected to be obtained by the end of this project as follows;

1) Output 1: In the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation.

2) Output 2: At both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened.

For the output 1, following activities are required;

1-1 SIWRP determines pilot areas.

1-2 SIWRP analyzes the current situations of relevant organizations in the field of flow water management in the pilot areas.

1-3 SIWRP makes a basic design of observation network, computer systems and information network.

1-4 SIWRP formulates an observation plan of fresh water and saline water.

1-5 SIWRP installs observation equipments.

1-6 SIWRP conducts training courses for observation and observation data processing to the officers of DARDs and IMCs (Irrigation Management Companies, under DARD).

1-7 SIWRP conducts observation data storing, managing and sharing.

1-8 SIWRP, DARDs and IMCs conduct observation.

1-9 SIWRP, DARDs and IMCs reflect the observation results to the exiting gate operation.

1-10 MARD, DARDs and SIWRP formulate an integrated flow water management plan including observation plan and gate installation, operation and maintenance plan in the pilot area.

For the output 2, following activities are required;

2-1 SIWRP analyzes the current situations of flow water management at the national and provincial level.

2-2 SIWRP establishes analysis system for flow water management including fresh water and saline water.

2-3 SIWRP advises MARD on institutional and organizational arrangement for future inter-provincial/ river basin-based flow water management including the system of information sharing among relevant organizations.

2-4 SIWRP establishes training systems for the effective and integrated flow water management including fresh water and saline water management.

3.3.2 Inputs Required

To realize the outputs aforementioned and thus achieve institutional capacity development in the area of flow water management, a process-oriented approach is required, for which involvement of experts in long-term position is appropriate, who is then supported by a range of expertise in short-term position. Inputs including the experts are presented as follows;

Donor

1) Long Term Experts

-	Chief Advisor/ Water Resources Policy	1 person
-	Coordinator	1 person

2) Short Term Experts

-	Water Resources Planning	1 person
-	Irrigation and Drainage Planning	1 person
-	Hydrological Observation and Analysis	1 person
-	Water Quality Observation and Analysis	1 person
-	Observation Equipment	1 person
-	Observation Data Processing	1 person
-	Information Network	1 person
-	Geographical Information System	1 person
-	Water Balance Analysis	1 person
-	Database	1 person

3) Materials/Equipment

-	Meteorological and hydrological observation equipment	1 unit
-	Water quality observation equipment	1 unit
-	Office equipment (copy machine, etc.)	1 unit
-	Computer software (GIS etc.)	4 units
-	Vehicle	2 units

4) Training Courses

-	Training of provincial officers	30 officers/time	(2 times/year)
-	Third country training	10 officers/time	(2 times/year)
-	International training	2 officers/time	(6 months)

5) Others

-	Operation cost	as required

Vietnamese Government

1) Counterpart personnel

-	Water resources planning (fulltime)	2 officers

-	Irrigation and drainage planning (fulltime)	2 officers
-	Hydrological observation and analysis (part-time)	2 officers
-	Water quality observation and analysis (part-time)	2 officers

2) Facilities

-	Land, buildings and facilities necessary for the project	1 unit
-	Office space, furniture, etc for the project members	1 unit

3) Others

-	Operation cost	as required
-	Tax exemption	as required

3.4 Preparatory Project Evaluation

3.4.1 Evaluation by Five Criteria

1) Relevance

Relevance of this project is high with following reasons:

✓ The government of Vietnam is pursuing to keep the production level of paddy as it is today. In terms of the paddy cultivation, Mekong Delta shares 52.8% of the total planted area of paddy (3,970,500ha/ 7,513,700ha) and 54.4% of total production (21,769,500 ton/ 39,988,900ton) in the nation[1]. Despite its importance, this area is exposed to a threat of production loss due to foreseeable climate change. Meanwhile, production area of brackish shrimp culture is also targeted to increase. In this context, this Project helps achieve the production targets by introducing flow water management which create water environment conducive to fresh water cultivation as well as brackish water cultivation across the concerned provinces. Hence, this Project is very relevant to the government policy.

✓ Aside from the proposed Project, there are a number of project proposals that are oriented toward infrastructure development for controlling saline intrusion, i.e., installation/rehabilitation of sluice gates. Infrastructure development often requires relatively large amount of investment cost and therefore such infrastructure should well function according to the changing water environment. Existing gates are also needed to work well in line with the flow water condition, e.g. according to the salinity level. Since this Project focuses on technical aspects and relatively applicable financially and technically, it can improve the operation of those sluice gates. As a matter of fact, this Project will enhance the operation of sluices gates, which can meet the changing water environment and therefore the Project together with such infrastructure oriented projects could well cope with the impacts from climate change at a satisfactorily higher level.

2) Effectiveness

Effectiveness of the project is confirmed with following reasons:

✓ This Project aims at strengthening a planning capacity of the implementing body for making agricultural and aquacultural production system more suited to saline prone areas. As farmers on the ground are dully facing apparent problems incurred by saline intrusion, there is due needs for improving the flow water management and thereby adaptable to and coping with the climate change impact. As such, especially combined with sound operation of sluices gates, the Project is expected to be highly effective in contributing to sustainable agriculture and aquaculture with a means of improved flow water management.

[1] Statistical Yearbook of Vietnam, General Statistics Office (2010)

- ✓ The Project is also to enhance coordination among the concerned offices e.g. DONRE, DARD, IMC (Irrigation Management Company under DARD), and SIWRP. Enhanced coordination will contribute to improved water management especially across provinces since at present little information on water management is shared amongst them. With this enhanced coordination, overall flow water management in the coastal Mekong Delta area will be improved; hence this Project should achieve high effectiveness towards overall improvement of agriculture and aquaculture production in the coastal delta.

3) Efficiency

Efficiency of the Project is expected as follows:

- ✓ Through donor-funded projects/programs, SIWRP, the implementing agency, has already gained technical experiences in flow water management and planning. For example, it maintains long and various experiences of hydrological and water resources survey/investigation, application of mathematics models in water resources assessment, application of GIS in natural resources development mapping, land and water resources development planning, master plan development, economic analysis and water resources and river basin development formulation. With such essential capacities in water resources management and planning, introduction of new approach can be smoothly conducted.

4) Impact

Impact of the Project is expected as follows:

- ✓ Capacity of technical personnel is strengthened through the implementing process of the Project. In particular, they will be able to assess the flow water resources situation and, based on it, formulate a suitable flow water management plan. Provided that climate change usually becomes critical in different timing and different degree by locations, the government institution can customize the flow water resources management plan according to the progress and locality of climate change. In fact, currently, there are many plans of sluice gate and barrages to be constructed. Yet, flow water quantity and quality data is the key to operate these structures efficiently, to which the Project can give a significant positive impact.

5) Sustainability

It is expected that the outcomes of the Project is sustained by the improved capacity of the implementing body with the following reasons:

- ✓ In its national development plan, the government of Vietnam emphasizes the importance of agricultural development. As Mekong delta region is seen as a production center of the country, this policy is expected to continue especially in the Project area. Hence, the project sustainability relating to policy change would not be affected.

- ✓ While climate change issues have already become a central issue especially along the coastal provinces, it is projected to expand and becomes severe in the long run. Given the fact, needs of getting flow water quantity and quality information more suitable to the Mekong Delta area are expected to increase in the future.

- ✓ SIWRP, the expected implementing agency, has been recruiting 3 – 6 new staff every year for the last 5-6 years, keeping the overall staff number to be about 90 – 100. Once those technical personnel have gained more capacity in flow water management and its application through the Project, they together with the existing staff will be a driving force to continue those activities after the projects.

3.4.2 Consideration on Poverty, Gender and Environmental Issues

✓ *Poverty*: due to climate change, water movement including saline intrusion in the coastal Mekong delta is expected to change. Flow water resources management is the basis of agricultural and aquacultural production not only for ordinary farmers but also for poor farmers in the Mekong delta area. Therefore, getting adequate information of flow water resources and, in the future, managing flow water resources effectively will contribute to the improvement of poor farmers' agricultural and aquacultural production.

✓ *Gender*: Fresh water is the basis of daily life. For example, cooking, washing clothes and washing dishes need fresh water and these are usually what women undertake. And even if piped water supply system is developed, the fresh water source is still the flow water in the canals and rivers of Mekong delta. Therefore, ensuring fresh flow water is highly related to the women's daily life improvement.

✓ *Environment*: given pronouncedly increasing tendency of saline intrusion, ecological environment might be changed in the future, unless any interventions are taken. For example, the flora/vegetation might be changed and then the fauna might be changed. Keeping and managing fresh flow water resources in the coastal Mekong delta is the basis of environment in this area.

3.5 Institutional Arrangement for Project Implementation

3.5.1 Implementing Agency

In the project, Southern Institute of Water Resources Planning (SIWRP) functions as the implementing agency. Southern Institute for Water Resources Planning was formerly called the Sub-institute for Water Resources Planning. The institute was established under Decision 964/QĐ-TC.B2 issued on September 20, 1977 by the Ministry for Water Resources which now is the Ministry of Agriculture & Rural Development (MARD).

Decision 341/2005/QD-TTg issued on December 26, 2006 by the Prime Minister caused an upgrading of Sub-institute for Water Resources Planning to the Southern Institute for Water Resources Planning (SIWRP) which is directly under the administration of MARD. Functionalities, mandates, authorities and organizational structure of SIWRP are stipulated in Decision 09/2006/QD-BNN dated February 8, by the Minister of MARD. The charter of SIWRP organization and operation was approved in Decision 1107/QD-BNN-TCCB dated April 14, 2006. The Outline of the SIWRP is as follows:

1) Vision

The Southern Institute for Water Resources Planning (SIWRP) has the functionalities of management and planning for water resources and river basin development in southern Vietnam. SIWRP adheres to the principles of sustainable development and ceaselessly strives for the improvement of science and technology in preparing to meet the increasing water demands of society in regard to the economic, technical, environmental and social welfare aspects.

2) Focus

The Southern Institute for Water Resources Planning is an administrative institution with financial independence and income generating activities. SIWRP has the mandates of: basin-wide integrated water resources planning and management in the south of Vietnam; water resources development planning at local, regional, provincial and project level, i.e. water resources projects, socio-economic development projects relating to water resources and the environment; comprehensive and synchronized solutions for disaster mitigation, water-supply projects, riverside and seashore training, environment conservation, environmental impact assessment, small scale hydro-power plant development, etc.

The work conducted by SIWRP varies from technical surveys, planning design, feasibility studies, establishment of investment projects, technical design, cost estimation and construction monitoring, surveys, scientific studies, and international cooperation projects with regard to water resources development and river basin and disaster mitigation. Such activities aims at developing Vietnam sustainably with a thriving economy, high quality environment, harmonized and peaceful living, and sufficient and equitable water resources.

3) Mandates

SIWRP is an institution of water resources planning whose primary function is to develop water resources plans for the sustainable development of river basins and the environment with proper regulation and utilization for the socio-economic development of provinces in the south of Vietnam. Key mandates of SIWRP are stated by MARD as follows:

1) Arrangement of surveys for water resources planning including; 1) planning projects (water supply and drainage for respective uses, i.e. agriculture, major urban areas, and dense residential areas; flood and disaster control; and small scale hydro-power plant development); 2) surveys and treatments for the environment and water quality; 3) surveys of topography, geology, and hydrology for water resources development; 4) projects under international cooperation as assigned by the Minister of MARD; and 5) projects of inter-boundary rivers as assigned by the Minister of MARD.

2) Instructions and support to respective localities in the formulation of local water resources planning designs; participation and cooperation with respective sectors in the formulation of socio-economic development of specific localities and regions in order to ensure the agreement of overall planning and national socio-economic development.

3) Instructions and support to respective localities in the deployment and implementation of approved planning projects, recognition of irrelevant and outstanding issues in order to supplement and improve such planning.

4) Establishment and updating of the overall utilization status of rivers and determination of water balance in order to support MARD with water licensing (of both surface and ground water) on the river basins assigned by the Minister of MARD.

5) Participation in the appraisal of water resources planning projects formulated by respective localities, sectors and institutions in accordance with decisions made by the Minister of MARD.

6) Participation in the formulation of water resources development strategy as assigned by the Minister of MARD.

7) Establishment of structure operation plans and the operation of major integrated hydraulic structures.

8) Surveys of water quality for the water demands of respective sectors and domestic use; monitoring and evaluation of water quality on the river basins, reservoirs, coastal areas, Peninsulas, flooded and boggy areas; and prediction and modeling of the development and transport of pollutants for water resources planning.

9) The investigation, assessment and prediction of impacts from existing and projected hydraulic structures to the local environment and ecology.

10) Arrangement of activities with regard to surveys for water resources planning and water

conservation activities, i.e.: 1) topography, geology, and hydrology (of surface and ground water); 2) water quality and water environment; and 3) relevant socio-economic conditions with regard to water utilization and conservation.

11) Participation in the formulation of process, procedures and methodology, and cost norm of water resources planning design as assigned by the Minister of MARD.

12) Arrangement and participation in scientific studies and programmes with regard to water resources planning, water resources and water quality development and conservation; training and enhancement of skills and knowledge for SIWRP competent staff and experts in the assigned fields.

13) Coordination with planning institutions which are under the umbrella of respective Ministries, i.e. Ministry of Fishery, Ministry of Construction, Ministry of Transport, Ministry of Natural Resources & Environment, and relevant localities in the sustainable use and management of water resources.

14) Execution of international cooperation tasks in regard to water resources, water environment, and water quality in accordance with regulations of MARD and the Government.

4) Structure and Human Resources

Organizational chart and also staff establishment as of 2012 of SIWRP are shown below;

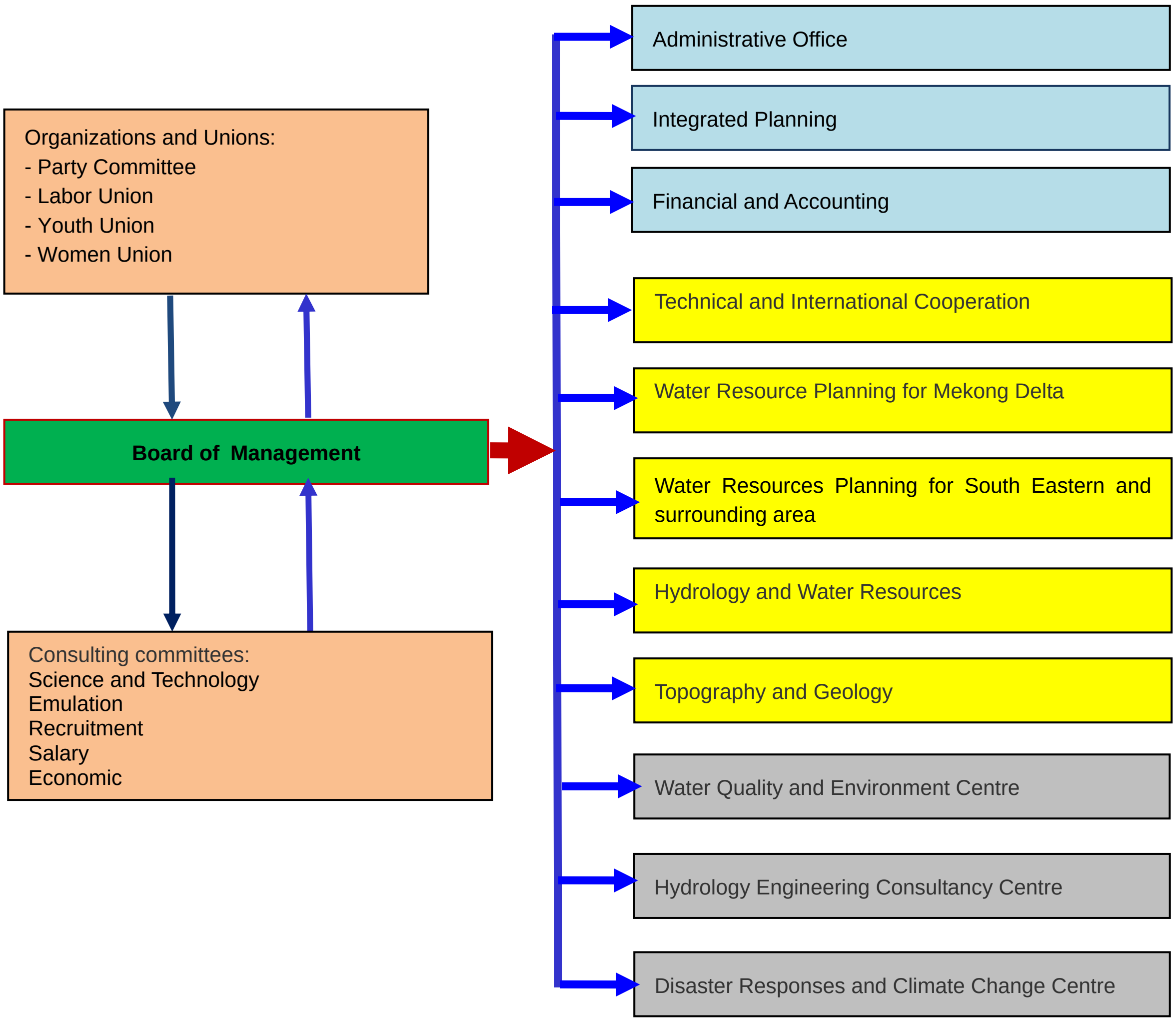


Figure 3.5.1 Organizational Structure of SIWRP

Source: SIWRP (2012)

Table 3.5.1 Table Number of Officers in each Division of SIWRP

Order	Division	No. of Officers (people)
-	TOTAL	90
-	Board of Manager	2
1	Administrative office	8
2	Integrated planning	5
3	Financial and Accounting	4
4	Technical and International Cooperation	9
5	Water Resources Planning for Mekong Delta	12
6	Water Resources Planning for South Eastern and surrounding area	11
7	Hydrology and Water Resources	9
8	Topography and Geology	10
9	Water Quality and Environment Centre	9
10	Hydrology Engineering Consultancy Centre	5
11	Disaster Responses and Climate Change Centre	7

5) Operational Capacity

SIWRP has total 90 permanent staffs including 1 assistant professor, 3 doctors, 6 postgraduates, 16 masters, 50 engineers, and 10 Bachelors. Field of study and number of year of experience are: thirty-year experience in surveys/investigation and hydrological and water resources determination, twenty-year experience in water quality analysis, twenty-eight-year experience in application of mathematic models in water resources assessment, fifteen-year experience in application of GIS in natural resources development mapping, twenty-five-year experience in land and water resources development planning, fifteen-year experience in master development planning, fifteen-year of experience in economic analysis, twenty-five-year experience in disaster mitigation study, ten-year experience in social surveys, fifteen-year experience in water resources and river basin development strategy formulation, etc.

6) Equipment

- ✓ Topographical survey: tachometer, ultrasonic equipment, leveling apparatus, theodolite, GSP and much other equipment.
- ✓ Geological survey: XY-1a auger and other field equipment
- ✓ Hydrological survey: ADCP, velocity meter, ultrasonic equipment, ware meter and many other equipment
- ✓ Water quality analysis: Gaschromatography, Atomic-absorption spectrophotometer, Flame spectrophotometer, Atomic-absorption spectrophotometer with hydride for arsenic analysis, Ionic gafchromatography, and other equipment.
- ✓ Office: computers, printers, scanner, photocopier, projector, camera, digital camera and other equipment.

7) Tools

- ✓ Flood hydrodynamic and salinity: VRSAP, SAL, MIKE11 & MIKE21
- ✓ Hydrology: RRMOD, TANK & NAM
- ✓ River basin water balance: MITSIM, MIKE BASIN & MIKE SHE
- ✓ Environment Impact Assessment: RIAM
- ✓ GIS software: MapInfo, Arc View, Arc/Info
- ✓ Software applied to structure design: ACAD
- ✓ Software applied for optimal analysis: GAMS

3.5.2 Proposed Project Steering Committee

Proposed institutional arrangement is illustrated in Figure 3.5.2. First, Joint Coordinating Committee (JCC) is established at central level in Hanoi, which is composed of MARD, MoNRE, and JICA. As general water resources management plan is subject to the approval from MoNRE, MoNRE should also be a part of the JCC. The JCC is responsible to authorize the direction of the project and coordinate the project activities to be in line with the government policy. For example, proposed change of water resources management plan should be submitted to the JCC, at which the plan should be approved.

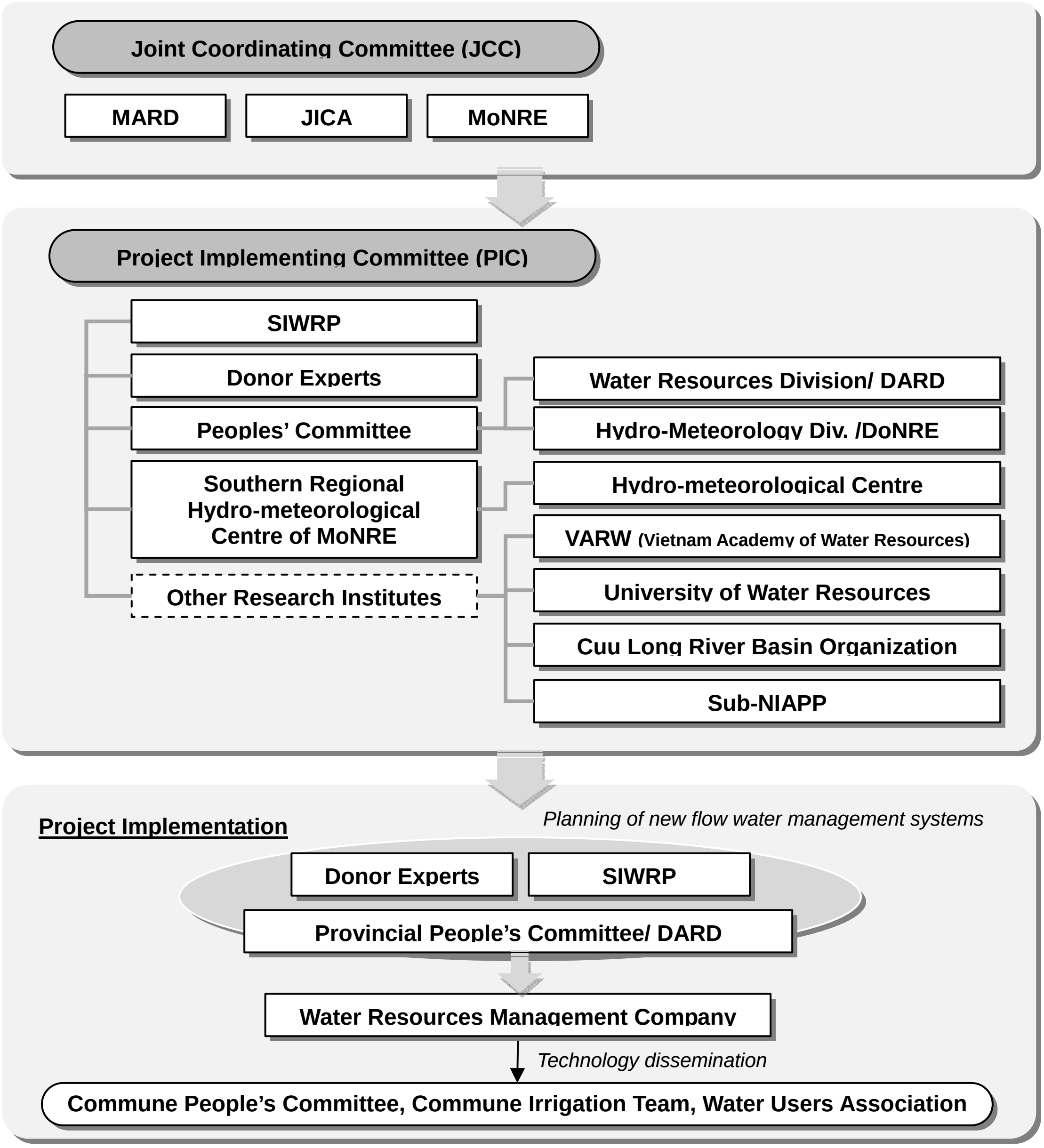


Figure 3.5.2 Institutional Arrangement

At regional level, Project Implementing Committee (PIC) shall be established in participation with responsible institutes in water resources management. The PIC is responsible in monitoring and improvement of project activities. SIWRP is the primary institute that administrates the entire process of the project in coordination with donor experts.

Those two parties, SIWRP and donor experts, coordinate with and get support from other agencies:

provincial peoples' committee that represents water resources division of DARD and hydro-meteorology division of DoNRE, Vietnam Academy of Water Resources (VARW) including Southern Institute for Water Resources Research (SIWRR), University of Water Resources, Cuu Long River Basin Organization, and Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP). The institutes provide technical guidance and help establish a set of improved flow water management system oriented to climate change adaptation, e.g. adaptation to saline intrusion.

Southern Regional Hydro-meteorological Centre and Hydro-meteorological Centre of MoNRE also play advisory roles in hydro-meteorological monitoring at Mekong Delta regional and provincial level. As hydro-meteorological monitoring is basis for flow water management, close coordination between organizations responsible for hydro-meteorological monitoring and water resources management should be established. Therefore, Southern Regional Hydro-meteorological Centre should be involved in the PIC.

The actual monitoring and observation of hydro-meteorological condition and the gate operation based on the collected hydro-meteorological information in provincial level under MARD are conducted by Water Resources Management Company/ Irrigation and Drainage Management Company (IMC). Therefore, improved systems are to be disseminated through current hydro-meteorological observation and gate operation system.

Here, Provincial People's Committee/ DARDs supported by the donor experts and SIWRP carry out provincial level project activities, and supervise the activities to be pursued by IMCs. IMCs take a lead as an interface of extension entities to Commune People's Committees, Commune Irrigation Teams, and Water Users Associations. Those participating officers from DARDs and IMCs are targeted to be functional and strengthened their capacities oriented to climate change adaptation through the project activities.

3.5.3 Proposed Project Site

Specific river course and canal systems and areas are to be selected after the project has commenced. Through a development study "The Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta", it was found that water flow improvement was highly needed in Ca Mau Province. It was also found important in Ben Tre and Bac Lieu Provinces. In addition, activities relating to capacity development of flow water management is closely related to the operation of saline prevention gates. Saline prevention gates construction is the top priority project in Ben Tre and Tien Giang, Tra Vinh, Bac Lieu, and Kien Giang. Thus, it is proposed to carry out the project activities first in Ben Tre, Bac Lieu and/or Ca Mau provinces.

In those provinces, specific river course and canal systems and areas are to be selected by the Project Implementing Committee (PIC) according to set criteria. In principle, project activities should be carried out where climate change issues, such as saline intrusion, have already become apparent and caused substantial problems. For example, there are some rive course and canal systems where saline intrusion in dry season become significant, at which cropping systems of individual farmer households in the area are not yet integrated due to complicated water management-some farmers cultivate paddy, while others do shrimp culture. In such places, flow water management and coordination among the interest farmer groups is quite important and thus the project is to be implemented.

3.6 Project Implementation Schedule and Cost

This project is carried out in a five-year period, which is divided into three phases. Major activities under each phase are presented below by each of the 2 outputs:

3.6.1 Project Activity Schedule under Output 1

Output 1 is 'In the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation'. To achieve this output, following activities are conducted by phase:

In phase I, pilot areas are determined based on the latest status of climate change issues especially saline intrusion. After that, current situations of relevant organizations in the field of flow water management in the pilot areas are analyzed, a basic design of observation/ monitoring stations and networks, computer systems and information networks are developed, an observation plan of fresh water and saline water movement is formulated, observation data storing, managing and sharing plan is formulated, and observation equipments and network/information systems are installed, training courses for observation and observation data processing to the officers of DARDs and IMCs are conducted.

In phase II, observation and monitoring of fresh water and saline water movement, processing observed data, storing, managing and sharing acquired data are conducted by DARDs and IMCs. Also, observation data is utilized to existing gates operation.

In phase III, based on the previous activities, integrated flow water management plan including observation/ monitoring plan and gate installation and operation plan in the pilot areas is formulated.

3.6.2 Project Activity Schedule under Output 2

Output 2 is to realize that at both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened. To achieve this output, following activities are required by phase:

In phase I, the current situation of flow water management at the national and provincial level is analyzed. Then, analysis system for flow water monitoring and management including fresh water and saline water movement is developed.

During phase II, training systems for effective and integrated flow water management including fresh water and saline water management are established.

In phase III, institutional and organizational arrangement for future inter-provincial and river basin based flow water management including the system of information sharing among relevant organizations is advised to MARD.

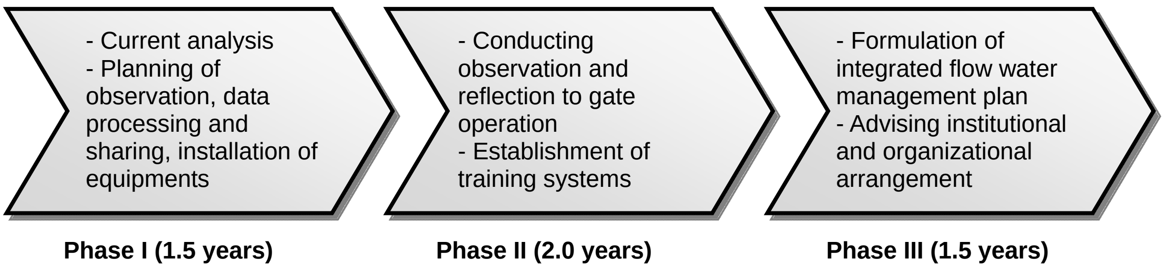


Figure 3.6.1 Phasing of the Project

3.6.3 Project Cost

Table 3.6.1 summarizes the project costs, divided into donor side and Vietnamese side, and further categorized into expert, materials/equipment, training, and others. As summarized, total project cost for the 5 year project duration comes to US$ 5,763,000 composed of US$ 5,435,000 by donor and

US$ 328,000 for counterpart fund:

Table 3.6.1 Summary of Project Cost, US$

Item	Amount		Unit Cost	Unit	Cost	Remarks
Donor						
1) Long Term Experts						
- Chief advisor/ water resources policy	60	MM	22,000	US$/MM	1,320,000	
- Coordinator	60	MM	20,000	US$/MM	1,200,000	
Sub-Total					2,520,000	
2) Short Term Experts						
- Water Resources Planning	20	MM	20,000	US$/MM	400,000	
- Irrigation and Drainage Planning	20	MM	20,000	US$/MM	400,000	
- Hydrological Observation and Analysis	10	MM	20,000	US$/MM	200,000	
- Water Quality Observation and Analysis	10	MM	20,000	US$/MM	200,000	
- Observation Equipment	5	MM	20,000	US$/MM	100,000	
- Observation Data Processing	10	MM	18,000	US$/MM	180,000	
- Information Network	10	MM	18,000	US$/MM	180,000	
- Geographical Information System	5	MM	18,000	US$/MM	90,000	
- Water Balance Analysis	5	MM	18,000	US$/MM	90,000	
- Database	10	MM	18,000	US$/MM	180,000	
Sub-Total					2,020,000	
3) Materials/Equipment						
- Meteorological and hydrological equipment	1	unit	200,000	US$/unit	200,000	
- Water quality equipment	1	unit	200,000	US$/unit	200,000	
- Personal computer (note book)	10	units	2,000	US$/unit	20,000	
- Printer (printer A3 size)	2	units	5,000	US$/unit	10,000	
- Arc Info (GIS)	5	units	10,000	US$/unit	50,000	
- Photocopy machine	1	unit	10,000	US$/unit	10,000	
- Audio visual equipment (for extension)	1	unit	10,000	US$/unit	10,000	as mobile unit
Sub-Total					500,000	
4) Training Courses						
- Training of provincial officers (30 officers)	10	times	5,000	US$/time	50,000	2 times/year
- Third country training (10 officers)	10	times	10,000	US$/time/p.	100,000	2 times/year
- International training (2 officers)	2	times	50,000	US$/time/p.	100,000	6 months
Sub-Total					250,000	
5) Others						
- Vehicle	2	units	50,000	US$/Car	100,000	
- Operation cost (1% of expert cost)	1	LS	45,000	US$/LS	45,000	
Sub-Total					145,000	
Total of Donor					**5,435,000**	
Vietnamese Government						
1) Counterpart personnel						
- Water resources planning (fulltime)	120	MM	1,000	US$/MM	120,000	2 officers
- Irrigation and drainage planning (fulltime)	120	MM	1,000	US$/MM	120,000	2 officers
- Hydrological observation & analysis (part-t)	60	MM	600	US$/MM	36,000	
- Water quality observation & analysis (part-t)	60	MM	400	US$/MM	24,000	
Sub-Total					300,000	
2) Facilities						
- Office space	1	unit	5,000	US$/unit	5,000	5 year
- Farm plots for pilot activities	40	units	200	US$/unit	8,000	4 unit/district
Sub-Total					13,000	
3) Others						
- Operation cost (5% of expert cost)			15,000	US$/unit	15,000	
- Tax exemption						
Sub-Total					15,000	
Total of Vietnamese Gov.					**328,000**	
Grand Total					**5,763,000**	

Source: JICA Study Team

3.7 Project Design Matrix (PDM) and Plan of Operation (PO)

Project Design Matrix (PDM) of the technical cooperation project is attached hereunder, which is summarized based on the contents as described above. Then, specific Plan of Operation (PO) is also drafted and attached.

Project Design Matrix (PDM) __Ver.0.1

Project Title: The Project on Capacity Development for Flow Water Management in Mekong Delta
Target Area: Coastal Mekong Delta)

Duration: April 1, 2014 to March 31, 2019
Target Group: Technical Officers under DARD

December 5, 2012

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Inter-provincial and integrated flow water management system for sustainable agricultural and rural development in adaptation to the climate change is expanded to the coastal Mekong Delta.	1. Staff of MARD and related organizations in charge of flow water management has capacity to implement inter-provincial and integrated flow water management in the coastal Mekong Delta. 2. An organization which collects and manages all data/information for the inter-provincial and integrated flow water management is established in the coastal Mekong Delta. 3. Training system for the inter-provincial and integrated flow water management in the MARD, MONRE and related organizations is established in the coastal Mekong Delta. 4. National and provincial budget for the inter-provincial and integrated flow water management is secured in the coastal Mekong Delta.	- Monitoring report - Sample survey - Statistic data (MARD, DARD)	- National water resources management system is not drastically changed. - Government policy on agricultural and aquacultural production is not significantly changed. - Climate change happens generally as simulated.
Project Purpose In the project target areas, water resources information management system for flow water including fresh water and saline water is developed and adapted to contribute to	1. Staff of MARD and related organizations in charge of flow water management has capacity to	- Monitoring report	- Cooperation from related agencies and local authorities

sustainable agriculture and aquaculture in adaptation to salinity intrusion caused by climate change.	implement inter-provincial and integrated flow water management in the project target areas. 2. An organization which collects and manages all data/information for the inter-provincial and integrated flow water management is established in the project target areas. 3. Training system for the inter-provincial and integrated flow water management in the MARD, MONRE and related organizations is established in the project target areas. 4. National and provincial budget for the inter-provincial and integrated flow water management is secured in the project target areas.	- Sample survey - Statistic data (MARD, DARD)	are continued. - Water resources management system and personnel at provincial level are not radically changed. - Mandate and manpower of implementing agency is not changed
Outputs 1. In the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation.	1-1 In the project target areas, an inter-provincial and integrated flow water management plan is formulated. 1-2 Numbers of MARD and related organizations officers in charge of flow water management in the project target areas.	- Project report	- Expected number of officers in charge of flow water management is assigned to the project at provincial and district level. - Outputs from the model activities are applied in other areas along coastal Mekong delta.
2. At both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened.	2-1 Future plans of MARD and SIWRP on flow water management covering personnel and budget is prepared. 2-2 Training plan, training materials and number of trainers 2-3 Percentage of MARD, DARD and	- Project report	

	SIWRP officers attend training courses by the end of this project. 2-4 In the project target areas, MARD and related organizations' institutional setup and budgetary system for water flow management are clearly defined and operated.		
Activities 1-1 SIWRP determines pilot areas. 1-2 SIWRP analyzes the current situations of relevant organizations in the field of flow water management in the pilot areas. 1-3 SIWRP makes a basic design of observation network, computer systems and information network. 1-4 SIWRP formulates a observation plan of fresh water and saline water. 1-5 SIWRP installs observation equipments. 1-6 SIWRP conducts training courses for observation and observation data processing to the officers of DARDs and IMCs. 1-7 SIWRP formulates observation data storing, managing and sharing. 1-8 SIWRP, DARDs and IMCs conduct observation. 1-9 SIWRP, DARDs and IMCs reflect the observation results to the exiting gate operation. 1-10 MARD, DARDs and SIWRP formulate an integrated flow water management plan including observation plan and gate installation, operation and maintenance plan in the pilot area. 2-1 SIWRP analyzes the current situations of flow	**Inputs** **<u>Donor</u>** 1) Experts - Chief Advisor/ Water Resources Policy 1 person - Water Resources Planning 1 person - Irrigation and Drainage Planning 1 person - Hydrological Observation and Analysis 1 person - Water Quality Observation and Analysis 1 person - Observation Equipment 1 person - Observation Data Processing 1 person - Information Network 1 person - Geographical Information System 1 person - Water Balance Analysis 1 person - Database 1 person - Coordinator 1 person 2) Materials/Equipment - Meteorological & hydrological observation equipment 1 unit - Water quality observation equipment 1 unit - Office equipment (copy machine etc.) 1 unit - Computer software (GIS etc.) 4 unit - Vehicle 2 units		- Counterparts are assigned continuously and work actively. - Inputs from the donor and the government of Vietnam are timely and adequately provided. **Preconditions** - Project implementation is approved by related departments/agencies/organizations.

water management at the national and provincial level. 2-2 SIWRP establishes analysis system for flow water management including fresh water and saline water. 2-3 SIWRP advises MARD on institutional and organizational arrangement for future inter-provincial/ river basin-based flow water management including the system of information sharing among relevant organizations. 2-4 SIWRP establishes training systems for the effective and integrated flow water management including fresh water and saline water management.	3) Training Courses - Training of provincial officers 30 officers/time (2 times/year) - Third country training 10 officers/time (2 times/year) - International training 2 officers/time (6 months) - 4) Others - Operation cost as required **<u>Vietnamese Government</u>** 1) Counterpart personnel - Water resources planning (fulltime) 1 officers - Irrigation and Drainage Planning (fulltime) 1 officers - Hydrological observation and analysis (part-time) 2 officers - Water Quality Observation and Analysis (part-time) 2 officers 2) Facilities - Land, buildings and facilities necessary for the project - Office space, furniture, facilities of communication and public utilities, and meeting rooms necessary for Japanese experts to undertake project activities - Other facilities mutually agreed upon as necessary for the implementation of the Project 3) Others - Operation cost as required - Tax exemption as required	- Production of paddy and brackish aquacultural commodities are kept as higher priority - Necessary infrastructure, such as sluice for saline water control, is well maintained and operated

Plan of Operation Ver.0.1

Project Title: The Project on Capacity Development for Flow Water Management in Mekong Delta

	Activities	Period (2014-2019)																								Remarks
		2014				2015				2016				2017				2018				2019				
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
0. Preparation of the project																										
0-1	Long term experts are dispatched																									
0-2	Project office is set up																									
0-3	Necessary equipments are procured and put in place																									
0-4	Joint Coordinating Committee is established																									
0-5	Short term experts/consultants are dispatched									as required																
0-6	Joint Coordinating Committee Meeting is carried out		▲		▲				▲				▲				▲					▲				
0-7	Monitoring																									
0-8	Reports		IC/R		P/R1				P/R2				P/R3				P/R4				DFR	FR				
Outputs 1. In the project target areas, MARD, MONRE and related organizations conduct observation of flow water including fresh water and saline water, share information from the observation and use it for the gate operation.																										
1-1	SIWRP determines pilot areas.																									
1-2	SIWRP analyzes the current situations of relevant organizations in the field of flow water management in the pilot areas.																									
1-3	SIWRP makes a basic design of observation network, computer systems and information network.																									
1-4	SIWRP formulates a observation plan of fresh water and saline water.																									
1-5	SIWRP installs observation equipments.																									
1-6	SIWRP conducts training courses for observation and observation data processing to the officers of DARDs and IWCs.																									
1-7	SIWRP formulates observation data storing, managing and sharing.																									
1-8	SIWRP, DARDs and IWCs conduct observation.																									
1-9	SIWRP, DARDs and IWCs reflect the observation results to the exiting gate operation.																									
1-10	MARD, DARDs and SIWRP formulate an integrated flow water management plan including observation plan and gate installation, operation and maintenance plan in the pilot area.																									
Output2. At both level of national and provincial level in the Mekong Delta, institutions and organizations for river basin based flow water management are strengthened.																										
2-1	SIWRP analyzes the current situations of flow water management at the national and provincial level.																									
2-2	SIWRP establishes analysis system for flow water management including fresh water and saline water.																									
2-3	SIWRP establishes training systems for the effective and integrated flow water management including fresh water and saline water management.																									
2-4	SIWRP advises MARD on institutional and organizational arrangement for future inter-provincial/ river basin-based flow water management including the system of information sharing among relevant organizations.																									

CHAPTER 4 RECOMMENDATIONS

To have the Project to be successfully implemented, several issues need to be addressed before the commencement of specific project activities. These issues are presented below as recommendations for the project approval for implementation and should also be referred to in the process of implementation:

- ✓ *Unpredictable climate change*: this project is proposed as to cope with agro-ecological changes to be incurred by expected climate change such as increased saline intrusion. Yet, extent and degree of climate change is difficult to precisely predict as it is associated with multiple factors worldwide. To keep the relevance of the project, therefore, selection of the specific project areas should be carefully done. Particularly, such area should be selected where climate change issues have already become obvious and the agricultural and aquacultural production systems are yet adapted to, whereby the same approach can be applied to the other areas in accordance with the actual progress of the climate change in the coastal Mekong delta.

- ✓ *Combination with infrastructure development project*: a change of production systems also requires a change of water management. Typically, quite a different water management is required for paddy cultivation and brackish shrimp culture as the former needs freshwater while the latter needs brackish water. To do proper control of brackish water, well-established infrastructure is essential. In this regard, project areas (pilot areas) should be selected from areas where there are sluices gates already put in place or otherwise so planned to implement with other development project such as establishment of sluice gate project, freshwater intake project, and improvement of canal system by, e.g. dredging, if any.

- ✓ *Application of modern technologies:* to cope with climate change issues, application of new technologies is essential. For example, use of new Horizontal-type Acoustic Doppler Current Profiler (H-ADCP) is useful for obtaining flow rate in tidal effected canals and rivers. Also, some technical advancement in terms of information and communication technology can widen the alternatives to be applied under the project, e.g. SCADA system. Therefore, combination with other technical assistances should be considered for the application of modern technologies.

- ✓ *Coordination between SIWRP and other institutes:* There should be a coordination mechanism in the process of disseminating collected information about water flow and quality (saline level). At present, DONRE is in charge of data measuring/ recording while the data is not shared with concerned provincial DARDs. Neither takes place for the collected, for example, saline content level by a DARD. If a provincial DARD finds that saline intrusion is coming up to a certain area, such information should be shared with, e.g. the province located at opposite of the Mekong tributary (e.g. Soc Tran vs. Tra Vinh). If such data is shared between the neighboring provinces, present gate operation could be improved even now. In this regards, SIWRP should be a coordination hub, through which such important information can be shared.