3.3.3 Impact on Crop Production by Flood Inundation under CC

Table 3.3.5 summarizes the simulation cases for flood inundation under climate change. Basically the cases are categorized in 3 groups as; 1) cases with the flood year's Mekong River discharge (2000), 2) cases with projected discharges by MRC including 1991-2000 average discharge, and 3) projected discharge taking into account 1% and 10% probabilities. Sea level rise has also been taken into account, e.g., 12 cm. 17 cm, 30/33 cm, 50 cm and 100 cm corresponding to relevant years and climate change scenarios of A1 (A1FI), B1 and B2. Note that the projected future discharge of Mekong River referred to those ones estimated under A1 scenario which gives higher volume of rainy season discharge than that estimated under scenario B2, which is thus considered to give more critical condition in the flood simulation.

Table 3.3.5 Simulation Cases for Flood Simulation

No.	Flood Simulation	Selection of the Discharge	Discharge Scenario	Sea Level Rise, cm	Sea Level Scenario
1	FY 2000	Year 2000	-	0	
2	FY 2000 SLR17	Year 2000	-	17	2030 B2&A1FI
3	FY 2000 SLR30	Year 2000	-	30	2050 B2
4	FY 2000 SLR50	Year 2000	-	50	2080 B1
5	FY 2000 SLR100	Year 2000	-	100	2100 A1FI
6	FBD 1991-2000	Average Discharge of 1991-2000 (MRC)	-	0	
7	FPD 2020 A1	Average Projected Discharge of 2011-2020	A1 (MRC)	12	2020 A1FI
8	FPD 2030 A1	Average Projected Discharge of 2021-2030	A1 (MRC)	17	2030 A1FI
9	FPD 2050 A1	Average Projected Discharge of 2041-2050	A1 (MRC)	33	2050 A1FI
10	FPD 1% A1	Probability 1% Projected Discharge	A1 (MRC)	33	2050 A1FI
11	FPD 10% A1	Probability 10% Projected Discharge	A1 (MRC)	33	2050 A1FI

Source; JICA Project Team

1) Damage Indexes under Flood Inundation

Flood inundation affects crop production and gives some damage to infrastructure such as houses and road. Damage index for flood inundation established in this section referred to the relevant research results including those by IAS-South Vietnam, SIWRP and also actual flood damage records in Mekong Delta in 2011. Interview and field investigation were done in provincial offices, commune office, and to farmers in Dong Thap and Tien Giang provinces which are generally prone to flood. Table 3.3.6 shows the damage indexes in percentage corresponding to inundation depth;

Table 3.3.6 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

With regard to estimating damage loss for paddy yield, there are two critical periods for growth against inundation; one is tillering stage and the other is maturing stage. Le Sam (2006)[7] had examined relationship between flood inundation depth and relevant paddy production loss in 1988 and 1989. Inundation with different depths was applied to experimental plots of paddy at tillering stage, flowering stage, and maturing stage, and the results are summarized in Figure 3.3.31. Based on the

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

liner approximation established for those data experimented by Le Sam, damage indexes in Table 3.3.6 were estimated.

For fruit, damage by inundation was estimated based on field interviews to fruit farmers living in Dong Thap and Tien Giang provinces. It was revealed that fertilization may be well associated with the level of fruit inundation damage in that serious damage tends to take place right after the application of fertilizers. Except for the effect of fertilization, fruit trees can usually survive about 3 weeks as the maximum period against inundation, and inundation period over 3 weeks may cause total loss of trees according to the farmers interviewed. Therefore, 25 cm inundation for 3 weeks period is set as the threshold, beyond which total loss takes place.

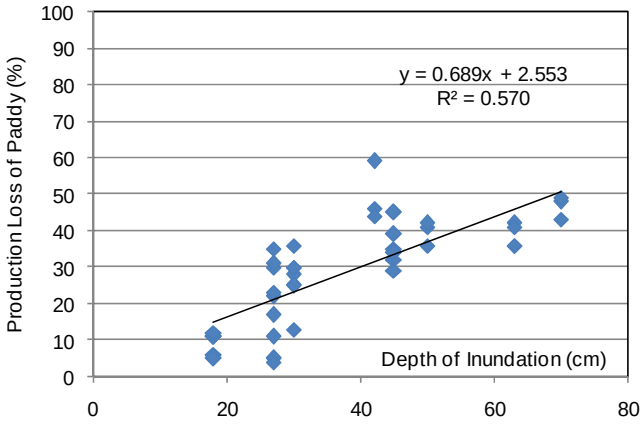


Figure 3.3.87 Inundation Depth and Yield Loss of Paddy
Source: Le Sam (2006), modified by JICA Study Team

Vegetables are well known not able to stand against inundation. According to interviews done in Dong Thap and Tien Giang provinces, only one day (or even one time) inundation is enough to cause total loss for the vegetable production. Therefore, 25 cm inundation for just one-day is set as the threshold, beyond which total loss for the vegetable production takes place. In case of less than 25 cm inundation, it is assumed that 10% loss of vegetable production takes place under one-day inundation.

With regard to shrimp culture, major problem caused by inundation is quite simple, for which shrimp can escape from the pond easily when the water level goes higher than the lowest portion of the bank of pond[8]. According to interviews, farmers said that only 10 cm water level rise is enough for shrimp to escape from the pond in some cases. On the other hand, there is usually a free board in the bank of pond. Also, sea level rise will proceed gradually, whereby farmers could, to certain extent, keep in raising the bank level of the pond by any means. Consequently, it is assumed that 50 cm depth of inundation is the threshold for shrimp to escape.

On the indigenous tree of Melaeuca, N. Marcar et al (1995) describes that Melaeuca has highly water-logging-tolerant and high salt tolerant characteristics, though there is no exact record or experimental results for survival rate under flood inundation. SIWRP considers commercial value of Melaleuca will decrease after deep inundation. Index of 50% damage is, therefore, considered to be fair under 3m inundation condition. Under inundation of 2.0 – 3.0 m, it is now assumed that 25% damage takes place.

2) Yield Loss and Damages under Flood Inundation

Figure 3.3.88 to Figure 3.3.91 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. Also, Figure 3.3.92 to Figure 3.3.95 do the same under the case of year 2050[9] projected Mekong River discharge by MRC under CC scenario A1 with the sea level rise 33 cm. These figures indicate;

1) As expected, severe flood takes place upper most reach of the Mekong Delta such as Dong Thap

[8] A fish farmer can sell fish before flood coming but the price of fish may decrease immediately because many farmers try to sell their fish out before serious flood arrival. Farmers may be able to receive inundation indemnity from the government if they have a loss.

[9] The discharge of 2050 was estimated based on the average discharge from 2040 to 2050. Note that MRC's simulation has been done up to year 2050.

and An Giang provinces. Along the coastal areas, the flooding level is not as severe as those in the upper reach of the Delta. However, since Kien Giang province is located upstream of the Delta bordering An Giang province, the province tends to be affected more as compared to other coastal provinces. In addition, upper reach of Tien Giang province is also affected by flood since this area receives not only Mekong River's flood discharge but also runoff coming from 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, the flood inundation level hits the peak in September and October. In detail, 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.

4) The difference between the ones with the FY 2000 discharge and the ones with future projected discharge is that the flooding level is much less extent in case of latter. This trend shows up almost over the Delta from the upstream to the downstream. This is because the future discharge simulated by MRC is not as big as the discharge of FY 2000, which is the biggest flood ever recorded.

Figure 3.3.96 to Figure 3.3.103 show the change of flood affected areas by inundation depth and by month for the case of FY 2000 Mekong River discharge with 30 cm sea level rise corresponding to year 2050's expected sea level rise under CC scenario B2. Figure 3.3.104 to Figure 3.3.111 do the same with the Mekong River future discharge of year 2050 simulated under CC scenario A1 with 33 cm sea level rise corresponding to A1 scenario's 2050 sea level rise. In addition, Figure 3.3.112 to Figure 3.3.119 show the change of flood affected areas for the case of FY 2000 Mekong River discharge with 100 cm sea level rise corresponding to year 2100's sea level under CC scenario A1FI. These figures indicate;

1) Least affected province by flood inundation under FY 2000 discharge may be Ben Tre and Tra Vinh, for which one can see relatively large areas affected in the shallower ranges such as less than 25 cm inundation depth, as shown in for example Figure 3.3.97 and Figure 3.3.98. In case that future Mekong River discharge is applied, all the provinces but Tien Giang and Kien Giang would be much less affected. As aforementioned, Tien Giang receives flood through Dong Thap province and Kien Giang borders with An Giang province, through which huge amount of flood discharge is supplied.

2) From Figure 3.3.104 to Figure 3.3.111 where 100 cm sea level rise is given, large extent of areas are affected by flood inundation. Even Ben Tre and Tra Vinh provinces are not exceptional though the inundation depths are not as deep as those of other provinces. Kien Giang is the most affected province by the flood inundation under 100 cm sea level rise. Most of the areas will be inundated more that 1.0 m.

Figure 3.3.120 to Figure 3.3.127 show change (decrease) in the production of rice, vegetable and shrimp, and change in the area of fruit and forest according to the level of flood inundation. The figures are summarized for the case of FY 2000 discharge with different sea level rises such as 17 cm (2030 B2 scenario), 30 cm (2050 B2), 50 cm (2080 B1) and 100 cm (2100 A1FI). On the other hand, Figure 3.3.128 to Figure 3.3.135 show the same production/area change in case of future projected

Mekong River discharge with different sea level rise of 12 cm (2020 A1FI), 17 cm (2030 A1FI) and 33 cm (2050 A1FI). In the latter case, the examination covers up to year 2050 only since the future Mekong River discharge is available till year 2050. These figures indicate;

1) Least affected province in terms of percentage change is Tra Vinh, and followed by Ben Tre and Bac Lieu till year 2050, which are corresponding to the flood inundation level as aforementioned. Tien Giang and Kien Giang provinces show the largest reduction in production/area in terms of percentage.

2) The most affected crop is vegetable as expected, followed by paddy, fruit and shrimp. Forest is the least affected and in fact almost nil damage takes place even under 100 cm sea level rise. Comparing paddy and fruit, usually fruit is more susceptible to inundation than paddy. However, in most cases fruits are planted at relatively higher ground while the paddy in lower lands. This situation attributed to the result where paddy is more affected by flood than fruit.

Figures 3.3.136 to 3.3.143 correspond to figures 3.3.120 to 3.3.127 while Figures 3.3.144 - 3.3.151 correspond to Figures 3.3.128 to 3.3.135. Those figures show the damage or reduction in terms of monetary value in billion VND. Figures 3.3.136 to 3.3.143 are summarized for the case of FY 2000 discharge with different sea level rises while Figures 3.3.144 to Figure 3.3.151 show the change/reduction in billion VND in case of future projected Mekong River discharge with different sea level rises. These figures indicate;

1) As aforementioned, in terms of percentage, what was affected the most was vegetable. However, in terms of monetary value, the most affected production/area is either fruit or shrimp, and in a case it is paddy. Since the cultivated area of vegetable is not big in the Delta whereby the damage in terms of monetary value is not as big as the one estimated as percentage change. Tien Giang and Ben Tre are in fact very famous for fruit production, whereby the damage of the fruit comes first. In Kien Giang province, there is large extent of paddy fields whereby the damage of paddy in terms of monetary value shows the most.

2) Damage cost for shrimp shows sharp increase in the monetary change at latter years where bigger sea level rises were applied. Since shrimp damage was assumed to take place at certain inundation depth where shrimp can start escaping from the pond, with for example 100 cm sea level rise the damage shows up in a larger magnitude of extent.

Figure 3.3.152 and Figure 3.3.153 show the change in production/area in terms of percentage by province. Likewise, Figure 3.3.154 and Figure 3.3.155 indicate the change (damage) in terms of monetary value by province. As shown in these figures, 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.

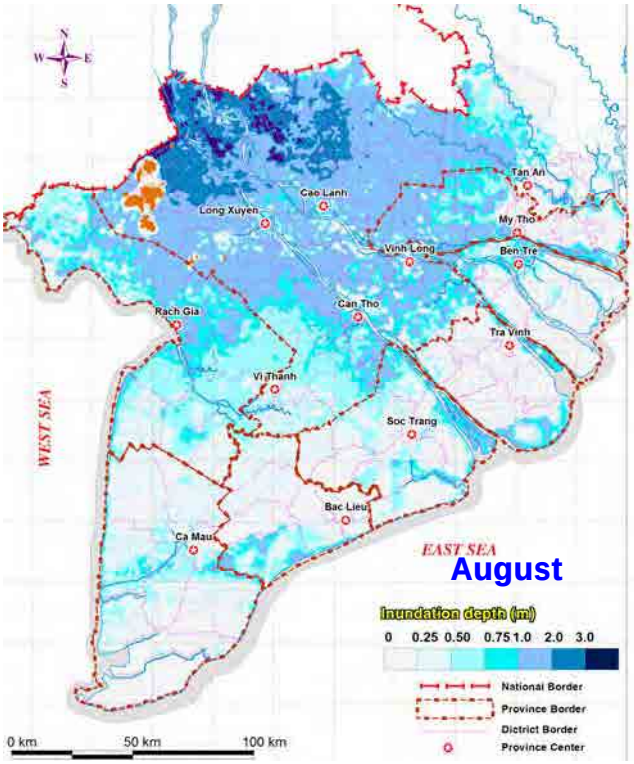


Figure 3.3.88 Flood Isolines of August for FY2000 MR Discharge with 30 cm SRL (2050)

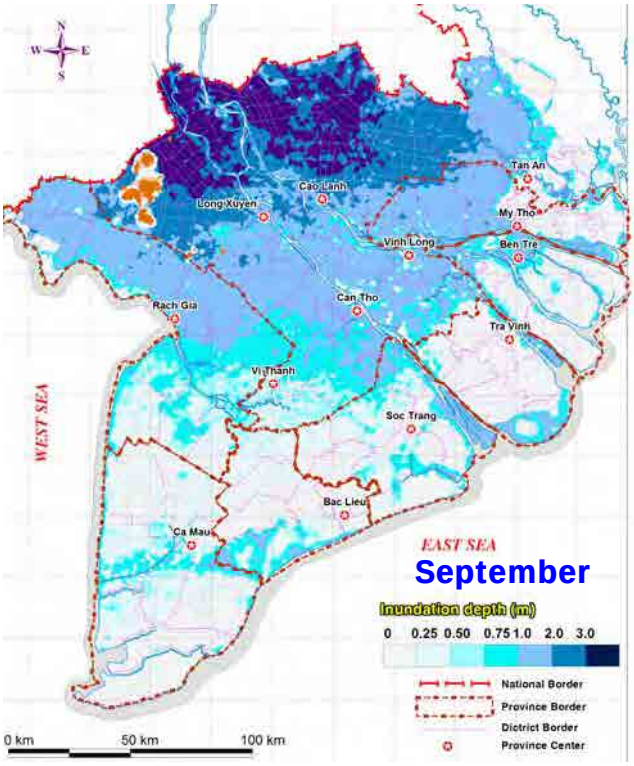


Figure 3.3.89 Flood Isolines of September for FY2000 MR Discharge with 30 cm SRL (2050)

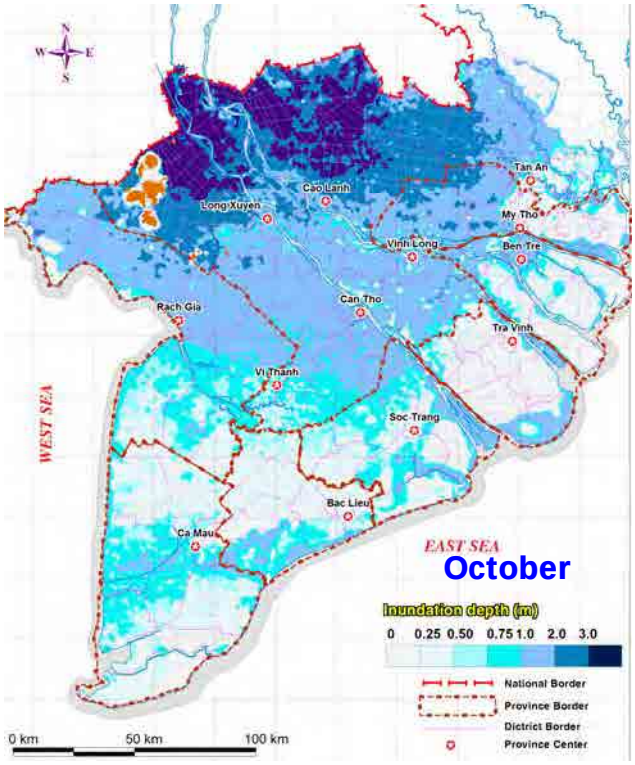


Figure 3.3.90 Flood Isolines of October for FY2000 MR Discharge with 30 cm SRL (2050)

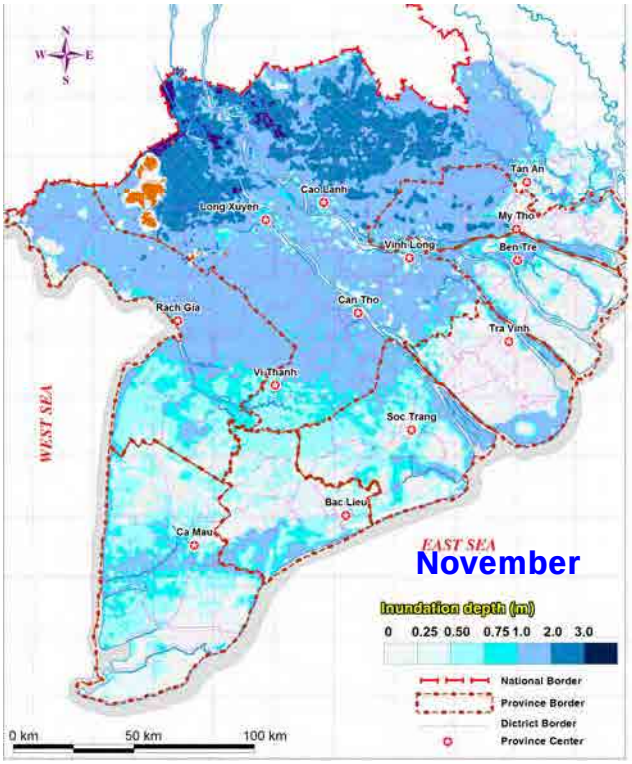


Figure 3.3.91 Flood Isolines of November for FY2000 MR Discharge with 30 cm SRL (2050)

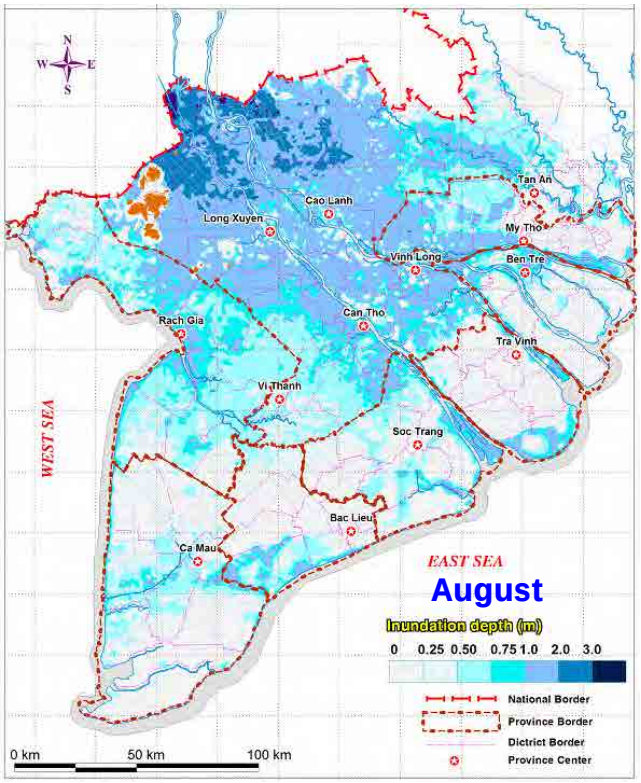


Figure 3.3.92 Flood Isolines of August for Scenario A2 with 33 cm SRL (2050)

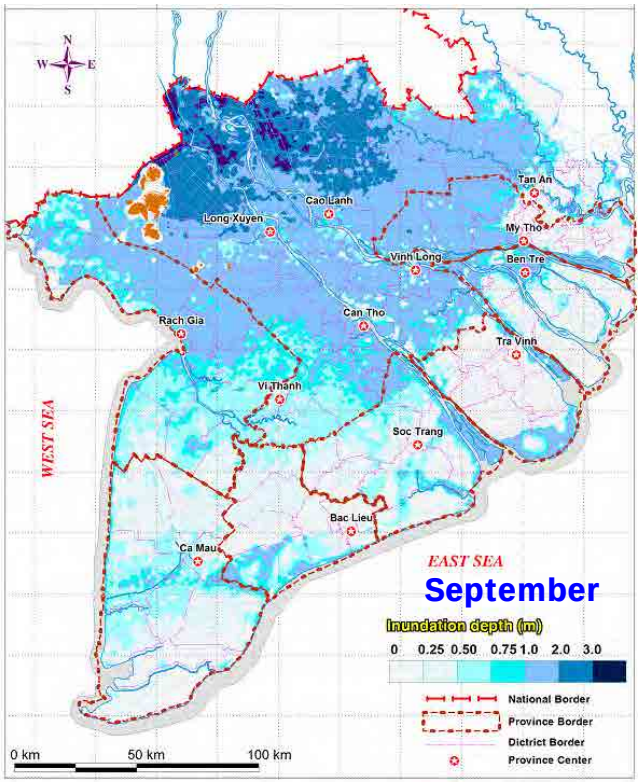


Figure 3.3.93 Flood Isolines of September for Scenario A2 with 33 cm SRL (2050)

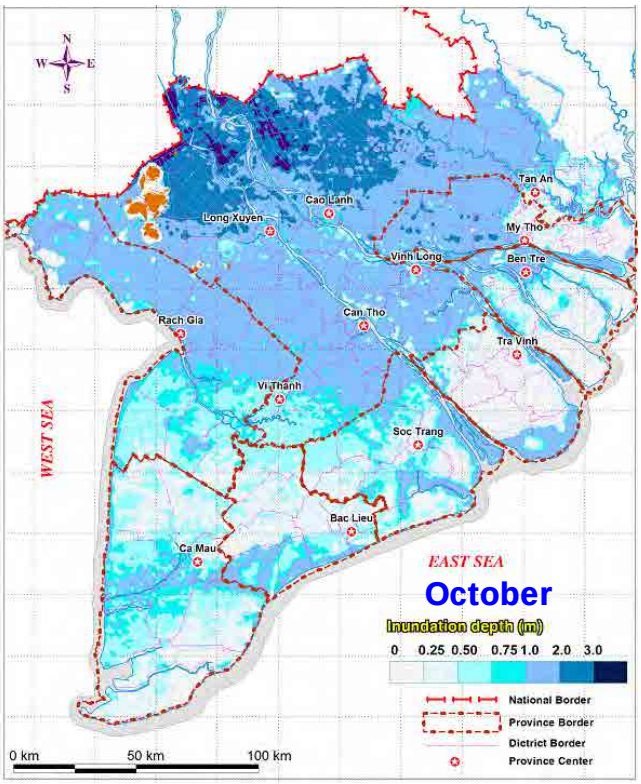


Figure 3.3.94 Flood Isolines of October for Scenario A2 with 33 cm SRL (2050)

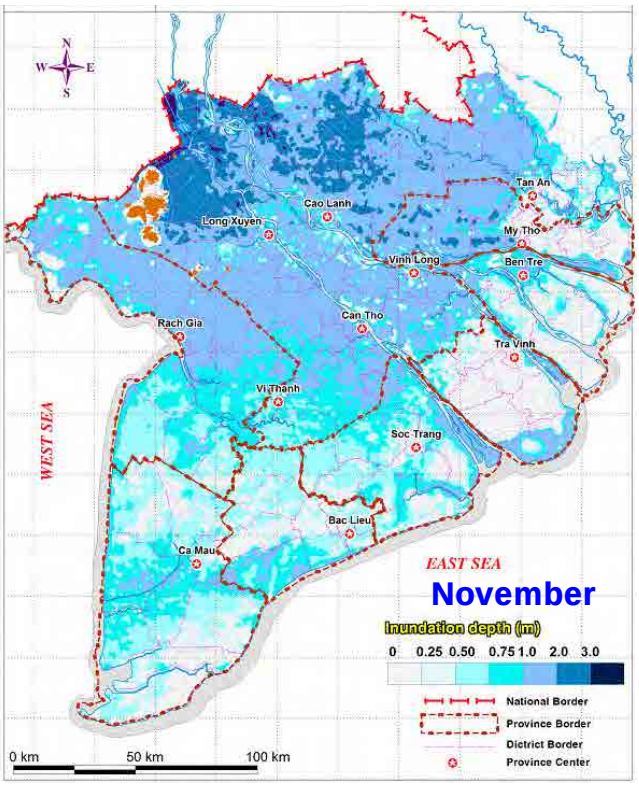


Figure 3.3.95 Flood Isolines of November for Scenario A2 with 33 cm SRL (2050)

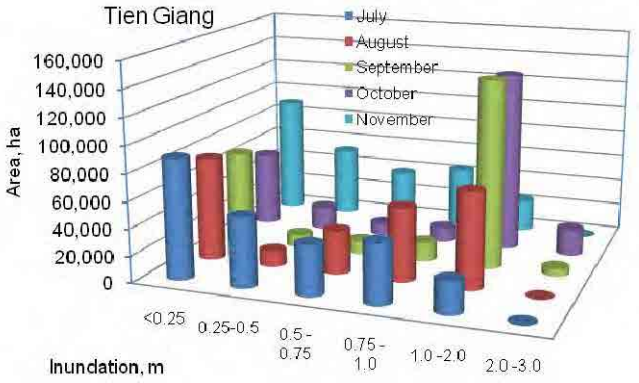


Figure 3.3.96 Inundation Area for Tien Giang Province (FY2000 MR Discharge with 30cm SLR, 2050)

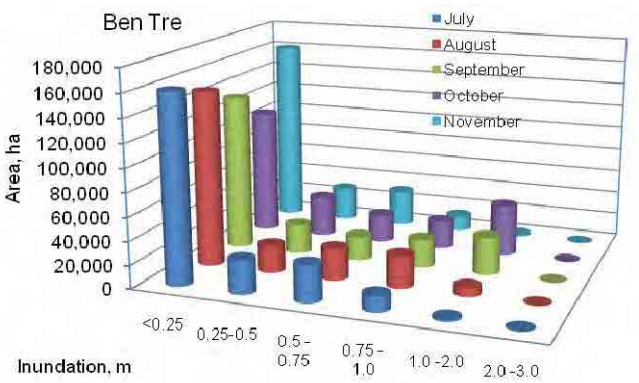


Figure 3.3.97 Inundation Area for Ben Tre Province (FY2000 MR Discharge with 30cm SLR, 2050)

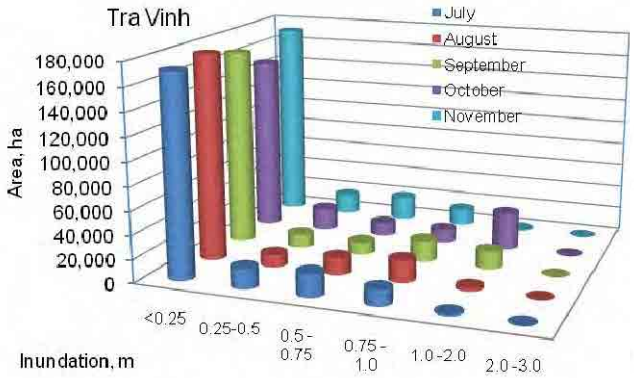


Figure 3.3.98 Inundation Area for Tra Vinh Province (FY2000 MR Discharge with 30cm SLR, 2050)

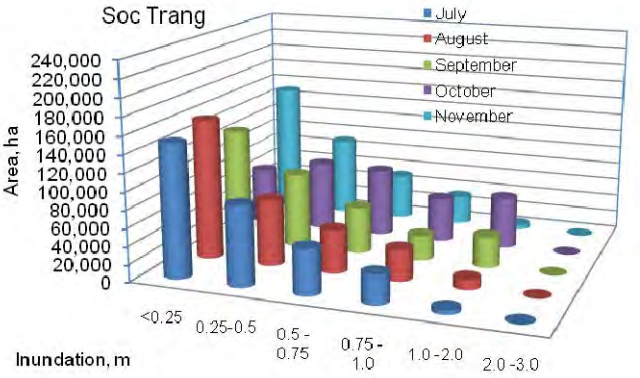


Figure 3.3.99 Inundation Area for Soc Trang Province (FY2000 MR Discharge with 30cm SLR, 2050)

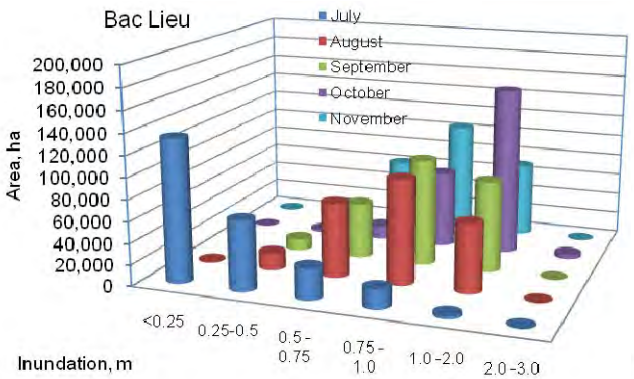


Figure 3.3.100 Inundation Area for Bac Lieu Province (FY2000 MR Discharge with 30cm SLR, 2050)

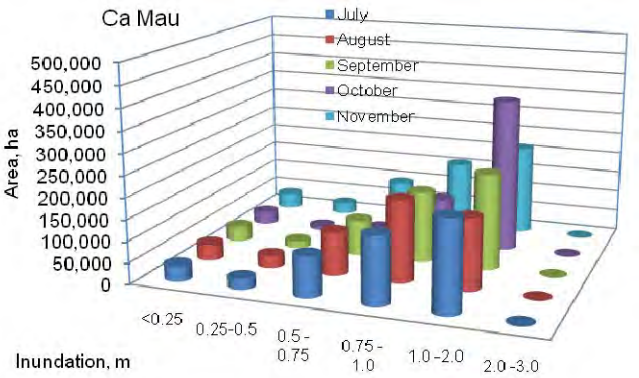


Figure 3.3.101 Inundation Area for Ca Mau Province (FY2000 MR Discharge with 30cm SLR, 2050)

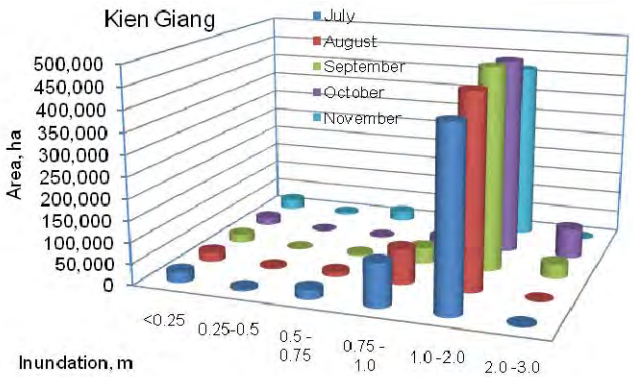


Figure 3.3.102 Inundation Area for Kien Giang Province (FY2000 MR Discharge with 30cm SLR, 2050)

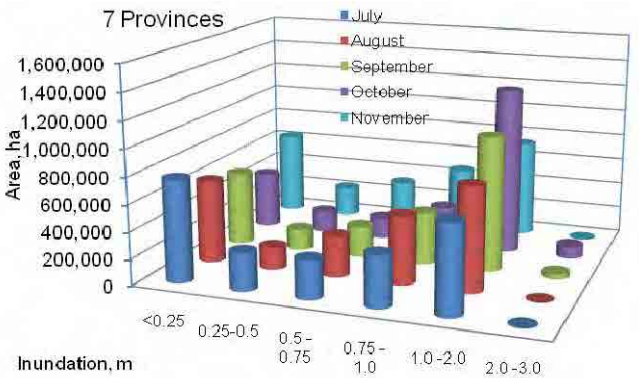


Figure 3.3.103 Inundation Area for 7 Provinces (FY2000 MR Discharge with 30cm SLR, 2050)

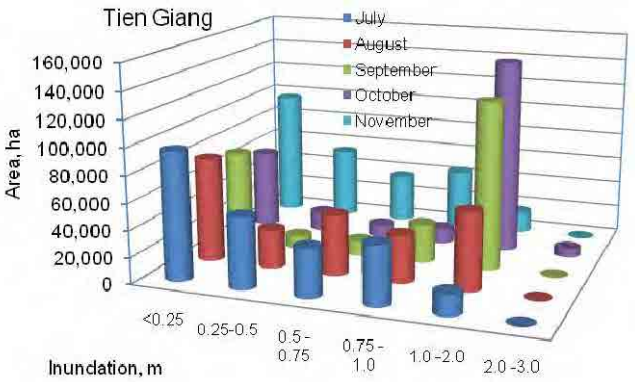


Figure 3.3.104 Inundation Area for Tien Giang Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

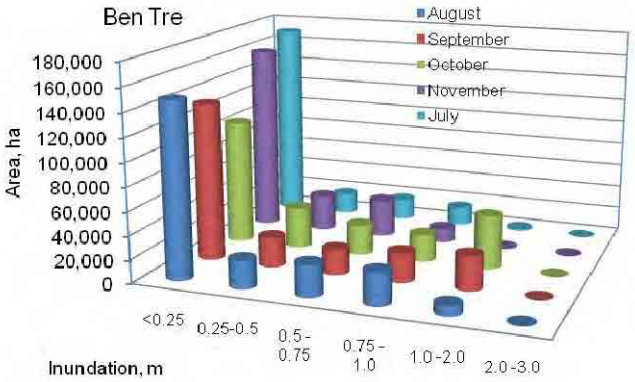


Figure 3.3.105 Inundation Area for Ben Tre Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

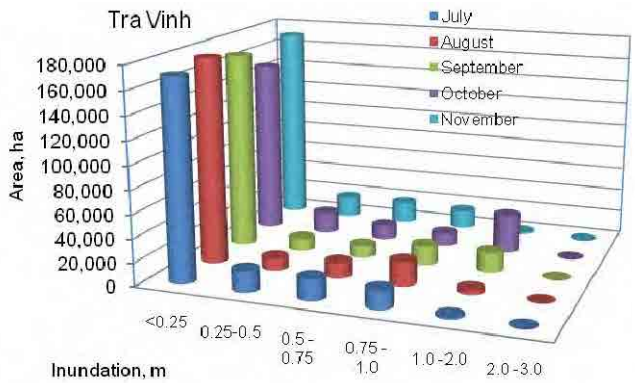


Figure 3.3.106 Inundation Area for Tra Vinh Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

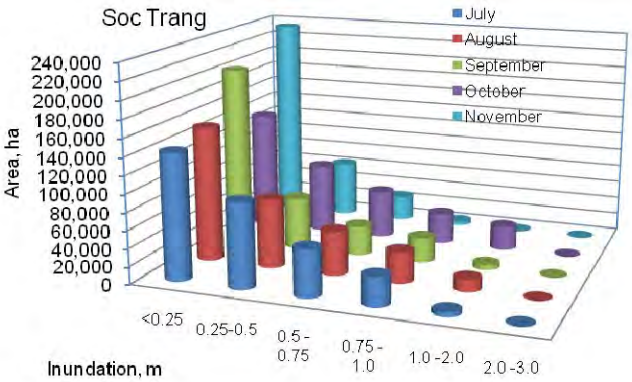


Figure 3.3.107 Inundation Area for Soc Trang Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

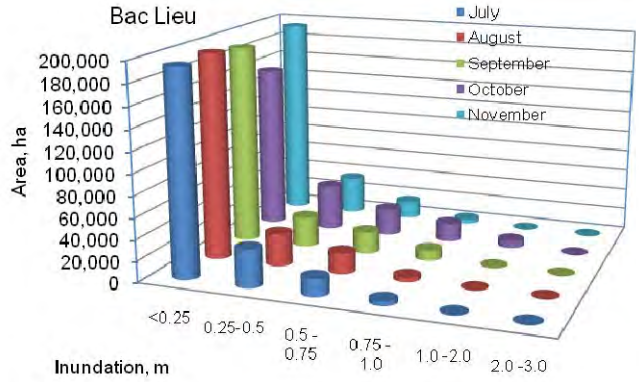


Figure 3.3.108 Inundation Area for Bac Lieu Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

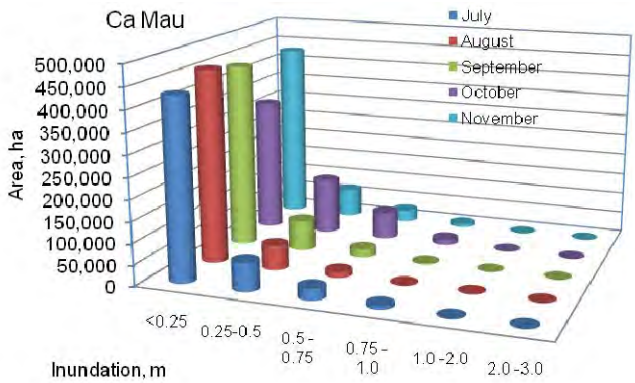


Figure 3.3.109 Inundation Area for Ca Mau Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

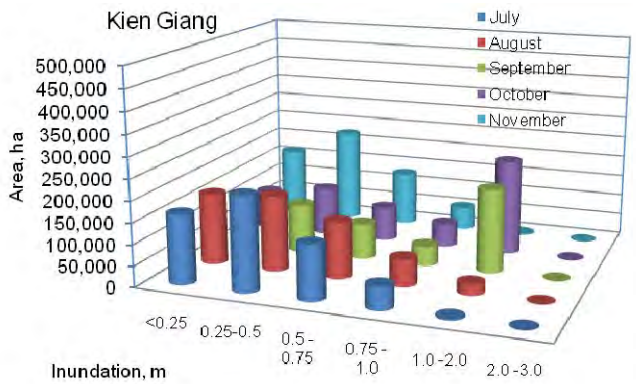


Figure 3.3.110 Inundation Area for Kien Giang Province (Scenario A2 MR Discharge with 33cm SLR, 2050)

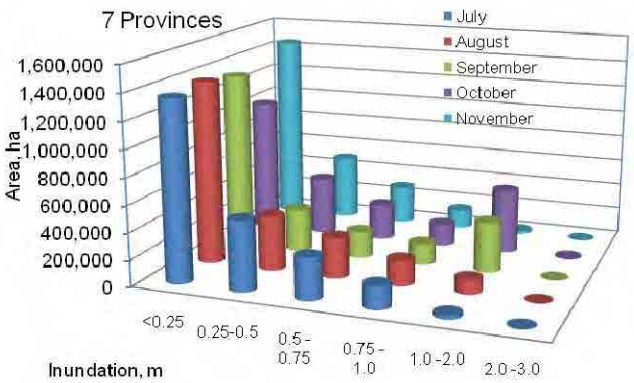


Figure 3.3.111 Inundation Area for 7 Provinces (Scenario A2 MR Discharge with 33cm SLR, 2050)

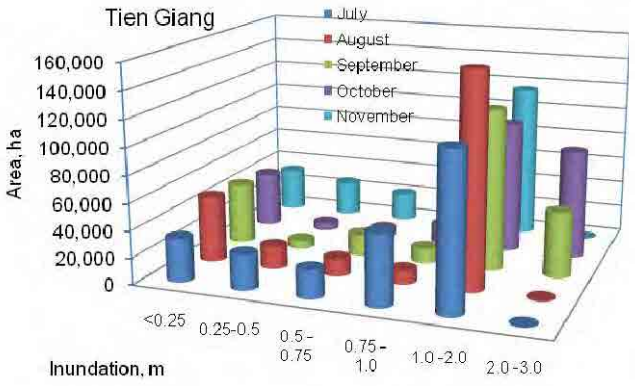


Figure 3.3.112 Inundation Area for Tien Giang Province (FY2000 MR Discharge with 100cm SLR, 2100)

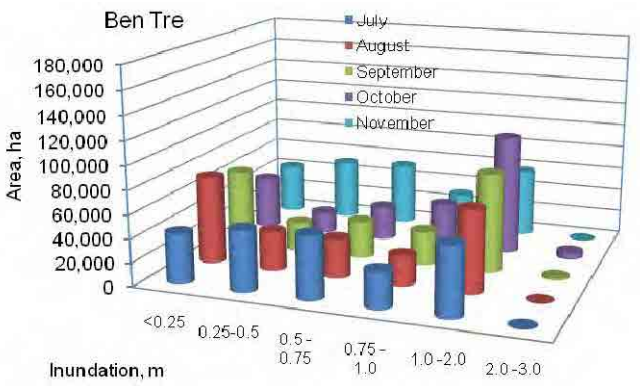


Figure 3.3.113 Inundation Area for Ben Tre Province (FY2000 MR Discharge with 100cm SLR, 2100)

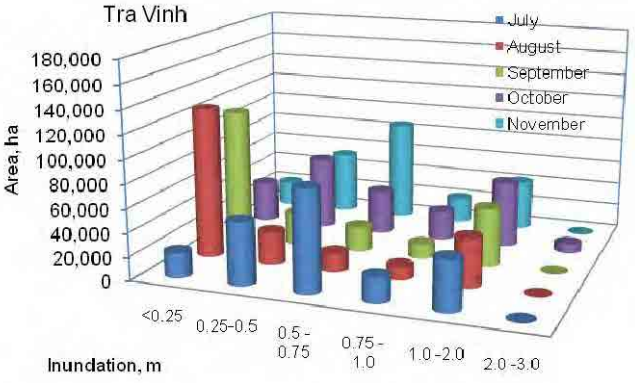


Figure 3.3.114 Inundation Area for Tra Vinh Province (FY2000 MR Discharge with 100cm SLR, 2100)

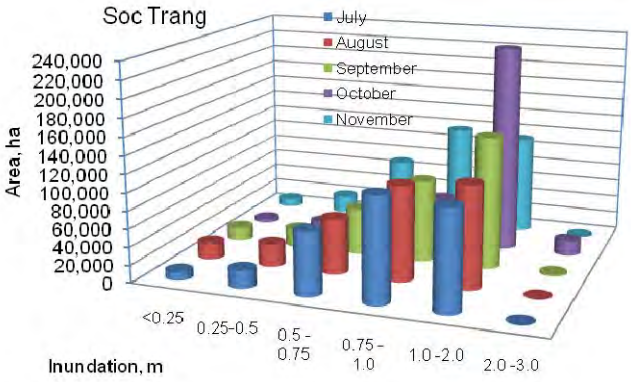


Figure 3.3.115 Inundation Area for Soc Trang Province (FY2000 MR Discharge with 100cm SLR, 2100)

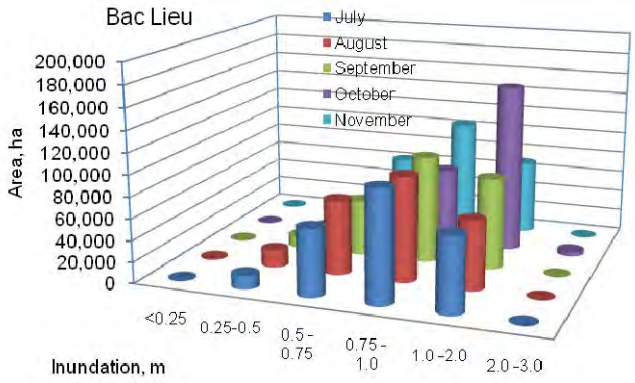


Figure 3.3.116 Inundation Area for Bac Lieu Province (FY2000 MR Discharge with 100cm SLR, 2100)

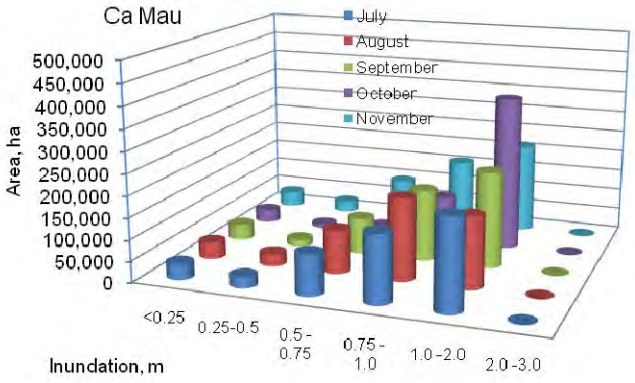


Figure 3.3.117 Inundation Area for Ca Mau Province (FY2000 MR Discharge with 100cm SLR, 2100)

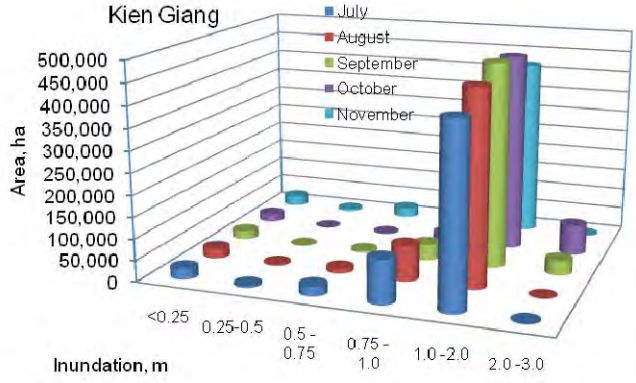


Figure 3.3.118 Inundation Area for Kien Giang Province (FY2000 MR Discharge with 100cm SLR, 2100)

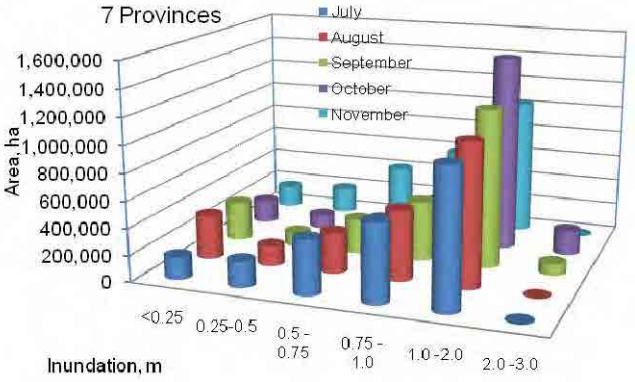


Figure 3.3.119 Inundation Area for 7 Provinces (FY2000 MR Discharge with 100cm SLR, 2100)

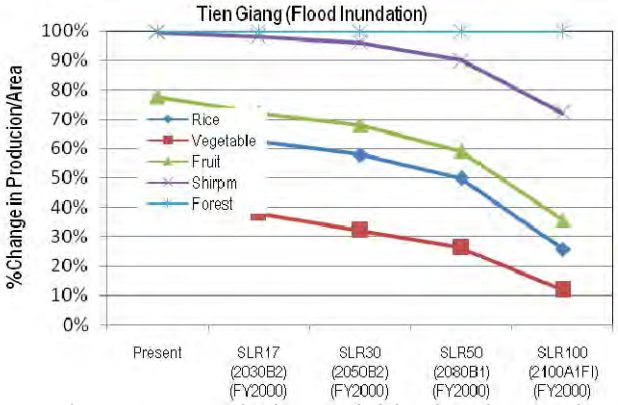


Figure 3.3.120 Production Loss(%) for Tien Giang Province (FY2000 MR Discharge with Different SLR)

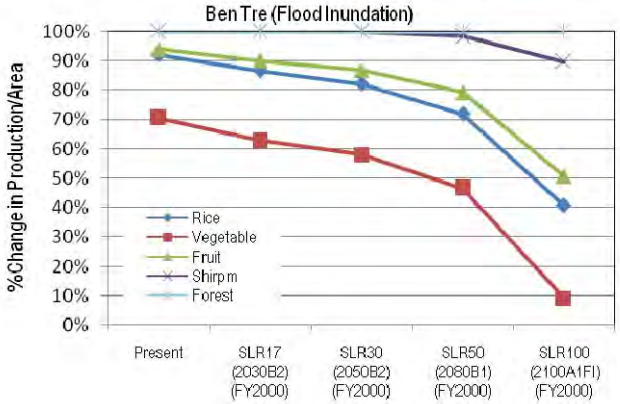


Figure 3.3.121 Production Loss(%) for Ben Tre Province (FY2000 MR Discharge with Different SLR)

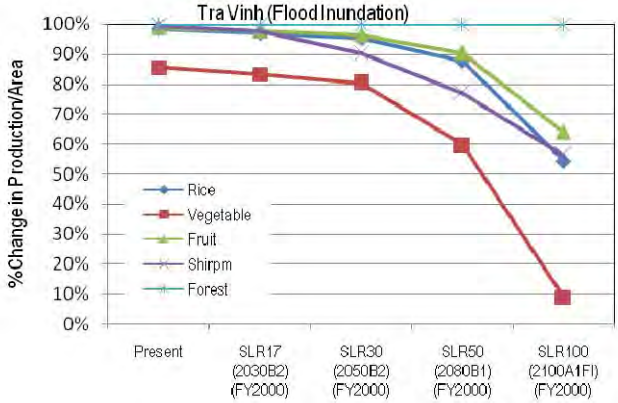


Figure 3.3.122 Production Loss(%) for Tra Vinh Province (FY2000 MR Discharge with Different SLR)

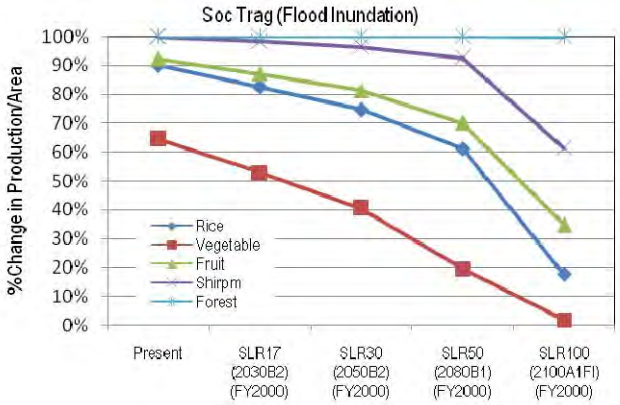


Figure 3.3.123 Production Loss(%) for Soc Trang Province (FY2000 MR Discharge with Different SLR)

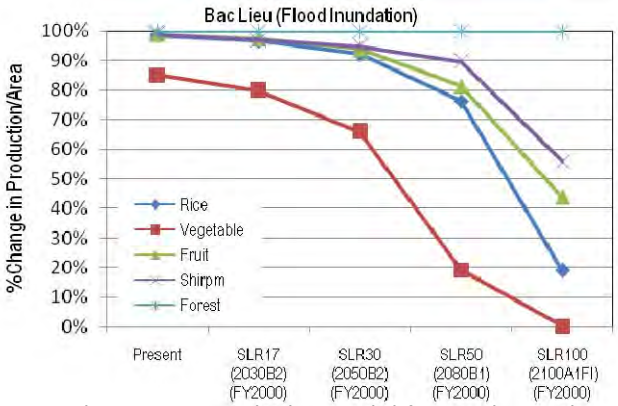


Figure 3.3.124 Production Loss(%) for Bac Lieu Province (FY2000 MR Discharge with Different SLR)

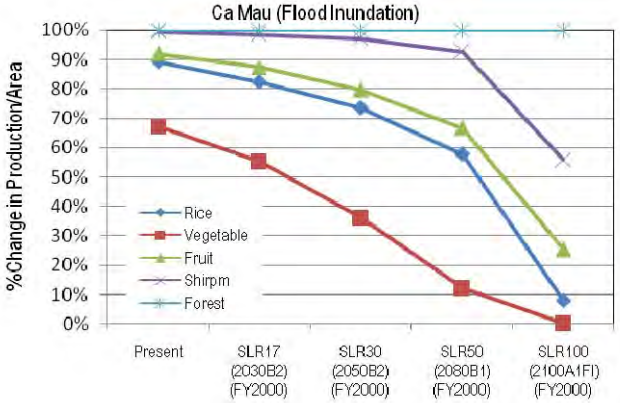


Figure 3.3.125 Production Loss(%) for Ca Mau Province (FY2000 MR Discharge with Different SLR)

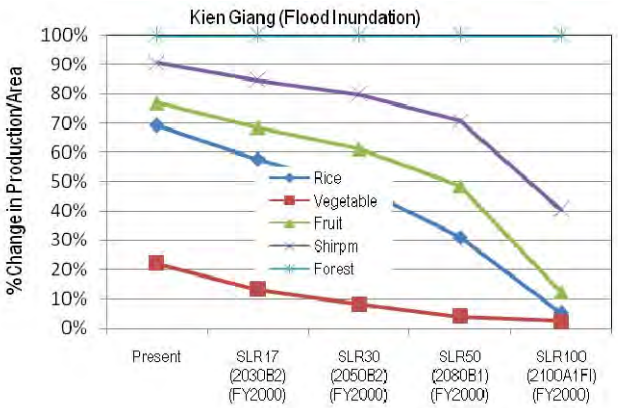


Figure 3.3.126 Production Loss(%) for Kien Giang Province (FY2000 MR Discharge with Different SLR)

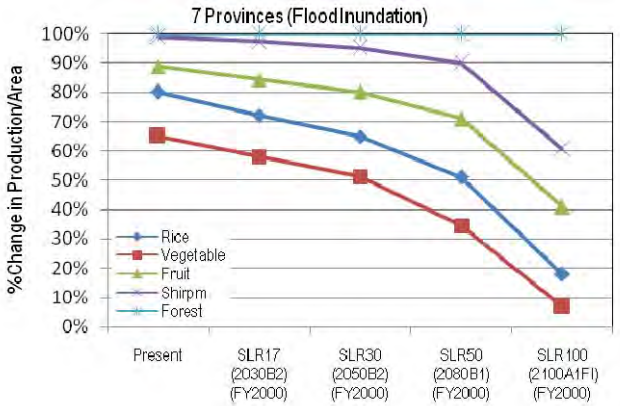


Figure 3.3.127 Production Loss(%) for 7 Provinces (FY2000 MR Discharge with Different SLR)

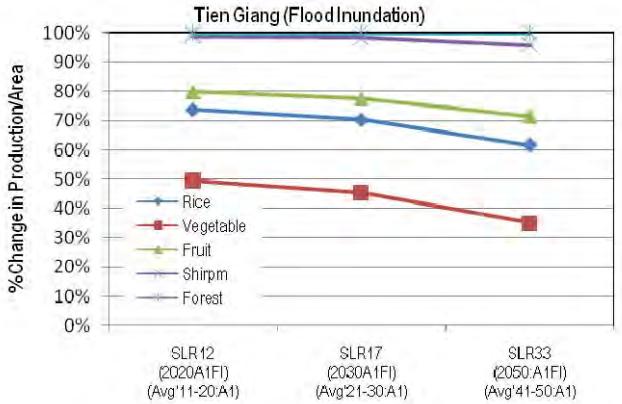


Figure 3.3.128 Production Loss(%) for Tien Giang Province (Scenario A1 MR Discharge with Different SLR)

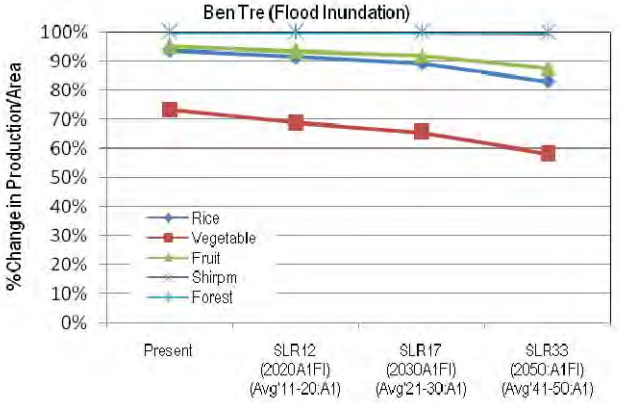


Figure 3.3.129 Production Loss(%) for Ben Tre Province (Scenario A1 MR Discharge with Different SLR)

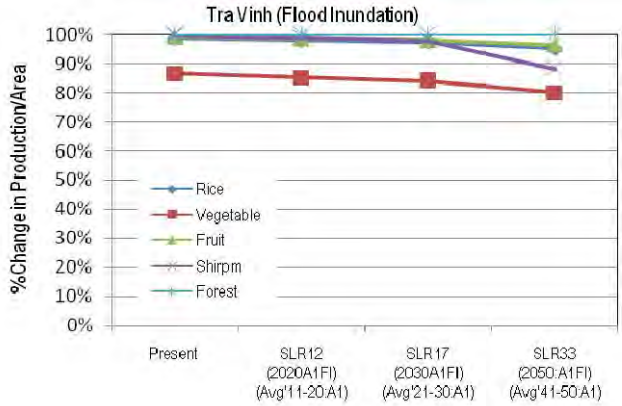


Figure 3.3.130 Production Loss(%) for Tra Vinh Province (Scenario A1 MR Discharge with Different SLR)

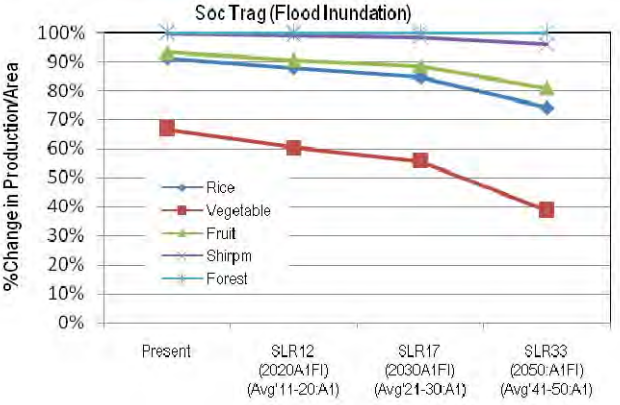


Figure 3.3.131 Production Loss(%) for Soc Trang Province (Scenario A1 MR Discharge with Different SLR)

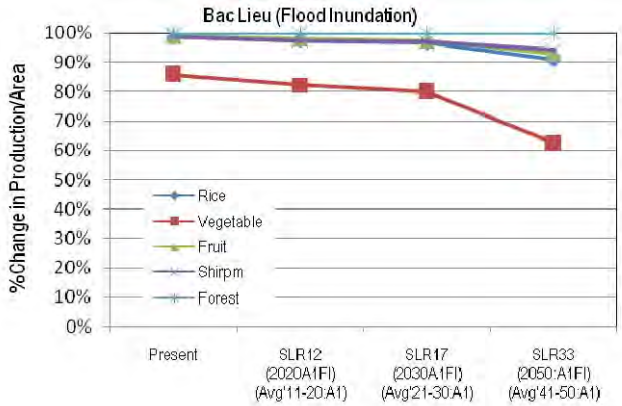


Figure 3.3.132 Production Loss(%) for Bac Lieu Province (Scenario A1 MR Discharge with Different SLR)

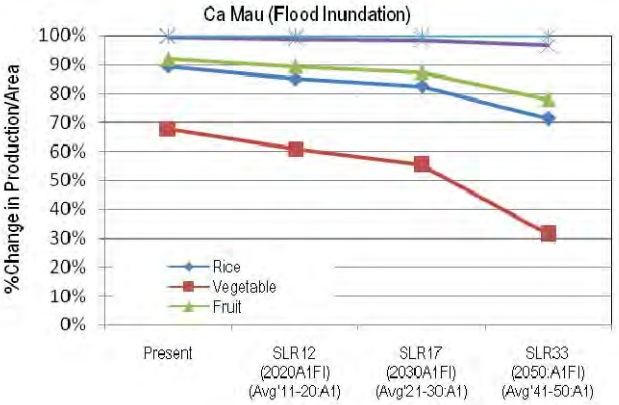


Figure 3.3.133 Production Loss(%) for Ca Mau Province (Scenario A1 MR Discharge with Different SLR)

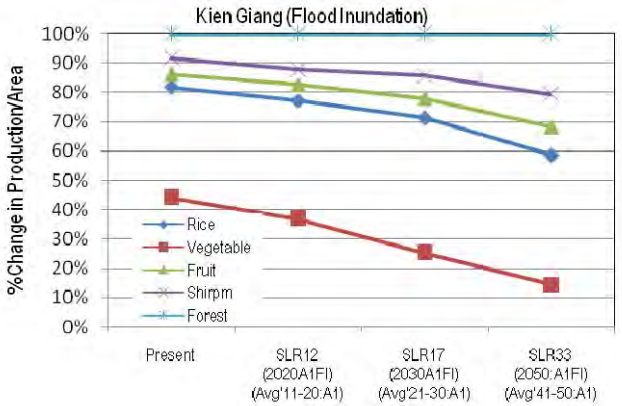


Figure 3.3.134 Production Loss(%) for Kien Giang Province (Scenario A1 MR Discharge with Different SLR)

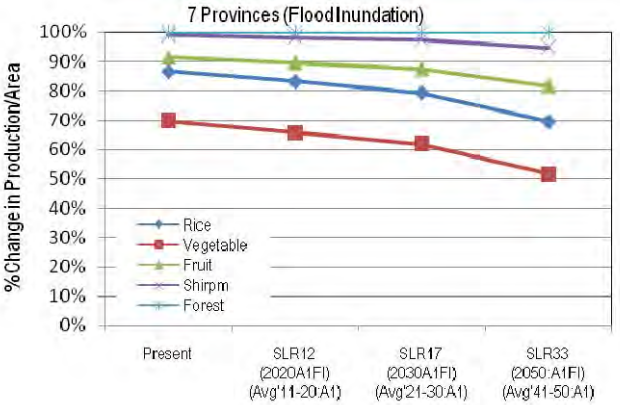


Figure 3.3.135 Production Loss(%) for 7 Provinces (Scenario A1 MR Discharge with Different SLR)

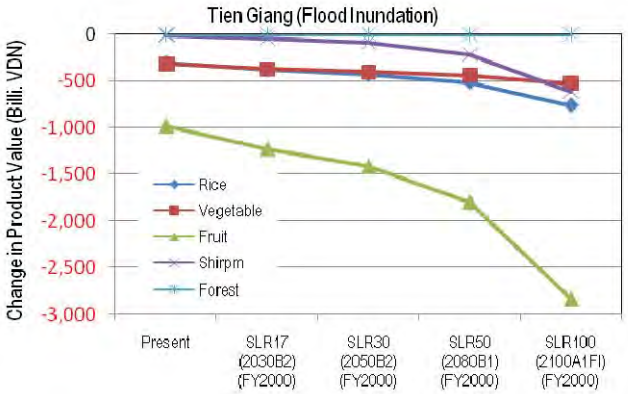


Figure 3.3.136 Production Loss(VND) for Tien Giang Province (FY2000 MR Discharge with Different SLR)

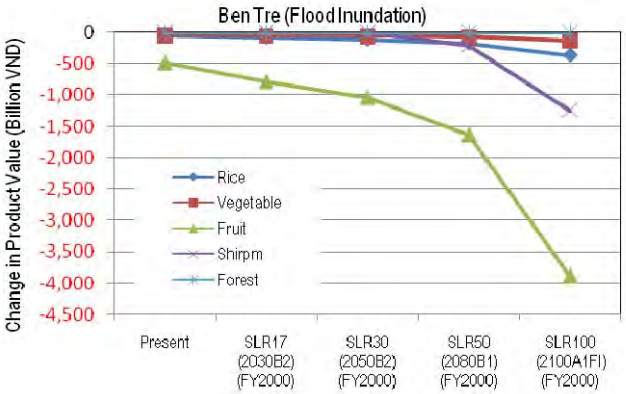


Figure 3.3.137 Production Loss(VND) for Ben Tre Province (FY2000 MR Discharge with Different SLR)

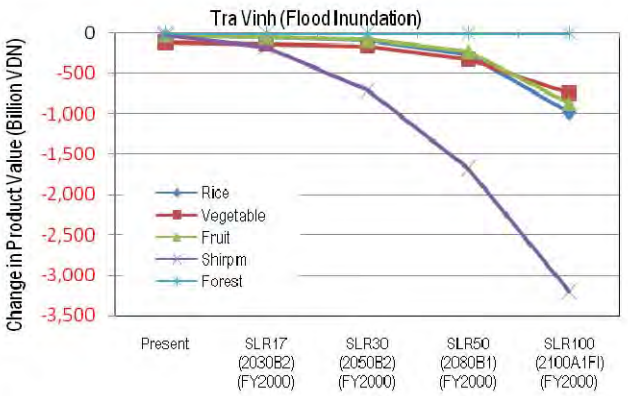


Figure 3.3.138 Production Loss(VND) for Tra Vinh Province (FY2000 MR Discharge with Different SLR)

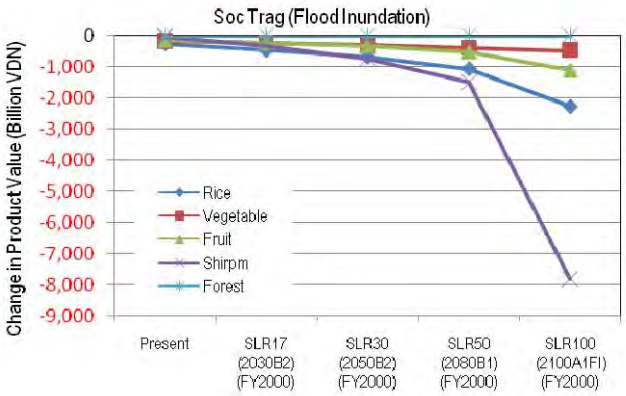


Figure 3.3.139 Production Loss(VND) for Soc Trang Province (FY2000 MR Discharge with Different SLR)

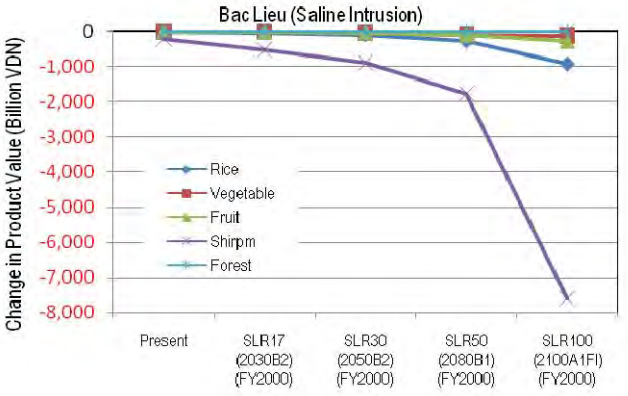


Figure 3.3.140 Production Loss(VND) for Bac Lieu Province (FY2000 MR Discharge with Different SLR)

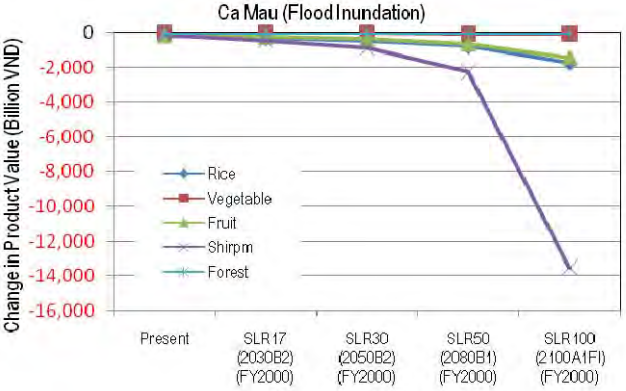


Figure 3.3.141 Production Loss(VND) for Ca Mau Province (FY2000 MR Discharge with Different SLR)

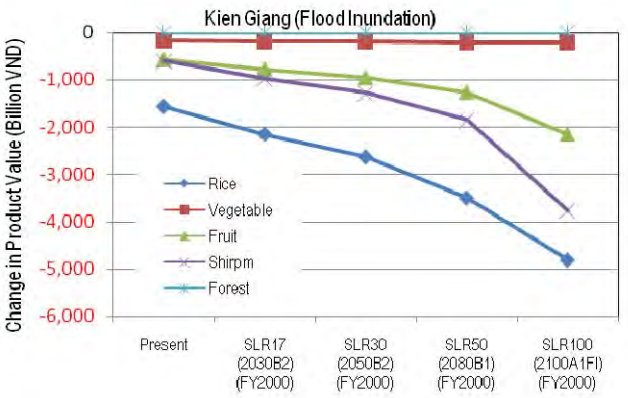


Figure 3.3.142 Production Loss(VND) for Kien Giang Province (FY2000 MR Discharge with Different SLR)

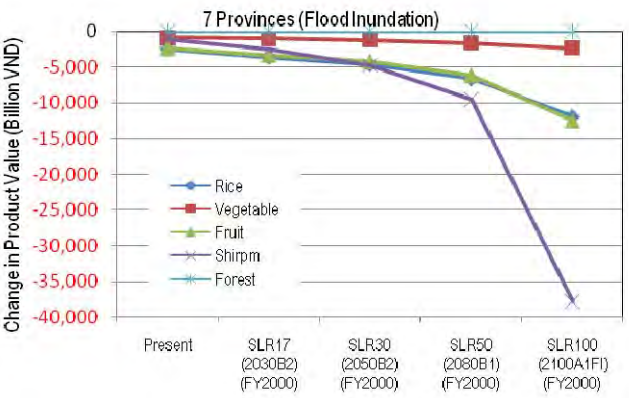


Figure 3.3.143 Production Loss(VND) for 7 Provinces (FY2000 MR Discharge with Different SLR)

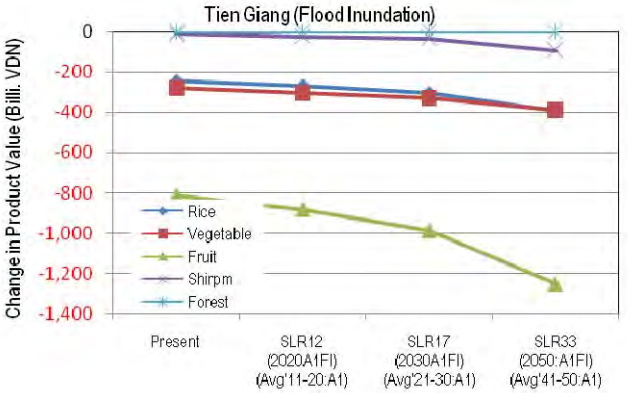


Figure 3.3.144 Production Loss(VND) for Tien Giang Province (Scenario A1 MR Discharge with Different SLR)

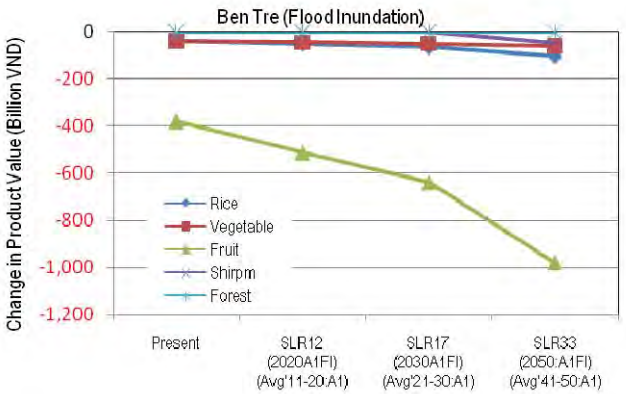


Figure 3.3.145 Production Loss(VND) for Ben Tre Province (Scenario A1 MR Discharge with Different SLR)

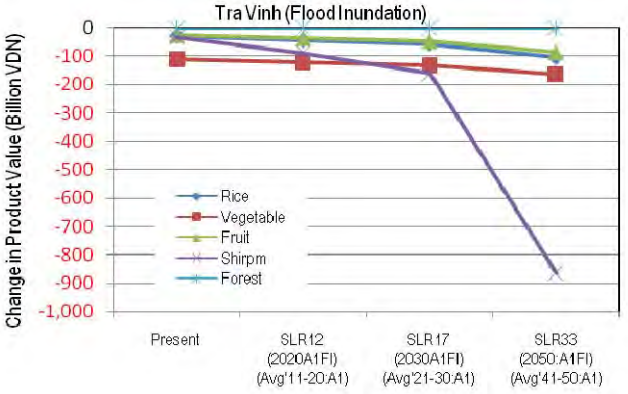


Figure 3.3.146 Production Loss(VND) for Tra Vinh Province (Scenario A1 MR Discharge with Different SLR)

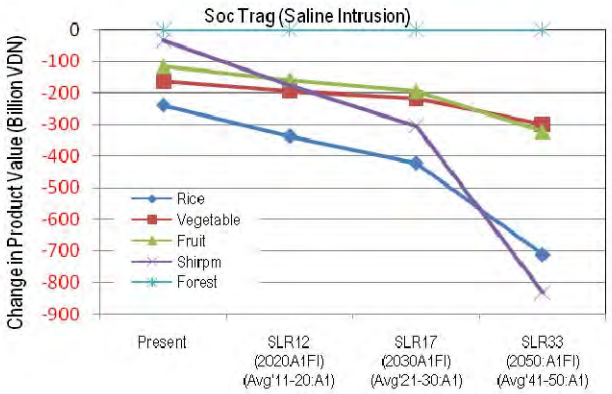


Figure 3.3.147 Production Loss(VND) for Soc Trang Province (Scenario A1 MR Discharge with Different SLR)

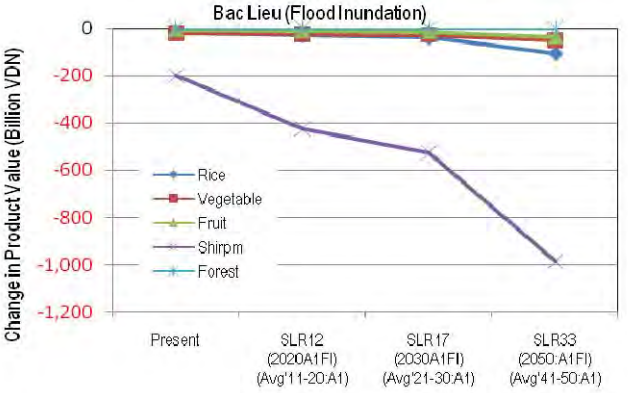


Figure 3.3.148 Production Loss(VND) for Bac Lieu Province (Scenario A1 MR Discharge with Different SLR)

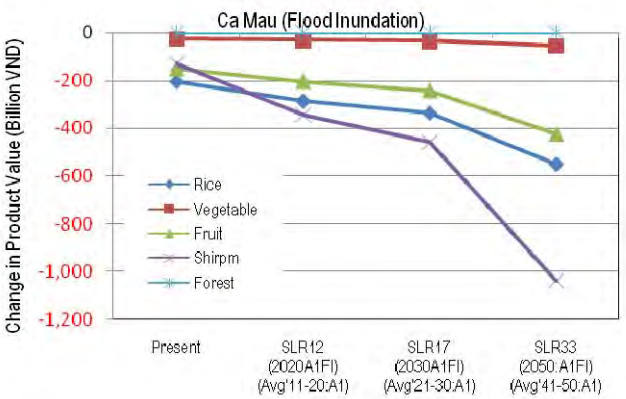


Figure 3.3.149 Production Loss(VND) for Ca Mau Province (Scenario A1 MR Discharge with Different SLR)

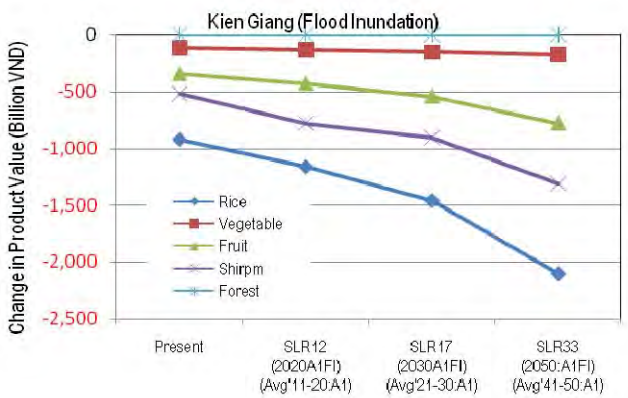


Figure 3.3.150 Production Loss(VND) for Kien Giang Province (Scenario A1 MR Discharge with Different SLR)

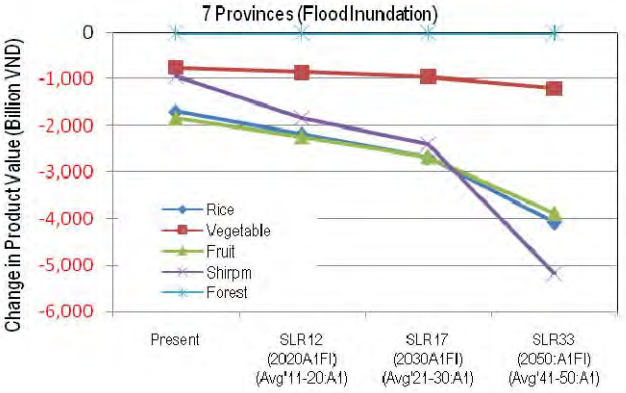


Figure 3.3.151 Production Loss(VND) for 7 Provinces (Scenario A1 MR Discharge with Different SLR)

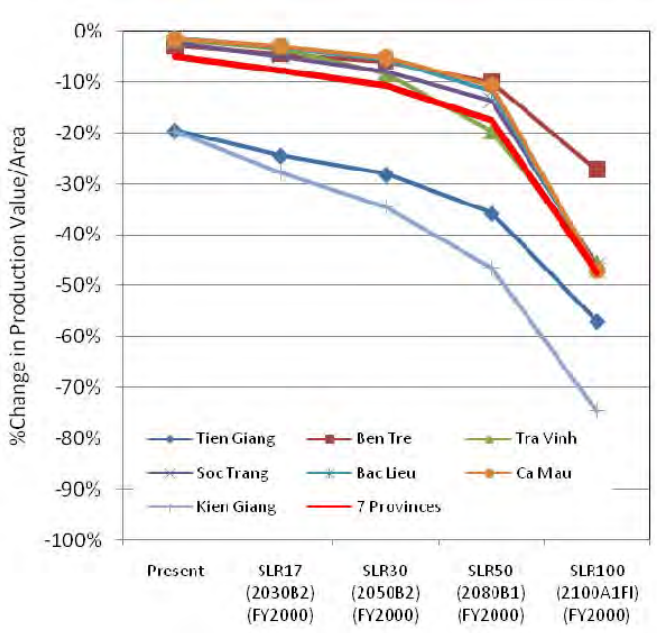


Figure 3.3.152 Production Loss(%) by Province
(FY2000 MR Discharge with Different SLR)

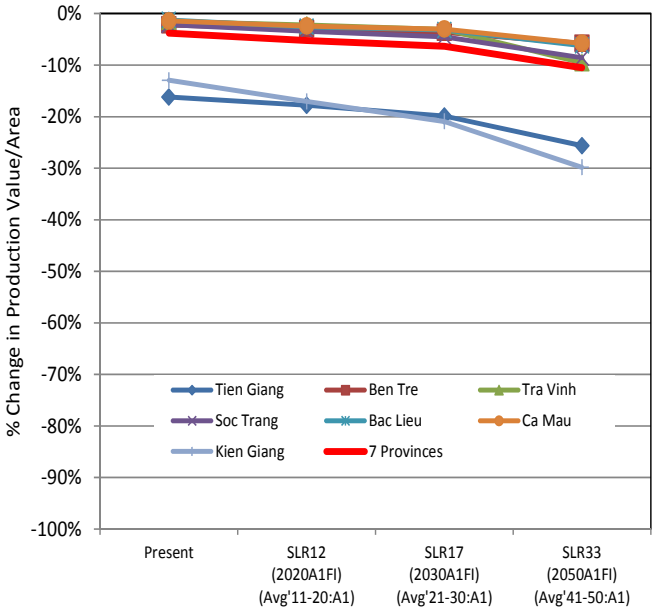


Figure 3.3.153 Production Loss(%) by Province
(Scenario A1 MR Discharge with Different SLR)

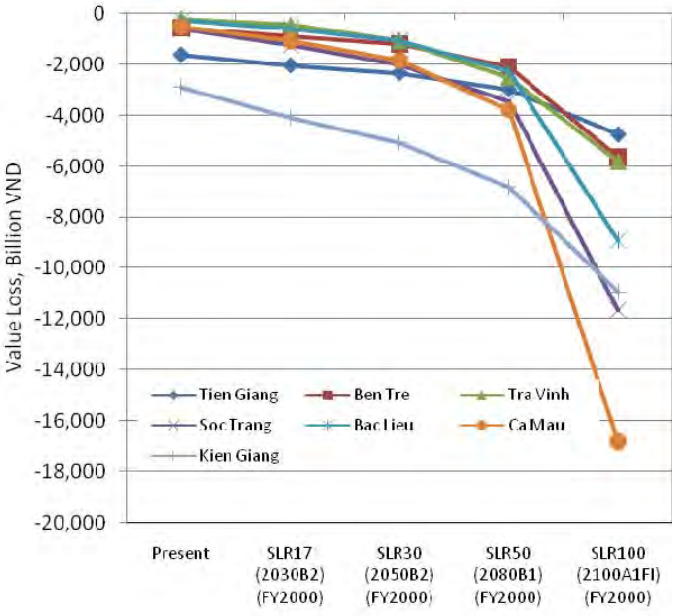


Figure 3.3.154 Production Loss(VND) by Province
(FY2000 MR Discharge with Different SLR)

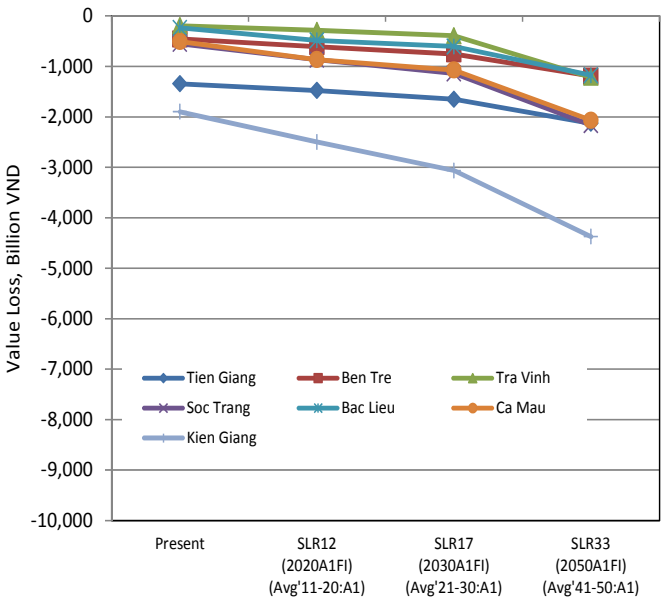


Figure 3.3.155 Production Loss(VND) by Province
(Scenario A1 MR Discharge with Different SLR)

3.3.4 Economic Loss by Saline Intrusion and Flood Inundation

Aforementioned sub-chapters discussed paddy yield loss by temperature rise (Winter-Spring Paddy), crop yield loss by saline intrusion taking place during dry season including area reduction of fruit and tree, and crops yield loss by flood inundation taking place during rainy season including area reduction of fruit and tree under different climate change scenarios, e.g. different Mekong River discharge as well as different levels of sea-level rise. In this sub-chapter, all those losses are counted as the level of economic loss or production value loss in percentage as well as in terms of VND.

There is, however, an issue of how 2 different impacts interact each other, for which the issue is how the temperature rise and the saline intrusion taking place in the dry season do affect the crop yield. Some may say there would be aggregated effect, or the other may say the larger effect may contain the lesser effect, which means the lesser effect does not take place or rather is replaced by the larger one. This issue concerns only to the Winter-Spring paddy, which is cultivated during dry season, because the temperature rise to the level affecting crop production shows up at latter stage of dry season and of course saline intrusion does only during dry season.

Since there is not agreed solution with reference to past research results and/or experimental results about how to deal with such spontaneous happening, this Report assumes that the larger effect could contain lesser effect, i.e., larger effect could surpass the lesser effect by containing the lesser effect. It means that the lesser impact on the reduction of Winter-Spring paddy between the temperature rise and saline intrusion will be neglected in the following discussion.

The yield loss to be caused by temperature rise will be 12 – 18 % at year 2050 under the temperature rise of scenario B2 and 15 – 19 % at year 2050 under the temperature rise of scenario A2 (refer to Figure 3.3.3 and Figure 3.3.6). On the other hand, yield loss by saline intrusion will be about 40% at year 2050 for the both cases of climate change B2 scenario and discharge of 1998 dry one (refer to Figure 3.3.58 and Figure 3.3.66). Therefore, only the effect of saline intrusion will be taken for the Winter-Spring paddy, neglecting the effect on the paddy yield by temperature rise.

Figure 3.3.156 and Figure 3.3.157 show percentage loss against the annual value (annual production) of those commodities of rice, vegetable, fruit, tree and shrimp. The loss in percentage at year 2050 ranges 20% to as large as 50% with an average of 30% for the severest case of DY 1998 discharge for dry season and FY 2000 discharge for rainy season. The minimum loss in terms of percentage shows up in Bac Lieu and Ca Mau provinces while the largest loss in Kien Giang, followed by Tien Giang. For the case of B2 discharge during dry season and A1 discharge during rainy season, loss takes place lesser extent.

Figure 3.3.158 and Figure 3.3.159 show the loss in billion VND aggregated for the loss by saline intrusion and for the loss by flood inundation on those commodities of rice, vegetable, fruit, tree and shrimp. As shown in the figures, the largest value loss shows up in Kien Giang province till 2080 attributed by loss of rainy season paddy affected by flood, followed by Soc Trang, Ben Tre, Ca Mau, Tien Giang, so on so forth. The least value loss appears on Bac Lieu province till year 2080. The loss at year 2050 ranges from 3,600 billion VND (Bac Lieu) to as large as 12,000 billion VND (Kien Giang) in the severest case (DY1998 + FY2000). The losses at year 2050 estimated under future B2 scenario (for dry season Mekong River discharge) and A1 scenario (for rainy season Mekong River discharge) come to 1,900 billion VND (Bac Lieu) and to 8,600 billion VND (Kien Giang).

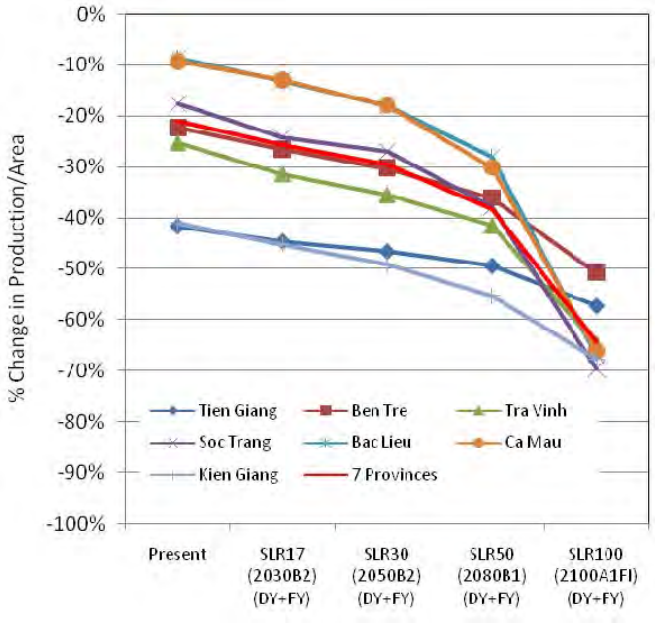


Figure 3.3.156 Annual Production Loss(%) by Province
(DY1998+FY2000 MR Discharge with Different SLR)

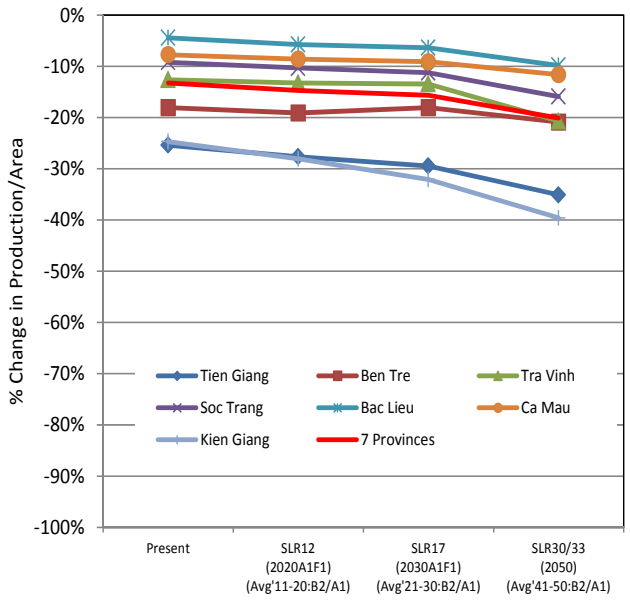


Figure 3.3.157 Annual Production Loss(%) by Province
(Scenario B2+A2 MR Discharge with Different SLR)

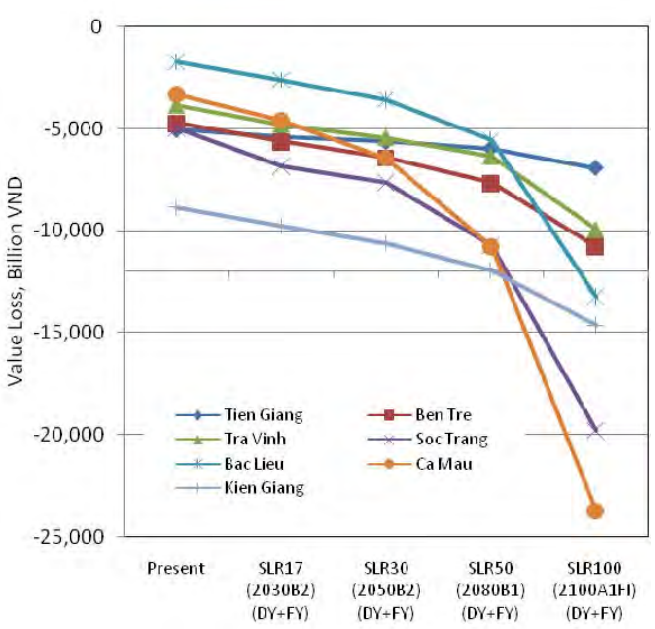


Figure 3.3.158 Annual Production Loss(VND) by Province
(DY1998+FY2000 MR Discharge with Different SLR)

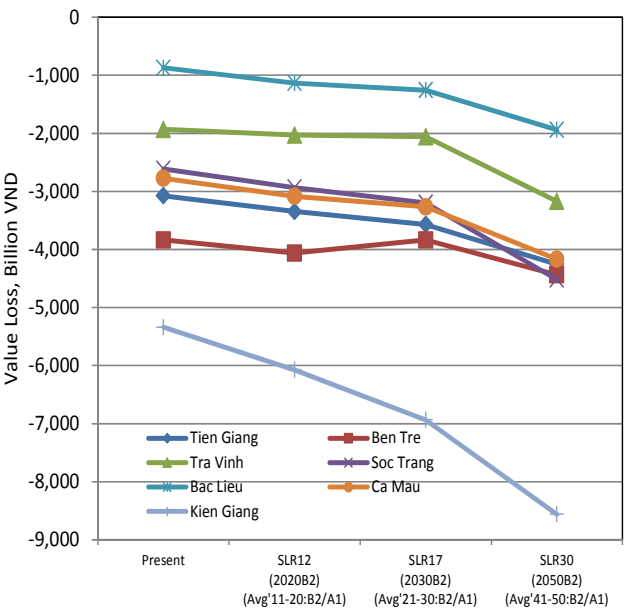


Figure 3.3.159 Annual Production Loss(VND) by Province
(Scenario B2+A2 MR Discharge with Different SLR)

CHAPTER 4 MASTER PLAN FORMULATION: PLANNING

This Chapter 4 undertakes master plan formulation on the climate change adaptation for agriculture and rural development for the coastal Mekong Delta. It starts with identification of issues relating to climate change, which had been carried out by government officers and also by villagers. Then, constraints and opportunities in implementing the climate change adaptation will be identified, and further relevant planned projects with their priorities are reviewed. Based on those aforementioned, the main part of the master plan formulation starts from framework setting, and goes into project identification, project designing and prioritization for those identified projects.

4.1 Government Officers' Perception on Climate Change

As an entry for the issue identification relating to climate change, 1-day kick-off workshop was held on October 27, 2011, inviting total 40 government officers from the 7 coastal provinces and another 10 officers from SIWRP. The officers from the 7 coastal provinces who attended the workshop were from provincial DARD and also Provincial People's Committee as indicated in the table below. The objectives of the workshop were to;

1) Know about the Climate Change prediction in Vietnam as well as in Mekong Delta region,
2) Identify Climate Change issues by province and prioritize them,
3) Identify Strengths, Weaknesses, Opportunities and Threats (SWOT) relevant to the provincial administration/DARD to cope with the Climate Change issues, and
4) Report the planned development projects and identify priority projects able to cope with the Climate Change issues.

Table 4.1.1 Participants to the 1-day Kick-off Workshop by Office, held on October 27, 2011

Province	DARD	PPC	Total
Tien Giang	5 (0F, 5M)	0 (0F, 0M)	5 (0F, 5M)
Ben Tre	5 (0F, 5M)	1 (0F, 1M)	6 (0F, 6M)
Tra Vinh	3 (0F, 3M)	4 (0F, 4M)	7 (0F, 7M)
Soc Trang	6 (1F, 5M)	1 (0F, 1M)	7 (1F, 6M)
Bac Lieu	5 (0F, 5M)	1 (0F, 1M)	6 (0F, 6M)
Ca Mau	6 (0F, 6M)	1 (0F, 1M)	7 (0F, 6M)
Kien Giang	2 (0F, 2M)	0 (0F, 0M)	2 (0F, 2M)
SIWRP	-	-	10 (3F, 7M)
Total	32 (1F, 31M)	8 (0F, 8M)	50 (4F, 46M)

Source: JICA Project Team, based on registration of the Workshop

The methodology of the workshop was of group work, presentation by group leaders, open-forum plenary discussions, etc., which were supported by participatory approach. The programme of the workshop is given of the following table, composed of mainly 5 sessions, e.g. 1) presentation on climate change prediction in the Mekong Delta (presentation by the Team), 2) climate change issue identification and the prioritization, 3) SWOTs analysis, 4) development project identification, and 5) identification of villages for workshop. Following discussion centers on sessions of No.2 and No.3 only, and No.4 and No.5 are to be undertaken in the following sub-chapters:

Table 4.1.2 Programme of the Kick-off Workshop held on October 27, 2011

Time	Activities	Remarks
07:30 – 08:00	Workshop Registration	
08:00 – 08:15	Introduction and Welcoming Remarks	SIWRP Director
08:15 – 08:45	Session 1: Presentation on Climate Change Prediction in Mekong Delta	JICA Project Team
08:45 – 10:30	Session 2: Climate Change Issue Identification and the Prioritization	All participants
10:30 – 10:50	Tea break	

10:50 – 12:00	Session 3: SWOTs Analysis	All participants
12:00 – 13:30	Lunch Break	
13:30 – 15:00	Session 4: Development Projects Identification	All participants
15:00 – 15:20	Tea break	
15:20 – 16:00	Session 5: Identification of villages for workshop	All participants
16:00 – 16:15	Closing Remarks	SIWRP Director

Source: JICA Project Team

4.1.1 Climate Change Issue Identification and Prioritization

For this session of 'Climate Change Issue Identification and Prioritization', the participants were divided into groups by province, hence there were 7 groups. The groups were requested the following works; 1) identify all the issues/constraints/problems in the sector of agriculture and rural development, 2) prioritize all of the listed issues by placing the severest issue at the top of the issue list, 2nd severest issue at the second place from the top, and alike, 3) mark those issues which are related to climate change or caused/worsened by climate change, and 4) mention the places where the issues are taking place, 5) how sever the issues are, etc.

Seven groups had identified the issues, all of which were related to climate change, and re-arranged those issues according to the priority. Table 4.1.3 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 in cases, 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 4.1.3 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

After having finished the presentation of the issues by group, they discussed and agreed overall priority order on the issues. They first divided the issues in 2 groups; first group issues are those which

can be directly affected or caused by climate change, and second group issues to be associated 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 4.1.4 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

4.1.2 SWOTs Identified in the Kick-off Workshop

A simplified SWOT analysis, a strategic planning method, was carried out during the workshop to analyze Strengths and Weakness of the provinces, and Opportunities and Threats that the provincial officers face. First, a facilitator made an explanation of the method in the plenary session. Then, participants were divided into groups by province. To identify the SWOTs to cope with and adapt to climate change, active discussions were conducted. After the discussion, each group made a short presentation on their own result to other groups, which was also followed by an additional clarification. Following table summarizes the SWOTs with numbers of the provinces in the bracket:

Table 4.1.5 Summary Results of the SWOT Analysis by Provinces

Strengths:	**Opportunities:**
✓ Attention of all levels on climate change put in place (4) ✓ Supporting policy put in place e.g. support to natural calamity and epidemic diseases (3) ✓ Focusing direction of provincial leaders are in line with climate change (2) ✓ Attention of government on climate change put in place (2) ✓ Authorities are concerned with climate change into policies and resolutions (1) ✓ Appealing policies for investment put in place (1) ✓ Government are interested in investment to cope with climate change (1) ✓ Abundant human resources in offices (1) ✓ Young human resources to cope with climate change are existent (1) ✓ Staff interested in activities coping with climate change (1) ✓ Capacity to deploy trainings for community on climate change (1) ✓ Experience of project implementation/ operation (2) ✓ Development projects/ programs to cope with climate change on-going (2)	✓ Support of many organizations including international ones to cope with climate change (4) ✓ Attention of international organizations to cope with climate change (3) ✓ Agreement of stakeholders to work together for climate change adaptation (1) ✓ Investment fund from the central government available (2) ✓ Implementation of forecasting climate change research to cope with climate change (1) ✓ Construction of key national works e.g. Dinh An economic zone, thermal power (1) ✓ Policy and fund available for upgrading sea dyke by QĐ 667 (1) ✓ Good collaboration with private sector and local people put in place (1) ✓ Favorable natural conditions for aquaculture and farming to cope with climate change (1) ✓ Ecosystem diversity workable to cope with climate change e.g. forest, mineral, tourism, (1) ✓ Advantages of resources to develop available to cope with climate change (1) ✓ Partition of agricultural and fishing production areas put in place (1)
Weaknesses	**Threats:**
✓ Lack of investment (7) ✓ Fund disbursement sometimes not timely (1) ✓ Human resources can not meet technical needs to cope with climate change (4) ✓ Improvement of awareness (staff capacity) is not enough (1) ✓ Dissemination of knowledge on climate change at the basic level is not enough (1)	✓ Farmers do not pay proper attention on climate change (3) ✓ Farmers not interested in climate change issues (2) ✓ Farmers' awareness of the impact of climate change is not high (1) ✓ Present infrastructure cannot cope with climate change (4) ✓ Unfinished irrigation system/ infrastructure (2)

✓ Lack of forecasting system for climate change (2) ✓ Planning not well relevant to climate change (2) ✓ Feasible planning strategy to cope with climate change is not in place (2) ✓ No master plan be consistent with climate change (1) ✓ Lack of management capacity to cope with climate change (1) ✓ Work system is not synchronized among relevant departments (1) ✓ Operation and management of work system is not synchronized (1) ✓ Staff overlap in management (1) ✓ No training and raising the awareness on climate change (1)	✓ High rate of poor households not able to well cope with climate change (2) ✓ Small production not enough to cope with climate change (1) ✓ Lock of awareness of stakeholders on climate change (1) ✓ There are large ethnic minority accounting for over 30% (1) ✓ Economic growth not coupled with environmental protection (1) ✓ Lack of regional planning (1) ✓ ¾ of the area of province is affected with salt, resulting in difficulties for livelihood (1) ✓ Areas existent prone to damage by climate change (1) ✓ Segregated farmlands difficult to work systematically (1) ✓ Local government staff are not trained on climate change (1)

Source: JICA Project Team, summerized from the work results by officers in the workshop on October 27, 2011

From the table above, following can be identified as their common Strengths, Weaknesses, Opportunities and Threats, which should be well considered in formulating the Master Plan as well as designing the priority projects:

1) Strengths are mainly for awareness of the staff and concerned people on the climate change issues, government favorable policies to cope with and adapt to climate change, human resources available including young staff, and project/ programme implementation experiences. Four provinces raised 'Attention of all levels on climate change put in place' as one of their strengths. In fact, it is already well known among the government staff as well as people that the Vietnam is one of the countries in the world to be influenced the most by climate change. This information has been disseminated by radio and TV, and through workshops and meetings.

2) With the climate change knowledge already disseminated, the central government, local government, and local authorities are in favorable environment of coping with and adapt to climate change by putting policies, investment, etc. Three provinces listed as one of strengths 'supporting policy', 2 provinces listed 'focusing direction is in line with climate change', 2 provinces listed 'government attention on the climate change', etc. In this regard, it can be said that in Vietnam preamble to work on the climate change is already put in place, and one may say now is the time that the actions are needed on the ground.

3) Human resource related issues were also listed as one of the strengths, e.g. 'abundant human resources', 'young human resources', and also 'staff interested in activities coping with climate change'. One province also stated that with those human resources they have 'capacity to deploy trainings for community on climate change'. Two provinces listed 'experience of project implementation/ operation', and another two provinces there are 'development projects/ programs to cope with climate change on-going'. The experiences would enrich the staff capacity, and also the programmes/ projects would provide opportunities whereby the staff can develop their capacities.

4) On the other hand, the weakness which came from all the 7 provinces was 'lack of fund', and one province further added 'fund disbursement sometimes not timely'. As an example, to cope with saline intrusion, a series of sluice gates shall be installed at the exits of existing channels draining out to the Mekong River. Infrastructure requires a huge amount of investment and in fact, the Master Plan 2011 formulated by SIWRP recommends investing about US$ 620 million per annum over the period from 2011 to 2050. Given this huge investment, Vietnamese government alone can hardly implement the projects recommended in the Master Plan 2011 (SIWRP), nor meets the needs of the provinces.

5) Some weaknesses are related to human resources as ‘human resources can not meet technical needs to cope with climate change, and ‘improvement of awareness (staff capacity) is not enough’. Though most of the staff are already very aware of climate change issues, it may be said that they now require practical knowledge and capacity to cope with and adapt to climate change.

6) Lack of forecasting system for climate change was raised by 2 provinces as one of the weaknesses. Simulation on the climate change has been carried a lot, and therefore future prediction on the climate change in Vietnam and Mekong Delta is already available. The forecasting system at stake here means the forecasting of, e.g., when saline water comes up to which area, and when storms take place at which places, etc. In fact, there is an example in Tra Vinh province in 2011. The DARD examines salinity level every 15 days during the dry season. Unfortunately saline water in the dry season 2011 suddenly came up in between the measurements, intruding far deep into the paddy areas. About 11,000 ha of paddy had been damaged by this saline intrusion.

7) Planning issues were listed as one of weaknesses as ‘planning not well relevant to climate change’, ‘feasible planning strategy to cope with climate change is not in place’, and ‘no master plan be consistent with climate change’. Though SIWRP has formulated master plan 2011 taking into account the effect of climate change, no province so far has formulated specific development plan well taking into account the effect of climate change as at October 2011. This is one of the rationales why this JICA Project is implemented.

8) On the opportunities, all the provinces stated supports as one of the opportunities in such a statement as ‘support of many organizations’, ‘attention of international organizations’ and ‘agreement of stakeholders’ to work together for climate change adaptation. There are international donors carrying out projects in the coastal and Mekong Delta areas directly or indirectly mitigating the effects of climate change. Examples are construction of tide prevention sluice gage, rehabilitation and strengthening of canals and embankment, etc.

9) Some provinces raised as one of opportunities their natural resources. They stated such opportunities as ‘favorable natural conditions for aquaculture and farming’, ‘ecosystem diversity’, ‘advantages of resources’, and even ‘partition of agricultural and fishing production areas’. Though saline water intrusion is a threat for paddy irrigation, it can be on the other hand opportunity for shrimp culture to promote. Mangrove area can produce high value shrimp though environmental protection measures should be strictly put in place. If the land is well demarcated according to the use by agriculture and shrimp culture, both farmers can enjoy good income. They think these are one of good opportunities, not to cope against but to adapt to climate change.

10) Threat most of the provinces raised was ‘not much attention by farmers on climate change’. They stated ‘farmers do not pay proper attention on climate change’, ‘farmers not interested in climate change issues’, and ‘farmers’ awareness not high’. At least farmers have been informed about climate change through media and government officers, though; they may have difficulties to prepare themselves for climate change not immediately taking place. Provincial offices may consider this attitude of farmers as ‘not much attention by farmers’.

11) Another threat most of the provinces listed was on ‘present infrastructure’. They think the present infrastructure can hardly cope with climate change, and also they are concerned with unfinished irrigation system/ infrastructure. Though the tide prevention sluices have been constructed to date, they are still not enough. There are channels and canals which need sluice gates in order to prevent saline intrusion. Another example is Bac Lieu centre, which is often inundated during high tide coupled with rainy season’s heavy rainfall. They think upgrade and new construction of infrastructure especially hydraulic structures are to be more needed to cope with climate change.

4.2 Villagers' Perception on Climate Change

4.2.1 Workshop and Questionnaire Villages

Village level workshops and questionnaire survey were carried out in November 2011 exploring the villagers' perception on the climate change. The workshop has been held in six communes identified in the governmental officers workshop. Two communes were selected from Ben Tre Province, and one commune was selected from Tra Vinh, Soc Trang, Bac Lieu, and Ca Mau province respectively as shown in Figure 4.2.1 and Table 4.2.1. One commune consists of six to twelve villages, so that the participants of the workshop were from several villages under the same commune. To those participants, questionnaire was also administered covering basically 30 interviewees per commune, asking not only their socio-economic situation but also the perception on the climate change.

The six communes were identified to cover four categories by the type of their major livelihood. First category is paddy production. Paddy production is the major livelihood in An Binh Tay commune in Ben Tre Province and Huyen Hoi commune in Tra Vinh Province. Second category is shrimp production. Shrimp production is the major income source in Vinh Hai commune in Soc Trang Province and Tran Thoi commune in Ca Mau Province. Third one covered farmers who produce both shrimp and rice. Phuoc Long commune in Bac Lieu is categorized into this group since their main cropping pattern is the combination of shrimp and paddy. Last category is coconut and fruits production, which is Thuan Dien commune in Ben Tre Province. Farmers in this commune barely produce rice; instead coconuts and fruits are their major production.

Figure 4.2.1 Location of the 6 Villages for Workshop
Source: JICA Project Team

The number of participants was the smallest with 36 people at An Binh Tay commune in Ben Tre Province, and was the largest with 68 people at Thuan Dien commune in Ben Tre Province. Most of the participants were the Kinh (ethic Vietnamese), and there were few participants of the Khmel (ethnic Cambodian) at Vinh Hai commune in Soc Trang Province.

Table 4.2.1 Villages and the Participants for the Village Level Workshops

WS Date	Nov 9th	Nov 10th	Nov 11th	Nov 17th	Nov 16th	Nov 15th
Commune	Thuan Dien	An Binh Tay	Huyen Hoi	Vinh Hai	Phuoc Long	Tran Thoi
District	Giong Trom	Ba Tri	Cang Long	Vinh Chau	Phuoc Long	Cai Nuoc
Province	Ben Tre	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau
Major livelihood	**Coconut& Fruits**	**Paddy**	**Paddy**	**Shrimp**	**Shrimp & Paddy**	**Shrimp**
Total Participants	68	36	42	53	63	50
Male	53	32	38	53	61	49
Female	15	4	4	0	2	1
Age range	22 - 71	25 - 71	21 - 63	21 - 85	22 - 71	26 - 75
Average age	49.6	49.5	42.6	45.3	46.9	50.2
Land size range, m^2	0 – 17,000	1,500- 17,000	700 - 27,000	5,000-400,000	5,000-100,000	3,600- 60,000
Average land size	5,349 m2	5,964 m2	12,643 m2	39,491 m2	21,730 m2	21,728 m2
Ethnicity						
Kinh	68 (100%)	36 (100%)	42 (100%)	40 (75%)	63 (100%)	50 (100%)
Khmel	0	0	0	13 (25%)	0	0

Source: JICA Project Team, based on the registration for the workshops

The JICA Team has employed few tools in the workshops to identify issues that villagers are facing with and to know how the climate change affects their life. The tools employed in the workshop are 'Problem Analysis', 'Trend Analysis', 'Success Story', 'Village History', and 'Issue Identification associated with the Climate Change'.

'Trend Analysis', 'Success Story', and 'Issue Identification associated with the Climate Change' were conducted as a group work. The participants were divided into several groups in the workshop. The Problem Analysis was conducted with all the participants at Thuan Dien commune in Ben Tre Province, and at An Binh Tay commune in Ben Tre province, and at Tran Thoi commune in Ca Mau Province, while the participants were divided into two groups during the Problem Analysis session at the rest of the three communes. This is because it was easier for the facilitators to deal with smaller number of participants in the session.

4.2.2 Problem Analysis

The PCM Problem Analysis was employed in the workshop. The core problem was set as "Life is difficult". The reason for this general core problem is that people could identify broader issues in their daily life, and the Team would be able to find how the climate change adaptation or coping measures can mitigate these issues. After developing the problem trees as in the examples in Figure 4.2.2 and Figure 4.2.3, the participants had chosen three to four priority issues in their problem trees. Table 4.2.2 summarizes selected priority issues in each village. Following are the major findings in the problem analysis:

1) People concern about their health rather than the issues related to the climate change. As shown in Table 4.2.2, four communes out of six communes mentioned 'Health' as one of their priority issues. On the other hand, no communes chose the issues related to the climate change such as saline intrusion as their priority issue, they mentioned climate change issues in the problem trees though. In fact, there are a few cards written 'climate change' at the lower side of the trees. It is supposed that villagers are likely to choose specific and direct issues to their daily lives, yet the climate change issues affect many aspects of their lives indirectly.

2) Most frequent causes under 'Health' is 'using a lot of pesticides', and followed by 'toxic food'. This indicates that farmers are concerned with their health because they are using a lot of pesticides and chemicals nowadays. Rice production of the Mekong Delta has increased dramatically since mid of the 1980s, and now the production in this area accounts for 49% of the total rice production in the Country. Through this rapid growth of production, farmers have been using more and more pesticides and chemicals. In fact, farmers at An Binh Tay commune in Ben Tre Province and at Huen Hoi commune in Tra Vinh Province cultivate rice three times a year. Both of the communes chose the health problem as their first priority issue.

3) On the other hand, farmers who produce both shrimp and paddy are less concerned with the 'Heath'. Farmers at Phuo Long commune in Bac Lieu Province just mentioned the problem of insurance policy, but they did not mention pesticides and toxic food. This is because they do not use pesticides and chemicals a lot. They have to cultivate their field for both paddy and shrimp. If they use chemicals for paddy, they can not cultivate shrimps. Thus, Phuoc Long commune in Bac Lieu Province expressed less concern about the health.

4) Another concern for paddy farmers is unstable paddy price. The problem of paddy price is mentioned at both communes, An Bih Tay in Ben Tre Province and Huyen Hoi in Tra Vinh Province, both of which mainly produce paddy. According to the FAO[1], Vietnamese rice export price surged from 294 US dollars/ton in 2007 to 553 US dollars/ton in 2008. In 2009, however,

[1] The FAO Rice Price Update, tttp://www.fao.org/es/esc/15/70/highlight_533_p.thml

the price decreased to 384 US dollars/ton, presenting a large range of fluctuation. Since there is a strong correlation between export price and domestic prices, the paddy price within the country was also fluctuated very much. This situation seems to make farmers in both communes more aware of fluctuated rice price.

5) Shrimp farmers concern about water environment for shrimp. Farmers in Bac Lieu Province selected water environment problem as their first priority issue, and shrimp farmers in Ca Mau Province chose it as the second priority issue. Obviously, water environment is important for shrimp production. Research Institute of Aquaculture No.2, for example, pointed out that one of the reasons of shrimp disease is highly associated with poor water quality. In fact, both shrimp farmers in Vinh Hai commune in Soc Trang Province and in Tran Thoi commune in Ca Mau Province selected the problem of shrimp disease as one of the their priority issues. Therefore, these communes with any shrimp farmers are more sensitive about water pollution than other communes.

6) Another characteristic of shrimp farmer is for electricity. Shrimp farmers at both Soc Trang and Ca Mau Province listed up the 'lack of electricity' as one of their problems in their problem trees. It suggests that electricity is necessary for pumps for shrimp farms. Shrimp farmers at both these communes argued that electricity is coming to the village, but there are step-down voltage power transmitters, not able to use the power for the pumps. In this sense, the demand of step-down stations is given high priority for villages with shrimp producers.

7) The demand of financial support for coconuts and also shrimp production is high. 'Lack of fund' was identified as a priority issue in three communes: Thuan Dien commune with coconut production in Ben Tre Province, Vinh Hai commune with shrimp production in Soc Trang Province, and Tran Thoi commune with shrimp production in Ca Mau Province. Shrimp production and fruits production need a certain amount of capital. Besides, there are risks for these productions such as diseases. This situation indicates that lack of suitable loan program for shrimp and fruits production is one of the major constraints for the farmers who want to expand their production or diversify their crops.

Table 4.2.2 Summary of the Priority Issues

Commune (Province)	Thuan Dien (Ben Tre)	An Binh Tay (Ben Tre)	Huyen Hoi (Tra Vinh)	Vinh Hai (Soc Trang)	Phuoc Long (Bac Lieu)	Tran Thoi (Ca Mau)
Major Income	Coconut	Paddy	Paddy	Shrimp	Shrimp & Paddy	Shrimp
No.1 Issues	Unstable production	Health	Low income/ Health	Lack of fund for shrimp production	Shrimp production/ Water environment	Health
No.2 Issues	Epidemic diseases for production	Low income	Unstable price of paddy/ Low income	Electricity/ Shrimp environment	Demarcation of fresh and salt water	Water environment
No.3 Issues	Lack of fund	Polluted environment	High price of agricultural materials	Shrimp disease /Health	Health insurance policy/ Paddy seeding	Shrimp disease
No.4 Issues	Bad transportation system	-	Water environment	Lack of technique for shrimp	-	Lack of funds

Source: JICA Project Team, based on the Problem Analysis

Problem analysis further continued, during which issues related to climate change were separately picked up and discussed. The discussion clarified the following with the issues shown in Table 4.2.3 and Figure 4.2.2 and Figure 4.2.3;

1) 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.

2) 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.

3) 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.

4) 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 Tran Thoi commune in Ca Mau and Phuoc Long commune in Bac Lieu Province.

Table 4.2.3 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

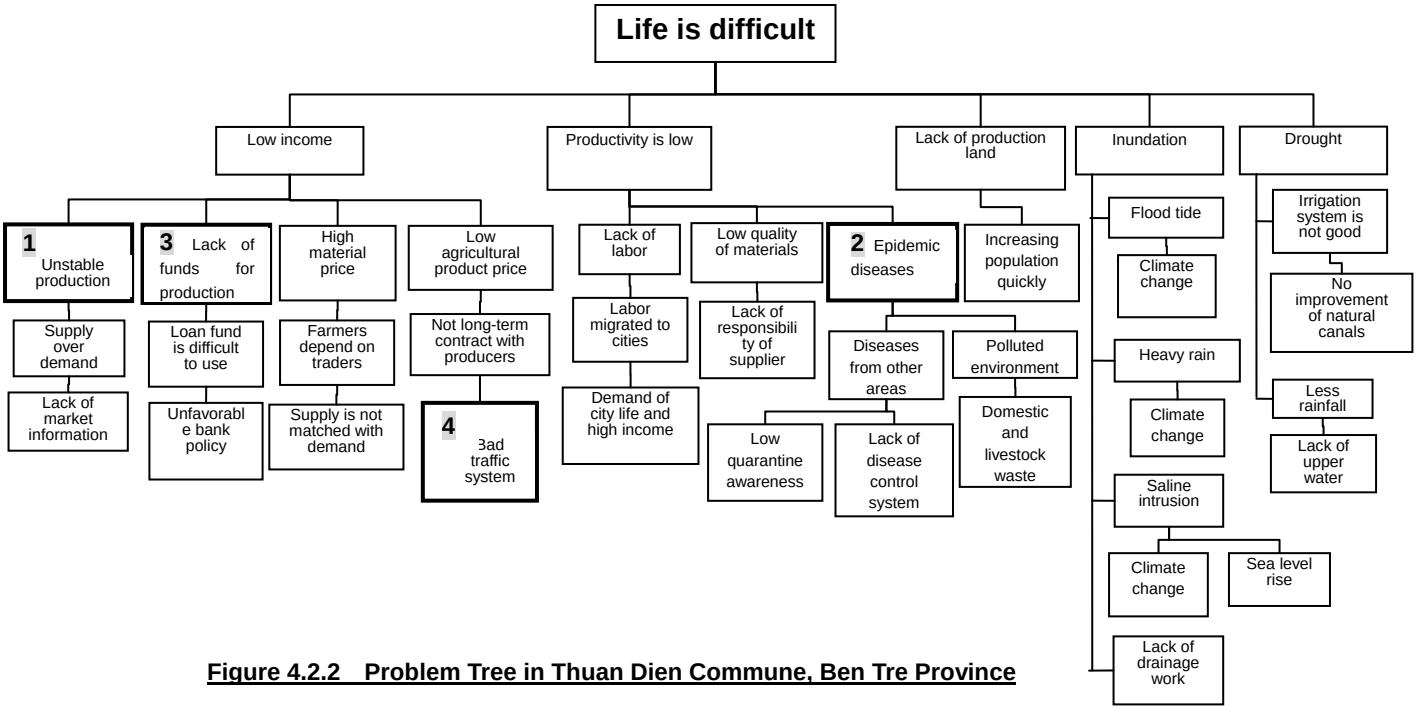


Figure 4.2.2 Problem Tree in Thuan Dien Commune, Ben Tre Province

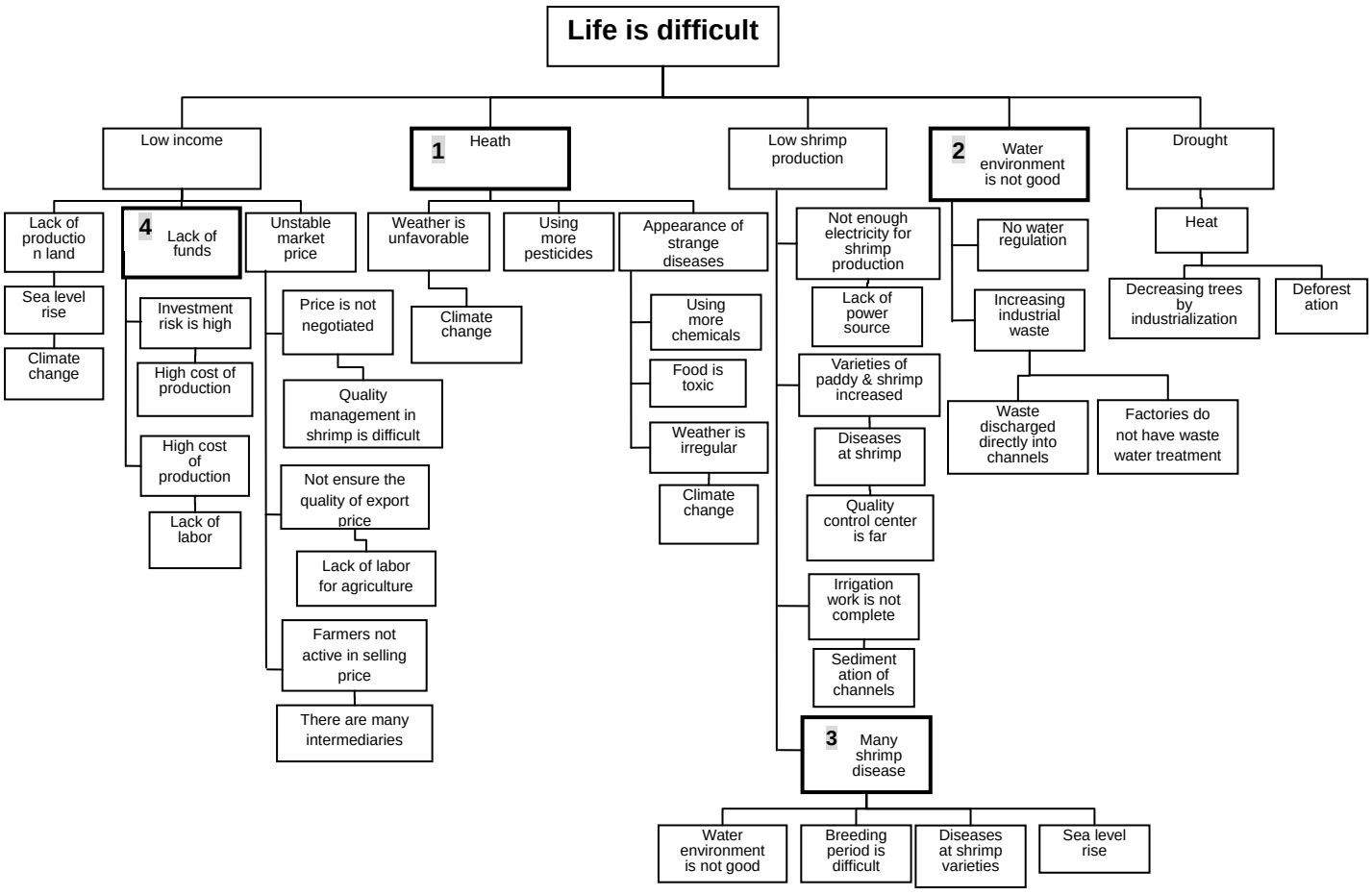


Figure 4.2.3 Problem Tree in Tran Thoi commune, Ca Mau Province

4.2.3 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. They put ten cards at maximum period, and if they put eight cards on next period, this means that the magnitude of the trend was decreased to 80%. First, the topics were chosen by all the participants, and then they were divided into several groups to discuss the trend of each topic. Following are excerpts from the analysis:

1) Thuan Dien commune in Ben Tre Province and Tran Thoi commune in Ca Mau Province have rapid upward trend of drought (see Figure 4.2.4). 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.

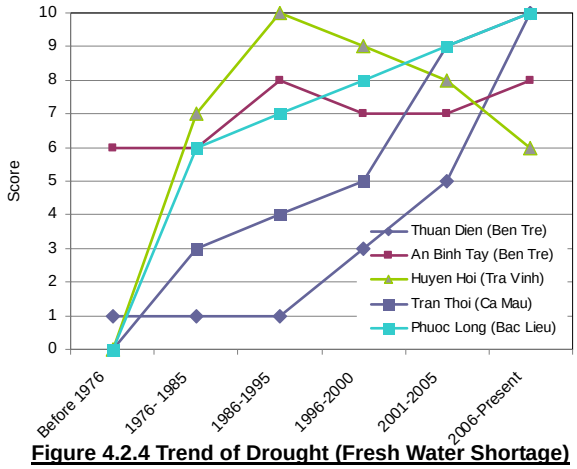


Figure 4.2.4 Trend of Drought (Fresh Water Shortage)
Source: Village Workshop

2) 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 4.2.5). 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 point of view, influence of inundation is surely increasing, but it affects on farmers' livelihood slowly compared to other climate change issues such as drought and saline intrusion.

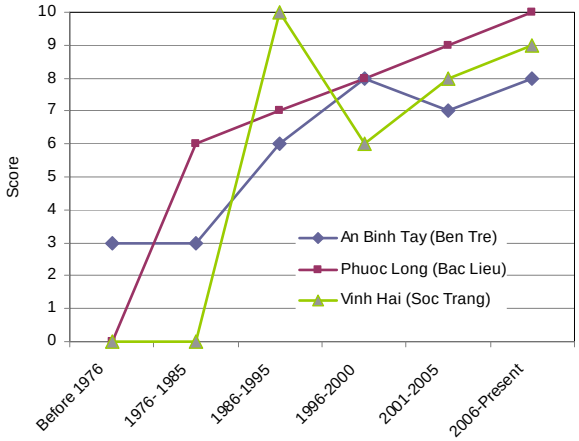


Figure 4.2.5 Trend of Inundation
Source: Village Workshop

3) 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 4.2.6). 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.

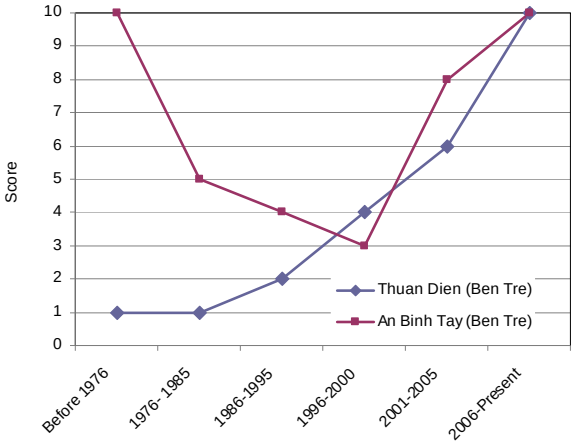


Figure 4.2.6 Trend of Saline Intrusion
Source: Village Workshop

4) Most villagers are quite aware of the climate change. An Binh Toay and Phuoc Long commune stated that irregular weather has started since between 2000 and 2005. Not only these communes but also many other villagers mentioned the climate change. For example, some of the villagers answered that drought has occurred more often because of the climate change. This situation is the same as what was stated in the Problem Analysis. There were statements of climate change as major causes of some problems.

5) Climate change is well known for the villagers already. One of the reasons of this is that the people can get the information about the climate change from TV and radio programs. According to the Living Standard Survey in 2010, more than 80% of the rural population has TVs and almost all the households have radio. Through relevant programs or news on climate change, people are nowadays ready to learn any changes in their environment to be associated with climate change.

4.2.4 Villagers Perception on Climate Change by Questionnaire Survey

1) 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 4.2.4. 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 responses, 5%).

Table 4.2.4 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

2) 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 4.2.5, 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 responses) 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 4.2.5 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

3) Countermeasures Taken

To cope with climate change problems, the respondents have taken a series of countermeasures. As shown in Table 4.2.6, 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 4.2.6 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.

4) People's Observation on Saline Intrusion

Table 4.2.7 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 4.2.7 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

4.3 Relevant Planned Projects and the Priorities

In Vietnam, there are provincial level offices of MARD, called DARD (Department of Agriculture and Rural Development). DARD is in charge of not only agriculture and rural development sector but also forestry, aquaculture, and rural water supply sectors at the provincial level. Most of the projects in the sectors are therefore identified by this DARD according to the needs of the people.

DARD carries out identification and preliminary designing of their priority projects, and then submits the project documents to the central government for its approval. Upon approval, investment planning is usually commenced including feasibility study with fund provided by the central government. In this regard, formulation of the coastal area's Master Plan should refer to the priority projects already identified by the provincial DARD.

In addition, as aforementioned, SIWRP has prepared a master plan 2011 in the context of climate change. The Master Plan for the coastal 7 provinces shall also refer to the project list recommended in the SIWRP master 2011, or in other words, the projects identified by provinces and recommended by SIWRP shall be well synchronized in the coastal area's Master Plan to be formulated under this Project. Following section briefly discusses the priority projects, though some are just idea level, identified by the provinces and also the projects listed by SIWRP in the Mater Plan 2011.

4.3.1 Relevant Planned Projects and the Priorities by 7 Coastal Provinces

During a workshop held on October 27, 2011, invited provincial officers presented their priority projects together with the purpose, status of the project (e.g. planning stage, designing stage, approved by the central government, etc.), and also the priorities in the province. With regard to the priority, though the officers tried to list the projects from top to down according to their priorities; this was not always the case since the participants had a difficulty of representing the overall priority in the province.

Table 4.3.1 summarizes the priority projects by categorizing into civil work and non-civil work and further by major work while Table 4.3.2 shows the detail of the priority projects by province. From the tables, it is known that all the provinces except for Ben Tre presented sea dyke construction project as one of their priority projects. Sluice gate construction, which is meant to prevent saline intrusion, was presented by 5 provinces with total 8 projects. River dyke construction project was also submitted by 5 provinces with 7 projects. Three provinces presented canal rehabilitation with total 4 projects, which included dredging to increase the flow capacity, strengthening of embankment mainly for the purpose of preventing flood, etc.

Four provinces presented fresh water recruitment project. In fact, the fresh water recruitment projects are in most cases coupled with saline intrusion prevention sluice gates. In the mid and downstream areas to be covered by the project, there have to be sluice gates which prevent the saline water from coming into the channels. Instead, the project area needs alternative fresh water which shall be now recruited from upstream areas not affected by saline water. This case applies to the projects in Ben Tre and Tra Vinh provinces.

For non-civil work, capacity development came first as presented by 5 provinces with total 7 projects. Capacity development targets not only government officers but also community people including minority such as Khmer ethnic people. Forestation project was recommended by 3 provinces, which is mostly the reforestation of mangrove, in some cases coupled with fencing made out of local materials as presented by Bac Lieu province. Research or study was presented by 2 provinces, which is meant to develop saline tolerant varieties of crop, mostly paddy, and farming method which can prevent or evade from the effect of saline intrusion.

Table 4.3.1 Summery of the Priority Projects presented by Provincial Officers

Major Work	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang	Total
Civil Work								
Sea dyke	2		3	1	1	1	1	9
Sluice gate		2	2		1	1	2	8
River dyke	1	2	2		1	1		7
Canal rehabilitat'n	1				2	1		4
Fresh water rec.*	1	1 ****	1 ****			1		4
Drainage					1			1
Pumping station				1 *****				1
Ring dyke	1***							1
Rural water supply		1						1
Non-civil work								
Capacity Develop.		1		2	1	2	1	7
Forestation	1			1	1			3
Saline T. R.**		1			1			2
Others	1			1	1	2		5

Source: JICA Project Team, based on the workshop held on October 27, 2011.

Note: * means fresh water recruitment by moving the intake point to upstream side; in Ben Tre a new intake point is planned at the almost top point of North Ben Tre area, and the one in Tra Vinh is planned from Vinh Long province located in upstream of Tra Vinh province.
** means Saline Tolerant Research which is a research or study to develop salinity tolerant variety or to establish a way of farming to avoid the effect of saline water.
*** means a ring dike to protect orchard gardens from flood. **** refers to the description of above *.
**** means pumping stations which serve for both irrigation and drainage purposes.

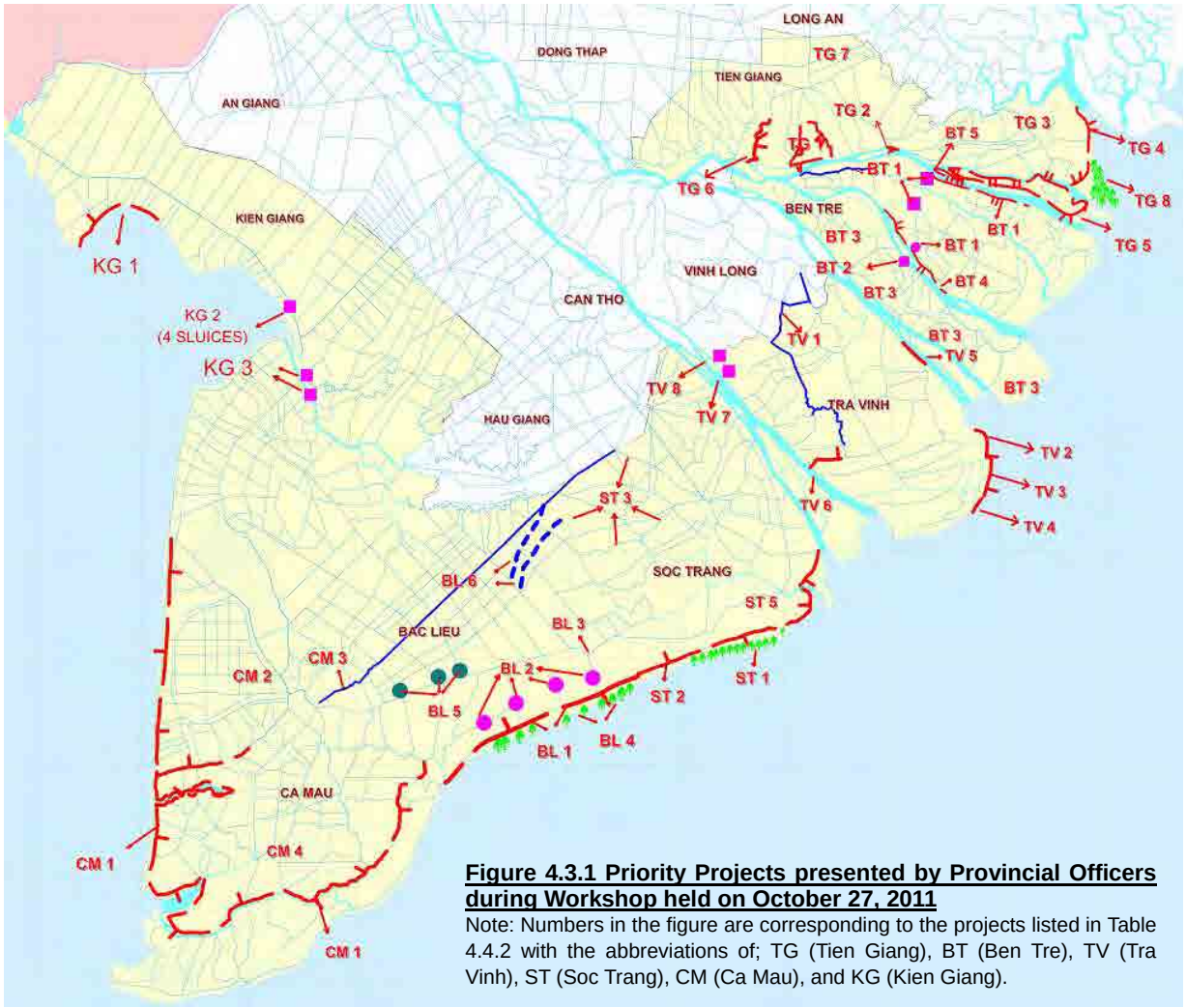


Figure 4.3.1 Priority Projects presented by Provincial Officers during Workshop held on October 27, 2011

Note: Numbers in the figure are corresponding to the projects listed in Table 4.4.2 with the abbreviations of; TG (Tien Giang), BT (Ben Tre), TV (Tra Vinh), ST (Soc Trang), CM (Ca Mau), and KG (Kien Giang).

Table 4.3.2 Detail of the Priority Projects presented by Provincial Officers

Priority Project	Status	Major Works	Purpose
Tien Giang Province			
1. Flood control to protect orchards along Tien River from Cai Be to My Tho City	NY proposed	Ring embankment	Protect fruit gardens
2. Improvement/ strengthening on the bank of Bao Dinh canal	Proposing	Canal embankment	Protect life and people's property from flood
3. Completion of the freshwater development project for Go Cong area	Proposing	W. rec., Embankment	Keep stable crop production (paddy) and people's living
4. Upgrading of the sea dyke in Go Cong area	Approved	Sea dyke	Protect production and improve livelihood
5. Dyke construction for Tan Phu Đong District	Proposing	Sea dyke	Ditto
6. Canal embankment in the west Ba Rai Canal (Cai Lay District)	Proposing	Canal embankment	Protect livelihood and people's property
7. Expanding of protected ecological areas for Đong Thap Muoi (Tan Phuoc Dist.)	NY Proposed	Flood protection	Maintaining ecosystem and biodiversity
8. Forestation outside the sea dyke in Go Cong area (incl. silt trapping)	Approved	Forestation (mangrove)	Strengthen and improve existing works
Ben Tre Province			
1. Water resources development in the north of Ben Tre (An Hoa, Tien river dikes)	Approved	Sluice gates, fresh w. recruit	Protect paddy agriculture in the north Ben Tre
2. Irrigation development for Cai Quao area in Mo Cay Nam district	Proposing	Cai Quao sluice gate	Protect paddy agriculture and people's livelihood
3. Fresh water development for Minh Islet, Cho Lach, Mo Cay Bac, Mo Cay Nam, Thanh Phu districts	Proposing	Rural water supply icl. industry	Supply water and protect living environment
4. Building of the embankment along the Ham Luong River	Proposing	River embankment	Prevent saline instruction and sea level rise
5. Building of the embankment for Tam Hiep Islet (Binh Đai District)	Approved	River embankment	To prevent saline intrusion, protect property and people.
6. Research on drought and salinity tolerant plant / livestock	NY proposed	Research	Establish drought and salinity tolerant varieties
7. Training to improve knowledge about CC, Planning residential area to protect citizen	NY proposed	Training (capacity building)	Keep residential area safe from flood
Tra Vinh Province			
1. Dredging of channel May Phop-Nga Hau (Cang Long District)	Approved	Dredging (fresh water rec.)	Provide fresh water for agricultural production.
2. Construction of embankment for Hiep Thanh - Duyen Hai- stage II	On-going	Sea dyke	Prevent erosion, protect production & residential areas
3. Construction of embankment for Hiep Thanh Duyen Hải-stage III	Proposing	Sea dyke	Ditto
4. Construction of embankment for Con Trung Duyen Hai	Proposing	Sea dyke	Ditto, plus protect tourism and thermal power plants
5. Embankment of the two sides of Co Chien River at Hoa Minh-Chau Thanh	Proposing	River embankment	Protect residential areas and economic activities
6. Building of river dikes in the south of Tra Cu river, Tra Cu district	Proposing	River embankment	Ditto
7. Construction of Bong Bot sluice in Cau Ke District .	Approved	Sluice gate	Prevent salinity, and freshwater supply for agriculture
8. Construction of Tan Dinh sluice in Cau Ke (Investment preparation stage)	Approved	Sluice gate	Ditto
Soc Trang Province			
1. Enhancement of mangrove forest resilience to adapt to the sea level rise and CC	Proposing	Forestation (mangrove)	Protect coastal areas
2. Construction of dykes and drains to prevent salinization of soils	Proposing	Sea dyke, drainage	Prevent saline intrusion, keep fresh water for sails
3. Irrigation & drainage pump stat'n in Nga Nam, Chau Thanh, My Tu, Thanh Tri dist.	Proposing	Pumping station	Supply water for agriculture production

Priority Project	Status	Major Works	Purpose
4. Establishment of suitable species and models for reforestation	Proposing	Reforestation	Protect coastal areas
5. Capacity building to help Khmer in adapting to CC in Vinh Chau Dist.	Proposing	Capacity development	Enhance awareness on ethnic Khmer
6. Assessment on the biodiversity of plant, animals in the costal zone & lowlands	Proposing	Assessment	Conserve biodiversity of species at risk
7. Improvement of local officials capacity in adaptation to climate change	Proposing	Capacity development	Create community networks on the climate change
Bac Lieu Province			
1. Construction of the East Sea Dyke (CT 667)	Proposing	Sea dyke	Prevent salinity intrusion, sea level rise and disaster.
2. Construction of 4 sluice gates along the coastal line	Proposing	Sluice gate	Prevent tidal effect at coastal areas incl. Bac Lieu Centre
3. Embankment for the both banks of Bac Lieu river	Proposing	River embankment	Prevented erosion, protect people and tourist area
4. Forestation for coastal area protection (2011-2020)	Proposing	Forestation	Protect coastal environment, and prevented disaster
5. Upgrading of the sluice system in the north of the national road No.1A	Proposing	Irrigation & Drainage	Cope with sea level rise, keep fresh water
6. Dredging for canal system level 1 and 2 (main and secondary canals)	Proposing	Dredging	Supply fresh water, 2 canals transferring fresh water
7. Training on human resources in the field of climate change	Proposing	Capacity development	Improve awareness and management capacity.
8. Study on transplanting of seedling and nurseries to cope with salinity	Proposing	Study (salinity tolerant)	Improve nursery to adapt to climate change
9. Upgrading of equipment and tools for officers	Proposing	Office equipment	Improve water management
Ca Mau Province			
1. Construction of sea dyke	Approved	Sea dyke	Protect agricultural production, transportation
2. Completion of 23 sub-region water system (irrigation & drainage, South – North)	Approved	Canal, gates, embankment	Protect regional economic development.
3. Recruitment of fresh water to Ca Mau Peninsula from Mekong River	NY proposed	Canal expansion	Promote agricultural production & domestic water supply
4. Construction and strengthening of river dyke system	NY proposed	River dyke	Protect agriculture production and people's life
5. Capacity building for officers to adapt to climate change	Approved	Capacity development	Prevent, adapt and limit the impact of disasters
6. Community based disaster risk management programme	Approved	Capacity development	Prevent, adapt and limit the impact of disasters
7. Ca Mau supplemental Master Plan under climate change adaptation	Proposing	Study	For economic, socio-cultural, security, national defense
8. Study on diversification of agricultural production in Ca Mau province	NY proposed	Study	Promote agricultural production development
Kien Giang Province			
1. Construction of sea dyke	Proposing	Sea dyke	Protect inhabitants and agriculture production
2. Four sluices on Rach Gia city, Branch Canal, Kien River, An Hoa, Rach Soi	NY proposed	Sluice gates (4 nos)	Prevent salinity intrusion, keep fresh water
3. Construction of Cai Lon – Cai Be Sluices gate	Approved	Sluice gates	Prevented salinity intrusion, keep fresh water
4. Improvement on community awareness for climate change and adaptation	NY proposed	Capacity development	Reduce risk of disaster

Source: JICA Project Team, based on the workshop held on October 27, 2011 inciting provincial DARD and PPC officers Note: For 'Status', 'NY' means Not Yet proposed to the central government for approval, 'Proposing' means that the project was already submitted to the central government but not yet approved for investment, and 'Approved' means that the central government has approved the project, so that the province can move onto next step, e.g. feasibility study, detail design, etc for investment.

4.3.2 Relevant Planned Projects by Master Plan 2011 (SIWRP)

The master plan 2011, prepared by SIWRP, covers the project up to year 2050, divided into 4 stages such as; 2011 – 2015, 2016 – 2020, 2021 – 2030, and 2031 – 205. The master plan 2011 (SIWRP) centers on hydraulic works and following table summarizes the proposed projects by each stage, further categorized by major work and also by province (Note that the following table discusses only the projects for the 7 coastal provinces). From the table, it is obvious that the priority works proposed are; canal rehabilitation/improvement including some control gate, dredging, strengthening of the canal slopes, etc., to supply more fresh water, and construction of sluice gate to prevent saline intrusion, sea dyke to prevent erosion associated with tidal effect, river dike to prevent flood and also saline intrusion.

Table 4.3.3 Summery of the Projects presented in Master Plan 2011 (SIWRP)

Major Work	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang	Total
Stage 1 (2011-15)								
Canal rehab./improv't	8	2	1		2	7	6	26
Sluice gate	1		3		1	3	11	19
Sea dyke			3			1		4
River dyke	2	1	3		1	2	2	11
Ring dyke	1			1				2
Pumping station				1				1
Aquaculture structure			2		1	2		5
Rural water supply							4	4
Reservoir	1							1
Stage 2 (2016-20)								
Canal rehab./improv't	14		24		1	13	15	67
Sluice gate				2	1	5	2	10
Sea dyke	2					4		6
River dyke			2			14	1	17
Rural water supply							1	1
Stage 3 (2021-30)								
Canal rehab./improv't	1	3		2		1	3	10
Sluice gate		14	3	3		5	1	26
Sea dyke		1		2	1	3	1	8
River dyke	2	4		2		9	2	19
Stage 4 (2031-50)								
Canal rehab./improv't			2					2
Sluice gate		4	2	2				8
River dyke				1				1
Ring dyke			2					2
Rural water supply							4	4
Total (2011-2050)								
Canal rehab./improv't	23	5	27	2	3	21	24	105
Sluice gate	1	18	8	7	2	13	14	63
Sea dyke	2	1	3	2	1	8	1	18
River dyke	4	5	5	3	1	25	5	48
Ring dyke	1		2	1				4
Pumping station				1				1
Aquaculture structure			2		1	2		5
Rural water supply							9	9
Reservoir	1							1

Source: summarized with reference to the Master Plan (SIWRP) 2011

The master plan 2011 (SIWRP) proposes 5 large scale sluices; 2 on Cai Lon and Cai Be rivers in Kien Giang province, and 3 on the tributaries of Tien River of Mekong i.e., one each on Ham Luong river in

Ben Tre province, Co Chien river in between Ben Tre and Tra Vinh provinces, and Cung Hau river in Tra Vinh province. These large scale sluices are proposed to construct in the following stages:

Sluices on Cai Lon and Cai Be rivers:	Stage 1 (2011-2015)
Sluice on Ham Luong river:	Stage 3 (2021-2030)
Sluice on Co Chien river:	Stage 4 (2031-2050)
Sluice on Cung Hau river:	Stage 4 (2031-2050)

Note: Cai Lon and Cai Be rivers are drainage ones from the Mekong River while the Ham Luong, Co Chien and Cung Hau Rivers are all tributaries of the Tien Mekong Branch.

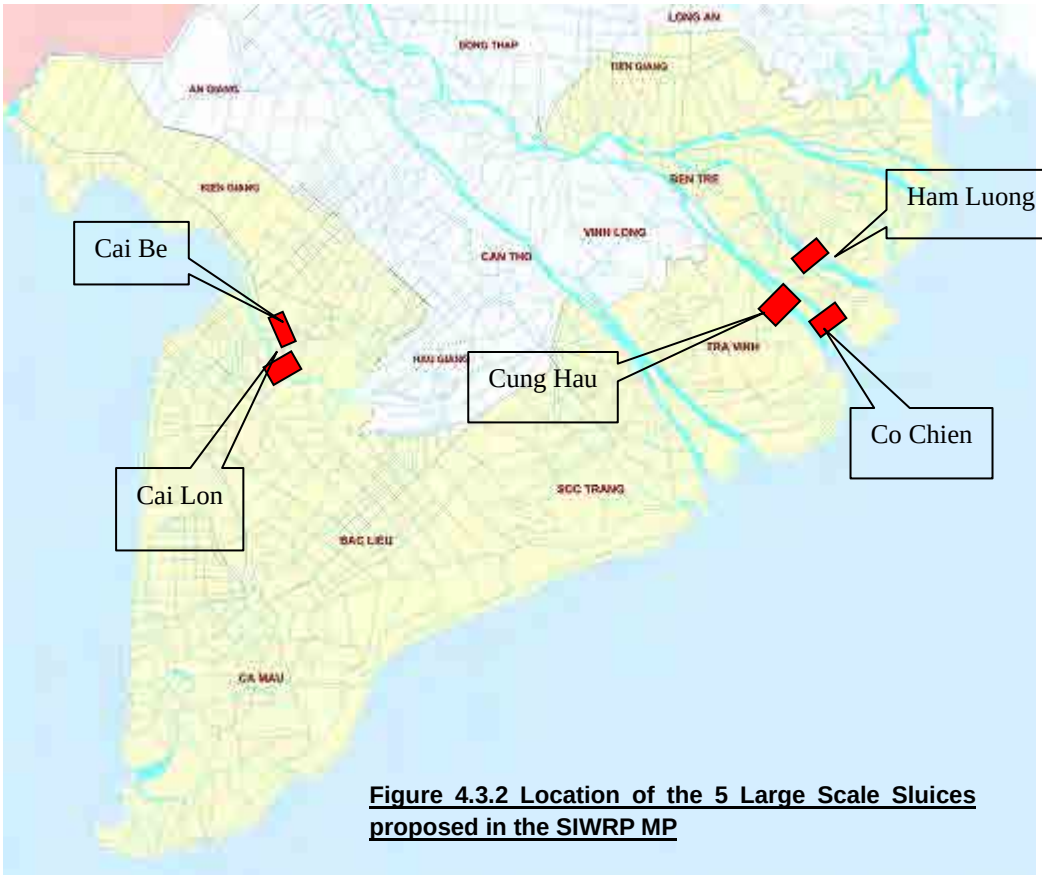


Figure 4.3.2 Location of the 5 Large Scale Sluices proposed in the SIWRP MP

4.4 Development Vision, Guiding Principles and Timeframe

4.4.1 Development Vision for the Project Area

Major means of livelihood for the rural population in the Project Area is dominantly agriculture and aquaculture, also to lesser extent animal husbandry and small-scale industries are run supporting the mainstay. While agriculture, mainly paddy cultivation and also fruit cultivation in the 2 provinces of Tien Giang and Ben Tre, is dominant at upstream parts of the costal provinces, aquaculture especially brackish shrimp culture becomes overriding mainstay as close to the coastal line taking advantage of saline water. In between the 2 mainstay areas, there is unique culture, i.e. alternate cultivation between paddy and brackish shrimp in a same plot according to the season.

Thus, a variety of livelihood and life have been established according to the environment in the Project area. Meanwhile, the impact for climate change is now projected to become ever big enough to negatively influence those people's livelihood. As demonstrated in Chapter 3 'Vulnerability Assessment for the Project Area', large extent of saline intrusion will be taking place aside from temperature rise and unstable rainfall pattern. Though the people have been sustaining the life by adapting to various natural environments, much effort is needed now to cope with and adapt to climate change taking place.

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

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

4.4.2 Guiding Principles for Adaptation to and Coping with Climate Change

To formulate any master plan, there should be guiding principles which can be the development strategies towards realizing the development vision aforementioned. This guiding principle should refer to the nature of the present situation of the Project area and also should take into account the future prediction on the climate change. As mentioned in earlier chapters, though simulation could give an indication on the future status of the Project area, the future status itself depends on how the people respond to the impact of climate change.

Thus, planning under climate change is always associated with a certain level of uncertainty for future. Furthermore, Mekong River's flow to the Mekong Delta will be greatly varied according to how the upstream riparian countries develop the Mekong River's water resources. A future scenario for Mekong Basin development suggests that the flow during rainy season will be less than the present while the flow in the dry season becomes more due to the effect of hydropower dams planned in upper reach of the River. Keeping these basics in mind, following 5 guiding principles are given to achieve the above proposed development vision;

1) NO Regret Investment: As aforementioned, future status of the Mekong River flow entails uncertainty. Sea level rise will be happening with certain level of accuracy, causing salinity intrusion back into the Mekong River. However, the saline intrusion depends more on the flow volume of the River. Therefore, should the development in the upstream riparian counties work in the direction of augmenting dry season flow, saline intrusion may not become severe even under sea level rise. Given this uncertain future, if once a large scale investment were made, for example, in putting up tidal prevention barrage at the estuaries of Mekong River, the investment might

become worthless. Therefore, from this point of view, large scale investment at one place at once is not recommended as it might result in 'regret' investment.

2) Flexibility in planning and investment: In conjunction with above 'No Regret Investment', planning should be flexible and so dose the investment. In fact, investment can be made progressively in parallel with, for example, the increase of saline intrusion over years. In this example, sluice gate can be put up one by one towards upstream in keeping pace with the increase of saline intrusion. Though any plan dose set target year, toward which investment is programmed by year or by stage, such investment plan shall be reviewed with reference to the magnitude of the climate change taking place in actual mode. Planning and thereby investment should be flexible in such a way of being modified according to the actual magnitude of the climate change.

3) Balanced structural and non-structural intervention: Intervention to adapt to and/or coping with climate change should be selected from both structural and non-structural measures. Though most intervention tends to centre on structural measures, there is a good example of adaptation having been practiced by farmers, which is brackish shrimp culture well adapted to saline intrusion. A great number of farmers conduct even alternate paddy-shrimp culture in a same plot well adapted to the season, rainy season and dry season. Cropping calendar adjustment may be another way of adapting to climate change. An advantage of non-structural measures is not as costly as do the structural measures. Interventions should therefore be made in view of not only structural measures but also non-structural measures.

4) Priority setting in the pipeline of vast number of projects: The Project area covers great extent of land, and much so does the Mekong Delta. In this area, there are a great number of hydraulic facilities, for example, total length of canals arrives at as 2 times long as the Globe's circumference with a great number of control gates. These facilities need to be rehabilitated periodically and may be upgraded under the influence of climate change. In addition to these existing facilities, there will be a great number of new facilities to cope with climate change as recommended by SIWRP's master plan (2011). Available investment can hardly cover all the recommended works simply because funds are not enough. In this regards, priority should be given on those great number of projects. Priority ranking should refer to the urgency of the project, cost efficiency, investment viability, environmental impact, etc.

5) Early warning system establishment (saline intrusion): flood early warning system in the Mekong Delta is already working. Monitoring of saline intrusion at major stations is conducted by DONRE, however the monitoring results does not serve for daily operation of sluice gates which are meant for preventing saline intrusion. DARD offices carry out monitoring of salinity level at the estuaries of major canals, in most cases, during dry season from January to June. However, this monitoring is conducted by a rotational visit of the provincial DARD officers or otherwise DARD district officers. Since they do not stay at the site, such monitoring is conducted one to 2 times a month. This frequency is not enough to timely respond against the saline intrusion. Once saline water starts intruding deep into canals, a great deal of paddy will be damaged. To avoid this, monitoring of salinity level shall be organized within the province and also in connection with DONRE, so that early warning system should be established.

4.4.3 Development Timeframe and Phasing

Time Framework should be defined, composed as it is of short, medium and long terms, when preparing any development plan. To define short, mid and long term frame, the Master Plan prepared under this Project should refer to the existing development plans including national socio-economic development plan as well as climate change related framework in Vietnam. Those that the Project should refer to are schematically shown in the following figure with the timeframe this Project

proposes;

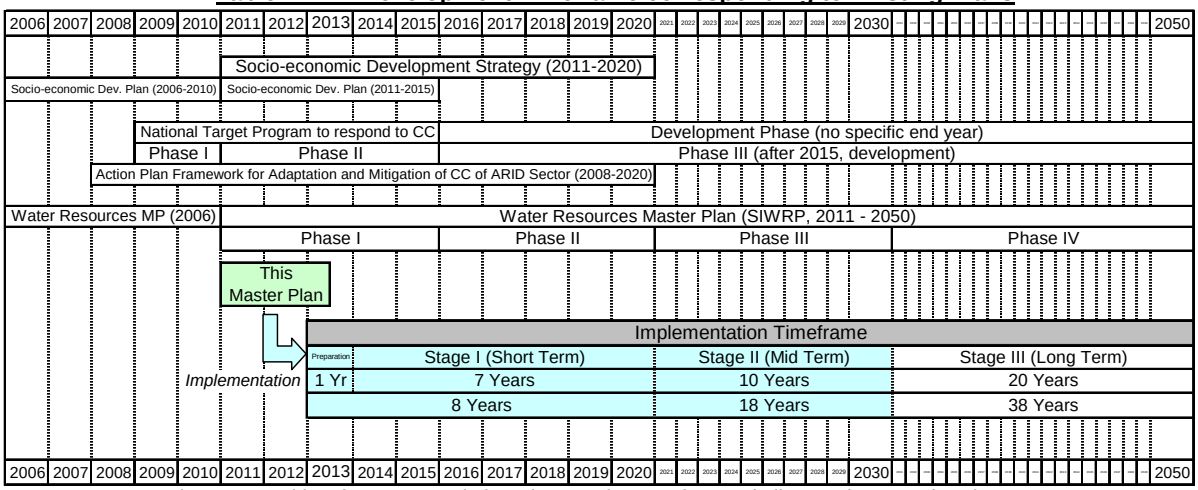
1) Current socio-economic development strategy covers up to 2020, within which current national socio-economic development plan is implemented till 2015, and thereafter it is expected that 5-year span national development plan will continue,

2) There is a climate change related overarching national target program, divided into 3 phases as phase 1 till 2010, phase 2 between 2011 and 2015, and phase 3 after year 2015 without specifying the end year,

3) In relation to the overarching national target program, there is an action plan framework for adaptation and mitigation of climate change (CC) for agriculture and rural development sector, covering from 2008 to 2020, and

4) There are 2 water resources master plan for Mekong Delta; master plan (2006-2010, SIWRP) and master plan (2011-2050, SIWRP), latter of which is divided into 4 stages as 2011-2015, 2016-2020, 2021-2030, and 2030-2050.

Table 4.4.1 Development Timeframe corresponding to Existing Plans



Source; JICA Project Team with reference to existing plans and strategies, and climate change related programmes

This Master Plan Project delivers the final version of the master plan in early part of year 2013 after feeding back all the findings from the in-depth study as well as referring to the feasibility examination on priority projects. Therefore, year-one of the Master Plan should start in 2013 corresponding to the end of this Master Plan Project. Stage I of the Master Plan (short-term development) should be then programmed to cover 7 years from year 2014 to 2020, end of which corresponds to the end year of Action Plan Framework for Adaptation and Mitigation of Agriculture and Rural Development Sector, and the Phase II of the Water Resources Master Plan (SIWRP, 2011). During this Stage I period, high priority and urgent focal projects should be undertaken.

Then, followed is the mid-term timeframe covering the next 10 years period from 2021 to 2030, last year of which corresponds to the end year of Phase III of Water Resources Master Plan (SIWRP, 2011). During this period, large scale projects which started in mid and latter parts of the Stage I are to be completed. Then, upon reviewing the achievement of the Stage I project implementation, next priority projects should also be taken up for the implementation during this Stage II.

Finally, the period from 2031 to 2050 is set as Stage III. However, since this period after year 2030 is far-off, no specific priority project is planned for implementation. Projects presented in this Stage are; for example, sluice gate construction in order to prevent saline intrusion along mid parts of Mekong Rivers with reference to the simulation results on the saline intrusion back into the River, routinely

required works, e.g. canal rehabilitation/improvement including dredging and embankment strengthening, and in addition probably some large scale projects[1] that the MARD Headhunters has preliminary been confirming the feasibility. Feasibilities on the large scale projects should be confirmed during Stage I or Stage II period. Now total stages are;

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

4.5 Development Options and Strategic Environmental Assessment

4.5.1 Development Options

To meet the development objective, there should be paths, which are called development options or development scenarios. In examining the development options, this Project integrates two of the most important means of intervention that are Structural and Non-structural interventions which together makes a four-quadrant matrix as shown in Figure 4.5.1 and elaborated in Table 4.5.1;

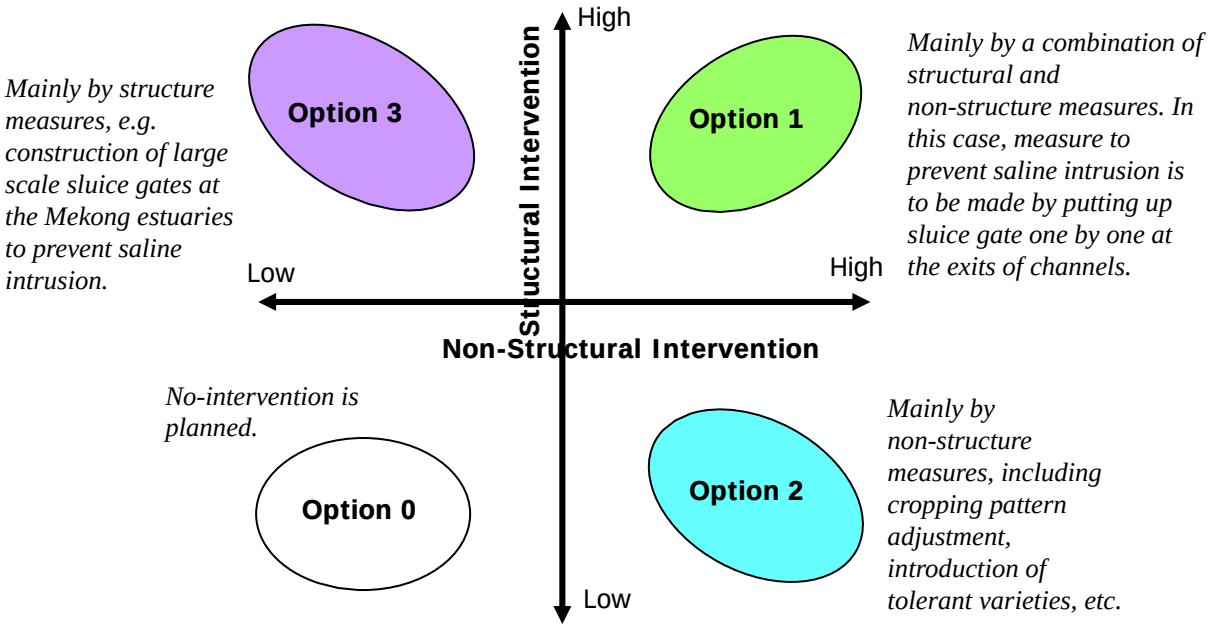


Figure 4.5.1 Four Potential Development Options based on Structural and Non-structural Interventions

Table 4.5.1 Development Options

Option	Explanation
Option 0	No measure will be made. It means no specific measurement will be undertaken to adapt to and cope with, e.g., saline intrusion.
Option 1	To adapt to and cope with climate change, both structural measurements and non-structural measures will be undertaken. Especially with regards to saline intrusion, sluice gate will be constructed one by one at the exits of channels out to the Mekong River. Aside from the construction, such non-structural measures will be undertaken e.g. cropping pattern adjustment, introduction of saline tolerant crops including brackish shrimp culture.
Option 2	Interventions will be made mainly by non-structural measures. In this case, fro example, saline water will intrude as the sea level rises whereby saline tolerant crops and/or brackish shrimp culture should be introduced. Cost for this option 2 may be the lowest; however there may be a

[1] Large scale projects that the MARD HQs proposes are, as of year 2012, 1) super sea dyke between Go Cong (Tien Giang province) and Vung Tau (Ba Ria Vung Tau province), sea dyke in Rach Gia bay (Kien Giang province), and three barrages planned at the estuaries of Mekong River.

	limitation to cope against all the impacts from the climate change.
Option 3 (Option 3A) (Option 3B)	Interventions will be made mainly by structural measures. Typical example is the construction of large scale sluice gates at the estuaries of Mekong River. In fact, SIWRP master plan (2011) proposes 3 large scale sluices at the 3 tributaries of Tien Mekong River (Cung Hau, Co Chien, and Ham Luong). According to SIWRP, since the 3 tributaries are located in almost mid of total 9 tributaries, the closure will contribute to augmenting fresh water to other tributaries located both sides of the closed tributaries, which in turn prevent saline water intrusion for those tributaries having no closure sluices. Beside, Mekong Delta Plan being formulated in collaboration with Dutch government as of 2012 proposes to close all the tributaries of Mekong River, except for one which is Hau River, as the version 0. This is meant to generate fresh water by storing and also to prevent saline water intrusion. The former plan may be called Option 3A, while the latter Option 3B. In both cases, since saline water intrusion is prevented with the structure to a large extent, non-structural measures will rarely be expected.

Source: JICA Project Team

Of the four development options, this Project recommends the Option 1, which is the combination of non-structural and structural measures in order to adapt to and cope with climate change as elaborated in the next sub-chapter "4.5.2 Strategic Environmental Assessment".

4.5.2 Scoping of Development Options

As shown in the following table, the expected adverse impacts by Option 1, 2, 3A and 3B are examined. Out of those options, Option 1, 3A and 3B will take structural measures, therefore, issues regarding air pollution, waste and so on can take place during the construction. However, these impacts are tentative and limited for a certain period. On the other hand, water pollution due to gate construction, involuntary resettlement, land acquisition (recovery), suspension of navigation in the Mekong River/tributaries by those options will be very tough issues. Especially, resettlement of people and land recovery including displacement of tombs can lead to change of social institutions, socio-economy, disparity between beneficiaries and adversely affected people and so on.

Table 4.5.2 Expected Environmental Impacts by the Proposed Options

Environmental Parameters	Option 1	Option 2	Option 3A	Option 3B
1. Air Pollution	X (construction stage)	-	X (construction stage)	X (construction stage)
2. Water Pollution	X	-	X	X
3. Waste	X (construction stage)	-	X (construction stage)	X (construction stage)
4. Soil Contamination/ salinization *1	-	-	-	-
5. Noise and Vibration	X (construction stage)	-	X (construction stage)	X (construction stage)
6. Ground Subsidence	-	-	-	-
7. Offensive Odor	-	-	-	-
8. Bottom sediment	-	-	-	-
9. Protected area *2	-	-	-	-
10. Ground water	-	-	-	-
11. Hydrological Situation	-	-	X	X
12. Topography and Geographical features	-	-	-	-
13. Involuntary Resettlement	X	-	X	X
14. Land Acquisition	X	-	X	X
15. Cultural heritage (tombs)	X	-	X	X
16. Landscape	-	-	-	-
17. The poor, indigenous and ethnic people	-	-	-	-
18. Livelihood	X	- and X	X	X
19. Local economy *3	X	-	X	X
20. Existing social infrastructures and services	X	-	X	X
21. Misdistribution of benefit and	X	-	X	X

Environmental Parameters	Option 1	Option 2	Option 3A	Option 3B
damage				
22. Social institutions	X	-	X	X
23. Water Usage or Water Rights and Rights of Common *4	-	-	-	-
24. Gender	-	-	-	-
25. Children rights	-	-	-	-
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	X (construction stage)	-	X (construction stage)	X (construction stage)
27. Accidents	X (construction stage)	-	X (construction stage)	X (construction stage)
28. Global Warming	-	-	-	-

X: Negative impact is expected - : Either positive or negligible negative impact is expected

Remarks:

*1: During construction stage, soil contamination by, e.g., oil leakage from heavy vehicles may take place; however this shall be controlled by the construction supervisor and even if it should take place, the impact should be minimal because it is limited only during the construction period.

*2: There is no protected area in and around the potential construction sites.

*3 Local economy would be negatively affected, e.g. by enlarging the economy gap between the beneficiaries and those who have to resettle.

*4: With the construction of sluice gates, water usage would be changed. However this change takes place in positive way by augmenting fresh water, whereby no negative impact is expected.

Based on the examination mentioned above, only permanent and key issues are picked up and compared among all options including Option 0. Not only negative impacts but also positive impacts by each option and those degrees of impacts are discussed. The summarized comparison is as follows;

Table 4.5.3 Main Environmental Impacts by Option

Environmental items	Option 0*	Option 1	Option 2	Option 3A	Option 3B
Water quality of Mekong River	-	-	-	XXX	XXX
Farming	XX	+++	+	++	++
Shrimp cultivation	-	++	+ and X	XX	XX
Eco-system of Mekong River	-	-	-	XXX	XXX
Resettlement and land acquisition (land recovery)	-	XXX	-	XX	XX
Transportation by water (Mekong River)	-	-	-	XX	XX
Possibility to be regrettable project	None	None	None	High	Very high
Project cost	Zero	Medium-high	Very low	High	Very high

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

+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

-: no impact or negligible

* Option 0 is compared with the current situation in terms of environmental impact.

4.5.3 Basic Environmental and Social Conditions in the Target Area

1) Land Use

Ratio of agricultural land use in the Project area as well as Mekong Delta is much higher than other areas of the Country. While 55% and 63% of the area is used for agricultural purposes in the Project area and Mekong Delta respectively, only 29% is used in the whole Country, which is far greater than any other regions including the Red River Delta (36%). Among the provinces of the Project area, Kien Giang (83%) was the highest in the paddy land, which was followed by Bac Lieu (75%) and Soc Trang (73%). On the other hand, paddy area of Ben Tre (27%) was quite limited followed by Tien Giang (53%), suggesting that the most agricultural areas in Ben Tre, also followed by Tien Giang province, are now planted with perennial cops i.e. fruits.

The agriculture in the Project area and Mekong Delta by large is diversified. The land use is consequently

quite diverse. By and large, double and triple cropping of paddy is dominant in the upper-middle delta especially along the Rivers, while brackish fishery stretches out along the coastal areas including the Project area. Those major two patterns of land use are further diversified by the different types of forest areas (protective, productive, reforestation etc.), annual crops (mostly fruits), and freshwater fishery (in this classification, shrimp culture is included in "fishery").

2) Economic Situations

The economy of the Mekong Delta is primarily agricultural. The Project area's overall economic structure is; 48% by primary sector, 23% by secondary sector, and 29% by tertiary sector. Primary sector agriculture in the Project area (48%) is higher than that of Mekong Delta as a whole (41%) and far higher than the national average (21%). The Project area and Mekong Delta as a whole have been achieving higher growth ratios -over 10% per annum in most provinces- compared to a national average of 5-8 % per annum.

GDP per capita in the Project area is, however, not as high as the national average. For example, the average GDP per capita in the Project area is US$ 987-US$1,040 for Mekong Delta as a whole - while the national average is US$ 1,127. (These GDP estimates are based on 2009 figures reflecting an exchange rate of 17,100 VND/US$). The province showing the lowest GDP per capita is Tra Vinh, followed by Ben Tre. The province with the highest GDP -US$ 1,286- is Kien Giang. There is little secondary and/or tertiary sector industry in the Project area despite huge production figures in the primary sector. As a result the GDP per capita in the Project area has been lowered.

3) Conservation Area and Rare/Endangered Species in the Target Area

In the target area, 5 natural reseve areas, which have unique eco-system, are specifeid to be conserved Basic information and location of those areas are shown in folllowing table and figure:

Table 4.5.4 Basic Information of Natural Reserve in the Target Area

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

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

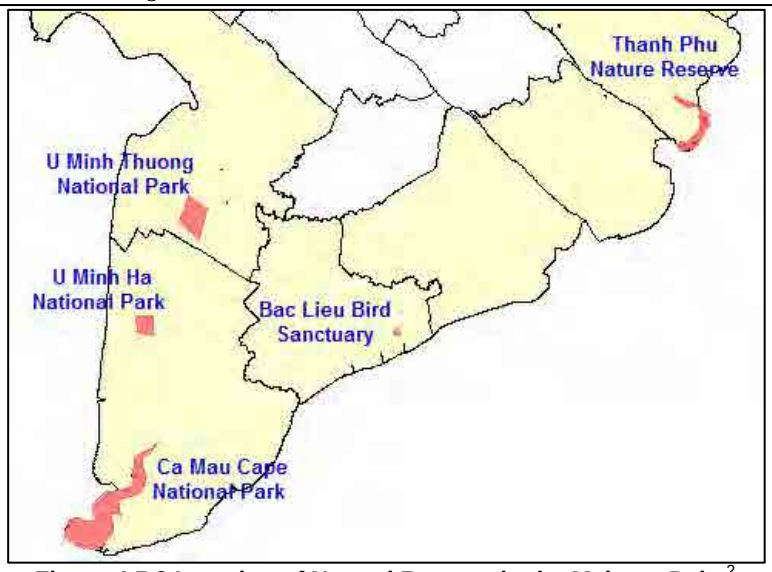


Figure 4.5.2 Location of Natural Reserve in the Mekong Delta[2]

4.5.4 Endangered Species on the Mekong River

The Mekong River within the Mekong Delta has rich and unique fish diversity, 481 fish species in total, including 28 endemic species, and the number of species in the Delta is bigger than those of other Mekong River basins (MRC, 2010a)[3]. Some of them are migratory between marine/estuarine and freshwater for spawning, their migration paths are thought to be various dependent on the species as illustrated in the Figure 4.5.3 (MRC, 2002)[4]. The migratory species are as follows (MRC, 2010b)[5], and as of now no species below except for *Pangasius krempfI* are listed as Globally Threatened -Critical (GT-CR) nor as Globally Threatened-Endangered (GT-EN). Note that *pangasius krempfI* is specified as Vulnerable (VU), which is presumed to face a high risk of extinction in the wild.

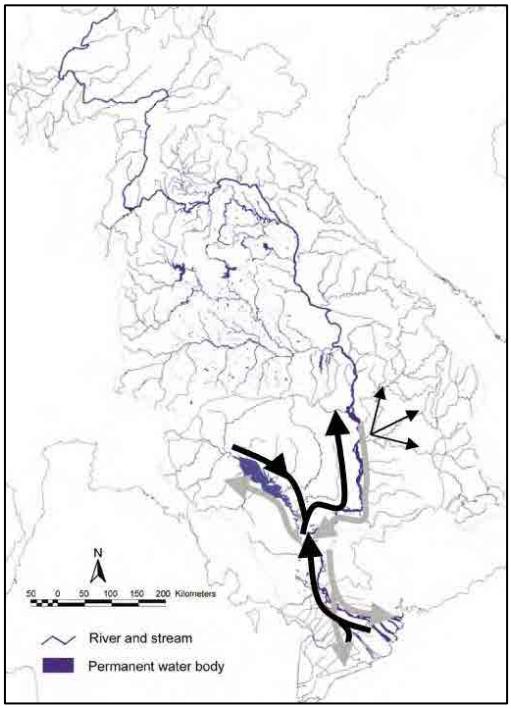


Figure 4.5.3 Paths of Migratory Fish in the Lower Mekong Basin (MRC, 2010b)

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

[2] Modified based on the map of "Forestry Planning in the Mekong Delta", SIWRP 2011
[3] MRC (March 2010), SEA for Hydropower on the Mekong Mainstream, Aquatic Systems Baseline Assessment, Working paper 8
[4] MRC (Oct. 2002), Fish migrations of the Lower Mekong River Basin: implications for development, planning and environmental management, Technical Paper 8
[5] MRC (June 2010), Impacts on Wetland and Biodiversity (Draft), Technical Note 9

6) Herrings: *Coila* sp., *Setipinna* sp.

The rapid development of the Mekong River Basin in those several decades, such as dam constructions, has caused big-scale environmental changes; consequently, the unique ecosystem has been affected adversely to some extent. Many fish species, especially, migratory fish (within the river) may have been damaged, and some of them are threatened as GT-CR or GT-EN. The Lower Mekong River basin has the richest biodiversity in the whole Mekong River basins; however, it faces to the same issue. Globally threatened fish species in Vietnam (the Mekong Delta) are as in Table 4.5.5:

Table 4.5.5 Globally Threatened Fish Species in Vietnam (Mekong Delta)[6]

Scientific name	Common name	Status (IUCN) [7]	Remarks
Chela caeruleostigmata	Leaping Barb	GT-CR	
Pangasius sanitwongsei	Giant Catfish	GT-CR	Highly migratory
Pristis microdon	Freshwater Sawfish	GT-CR	
Pristis zijsron	Green Sawfish	GT-CR	
Scleropages formosus	Golden Arowana	GT-EN	Heavily traded
Tenualosa thibaudeaui	Laotian Shad, Freshwater Herring	GT-EN	Highly migratory, Endemic
Probarbus jullieni	Jullien's Barb	GT-EN	Highly migratory
Himantura chaophraya	Giant Freshwater Stingray	GT-EN	
Himantura oxyrhynchus	Marbled Mekong Stingray	GT-EN	
Balantiocheilos melanopterus	Silver Shark	GT-EN	
Pangasius krempfl	Krempf's catfish	VU	Highly migratory between sea and river
Carcharhinus leucas	Bull Shark	LC	
Mekongina erythrospila	Striped River Barb		Endemic
Puntioplites falcifer	Silver Barb		Endemic

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

Aside from the threatened fish species listed in the above table, the Riverine Irrawaddy Dolphin (*Orcaella brevirostris*) is very famous as a flagship endangered wildlife in the Mekong River (see Figure 4.5.4 for the range areas). The freshwater sub-population ranges in the Mekong River, while the dolphins are distributed in the coastal, shallow, blackish, or fresh waters in Southeastern Asia from India to Indonesia. It is said that oil from boats, blast fishing, gillnet entanglement and so on have damaged the species[8] and recently the sighting of dolphin within Vietnam is very rare. The sub-population in the Mekong River is designated as critically endangered by IUCN in 2004 and the population number is estimated at 127 minimally (WCS, 2007)[9].

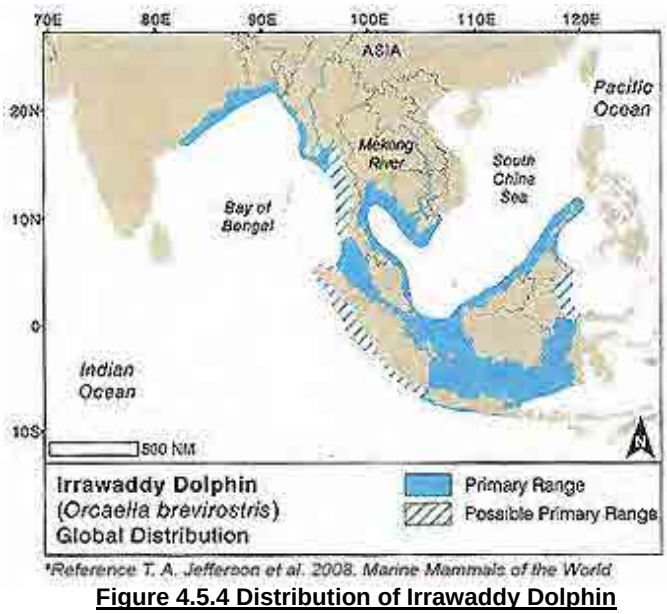


Figure 4.5.4 Distribution of Irrawaddy Dolphin

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

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

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

[9] Wildlife Conservation Society (WCS), 2007, Status and Conservation of Freshwater Populations of Irrawaddy Dolphins,

4.5.5 Legislative and Institutional Framework of Environmental Consideration in Vietnam

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

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

Table 4.5.6 Gap between JICA Guideline and Vietnamese Legal Frame

JICA Guideline	Vietnamese regulation	Remarks
▪ Alternatives of project shall be included in EIA report (JICA Guideline)	▪ No mention about examination of alternatives in EIA report contents preparation	
▪ After the disclosure of the scoping drafts, project proponents etc. conduct consultations with local stakeholders*. JICA incorporates the results of such consultations into its TOR. The consultations cover the needs of projects and the analysis of alternatives. (JICA Guideline)	▪ no mention	▪ There are description about consultation, however, the agenda does not cover scoping nor alternatives (Decree No.29-2011, Article 15).
▪ The socio-economic studies should be implemented in the early stages of project preparation and with the involvement of potentially displaced people (WB OP4.12, Para 6)	▪ no mention	
▪ Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets--provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan are eligible for benefit (WB OP4.12, Para 15)	▪ Those who have a certificate of land use right or satisfying all of the conditions for issuance of a certificate of land use right are qualified as targets of compensation by the State	
▪ Compensation based on the full replacement cost must be provided as much as possible (JICA Guideline).	▪ The land prices stipulated by people's committees of provinces and cities under central authority shall be used as the basis for calculating compensation when the State recovers land. They must be close to actual market prices for assignment of land use right in normal conditions and, when there is a big difference compared with actual market prices, they must be adjusted for conformity. (Law on Land Article 56)	▪ Since compensation is based on the land price specified by Provincial People's Committee, there are some cases that there are differences between actual land price and compensated ones, they are not significant ones, though (interview result by the JICA Team, 2012).
▪ In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA Guideline) ▪ Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood (JICA Guideline)	▪ Agencies (organizations) that are assigned by the provincial-level People's Committees to arrange resettlement must inform every household that has land recovered and must be relocated of the tentative resettlement arrangement plans and publicly post up these plans at their headquarters, at the offices of the commune-level People's Committees of the localities where exists the recovered land and in the resettlement areas 20 days	▪ Draft resettlement arrangement plan is informed to the affected people, however, people's participation in planning is limited.

JICA Guideline	Vietnamese regulation	Remarks
	before such resettlement plans are approved by competent State bodies (Decree 197-2004, Article 34)	

4.5.6 Anticipated Environmental Impacts

1) Option 0 (No Intervention)

Since no countermeasure will be taken against current issues, damage to crops by the sea water intrusion will increase in the future. Furthermore, it is difficult to avoid decrease of shrimp production due to overflow caused by flood. On the other hand, other negative impacts are not expected and no construction cost is necessary.

2) Option 1 (Combination of Structural and Non-structural Measures)

This option will make it possible to prevent sea water intrusion by structural measure, which means it can alleviate the crop production decrease. Also, non-structural measures, namely, salinity tolerance crop such as new rice variety introduction or coconut plantation can reduce the damage to the farming by saline water. Moreover, it is possible to change planting season depending on the water quality to avoid the salt damage. During dry season, sluice gates (not large-scale) can keep water salinity of shrimp cultivation ponds at the appropriate and constant level by gate switching to adjust sea water intrusion. As a whole, it means that the structural and non-structural intervention will give positive impacts on the farming and aquaculture in the area.

As mentioned before, discharge of Mekong River can be changed depending on development at the catchment area of the river in future. Proposed structures in the Option 1 are not large-scale, whereby it is possible to construct sluice gates in conformity with the situation change regarding discharge and salinization step by step. Therefore, there is very little possibility that the construction works in this Option 1 will be regrettable.

Concerning negative impacts by the Option 1, sluice gate establishment to prevent saline water intrusion requires construction space to some extent. In case of only sluice gate construction, the scale of resettlement would not be so big. However, if expansion of existing water canal is planned, large scale involuntary resettlement of the residents and land recovery by the State may be needed. In such case, compensation to the affected people for land and house resettlement is necessary, which leads to increase of project cost. Furthermore, close of water flow by sluice gates could change the eco-system in water channels.

3) Option 2 (Mainly Non-structural Measures)

Due to no construction works in this Option, project cost will be low and any damages to social and natural environment would not be expected. Conversion of crop varieties, e.g. from conventional paddy varieties to salinity tolerance ones will be efficient to reduce salinity damage to the crops. Also, it is possible to expand shrimp cultivation area to some extent based on the level of water salinity, though it is needed to take notice of disease control in the ponds.

Regarding negative impacts by the Option 2, it is very difficult to keep constant salinity of shrimp cultivation ponds in case of salinity increase and to prevent shrimp's flow out in case of flood. In addition, in case of drought after rice transplanting or coconut planting, those crops will be damaged. It can be said that effectiveness of non-structural measures is limited, and it man be very difficult to take measures to meet the changeable situations within a limited time of period under climate change.

4) Option 3A (Mainly Structural Measures, 3 Large Scale Sluices on the Mekong River)

Structural interventions will be very efficient to prevent sea water intrusion, which leads to decrease of crop salt damage. However, this option will close flow of Mekong River at three tributaries, which can cause irreversible negative impacts on eco-system and transportation in the river. Furthermore, involuntary resettlement and land recovery for the large-scale structure construction will be needed; however, the scale will be small as compared with that of Option 1 in case of canal expansion since the proposed number of construction site is only three (3). Yet, the project cost of this option will be much bigger than that of Option 1, and given the possibility that discharge of the Mekong River may be increased during dry season in future due to planned hydropower dams construction, the construction in this option may have a possibility of becoming regrettable project.

As mentioned above, there are species to be affected by the construction work on the Mekong River. Option 3A and Option 3B are to construct large scale sluices on the tributaries of Mekong River. The large scale sluices will give negative impact to the migratory species, for which total 6 species are known as of now, and also GT-CR and GT EN species will be further endangered. Though it is rare to see Riverine Irrawaddy Dolphin in the Mekong Delta, the endangered mammal will also be affected. Therefore, taking into account the existence of these species, Option 3A and Option 3B which require large scale construction work on the Mekong River shall need thorough environmental examination, or the options shall be set aside.

5) Option 3B (Mainly Structural Measures, Large Scale Sluices on all the Tributaries of Mekong River excluding Hau Ricer)

The tendencies of positive and negative environmental impacts caused by Option 3A and 3B are very similar. However, the number of large-scale construction points by Option 3B is more than that of 3A. Therefore, project cost of option 3B will be much higher than that of 3A. It means that the scale of negative impacts on the eco-system and transportation in the Mekong River will be more significant. Given these circumstances, there is a high possibility that Option 3B could be also a regrettable project by the same reason mentioned above.

4.5.7 Mitigation Measures

1) Option 1 (Combination of Structural and Non-structural Measures)

The most important issue in this option is land recovery and resettlement. Especially, if existing canals are expanded, many houses along the canals have to be resettled. To reduce the resettlement as much as possible, it is possible to select construction and expansion points where number of houses is smaller than the others. Also, tombs are very important for the residents, and therefore it is needed to avoid such places as the construction sites. For the resettlement and land recovery, it is necessary to prepare a compensation plan based on the regulations/rules set by the Government. On the other hand, there is a possibility that the discharge of Mekong River would be increased; based on the change, planning of sluice gate construction e.g. location or number of the gates have to be modified to avoid becoming regrettable project.

2) Option 2 (Mainly Non-structural Measures)

In the Option 2, since structural measure is not taken, severe negative environmental impacts are not expected while positive impacts are limited as mentioned before. Therefore, there is no point to be considered to minimize the expected adverse environmental impacts for this option.

3) Option 3A (Mainly Structural Measures, 3 Large Scale Sluices on the Mekong River)

It is important to consider the construction locations to minimize resettlement and land recovery as same as Option 1. Also, it is needed to study eco-system, especially in water body. Probably, Mekong River in the sites comprises diversified eco-system, namely, endangered species, rare species,

indigenous species, commercially worthy species, dominant species, vulnerable species, etc. and those should be examined in advance and list of existing species shall be prepared. Moreover, transportation by water in and around the construction sites will be affected. Weight transported per day, contents of freights, frequency of daily navigation should be studied to estimate economic damage by the structure constructions. Even though those countermeasures are taken, the effect would be limited. As compensation of environmental negative impacts, it is possible to examine compensation for the damage to transportation by water or to construct new range area for endangered/rare species, however, the cost can be significantly large, which is not realistic.

4) Option 3B (Mainly Structural Measures, Large Scale Sluices on all the Tributaries of Mekong River excluding Hau Ricer)

The points to consider environmental impacts for Option 3B is almost same as that of Option 3A. It is noted that the scale of negative impacts and project cost will be much bigger than those of Option 3A since all the tributaries except for one on the Hau River are planned to be closed under this Option 3B.

4.5.8 Evaluation and Examination of Alternatives

As a whole, large-scale structural measure, namely, Option 3A or Option 3B can cause significant adverse impacts on the surrounding environment. One may say, nevertheless, that such project should be taken into consideration on condition that the benefit surpasses the cost including mitigation measures for those significant adverse impacts. However, it should be considered that those options would have a possibility of becoming a regrettable project should the Mekong River discharge during dry season be increased. There are plans to construct hydropower dams in the upper most catchment areas of the Mekong River, which would augment the dry season discharge. Moreover, impacts by large-scale construction can be significant on eco-system, and effects of mitigation measures will be very limited. Given this probable scenario, therefore, the structural measure only, especially Option 3A and 3B cannot be recommended.

Concerning Option 2, the negative impacts are hardly expected; however, the positive impact will also be limited. As mentioned before, it can be said that effectiveness of non-structure measures only is not enough to cope with the impacts incurred by climate change. On the other hand, Option 1 will not be “Regrettable Project” and would not cause significant environmental impact, it will need resettlement and land recovery, though. It will give positive impacts on farming and shrimp cultivation. Considering those circumstances, the Option 1, namely, the intervention by both non-structural and structural measure is the most suitable as the path of development in the Project area under the condition that resettlement and land recovery are minimized as much as possible.

4.5.9 Monitoring

Monitoring of anticipated impacts by Option 1 will be implemented in terms of both negative and positive impacts, and whether planned mitigation measures are implemented. Proposed monitoring indicators are salinity of water canal, change of water level, crop production, frequency of high tide and so on. In addition, it is needed to confirm whether examination to minimize resettlement and land recovery is done or not. Draft monitoring plan is shown as below:

Table 4.5.7 Proposed Monitoring Plan

Development option	Positive/Negative impact	Mitigation measure	Monitoring indicator	Responsible organization
Structural measure of Option 1	Negative impacts: • Resettlement • Land recovery	• Site selection to minimize resettlement • Site selection to minimize land	• To confirm whether proper construction sites to minimize resettlement are	• DARD

Development option	Positive/Negative impact	Mitigation measure	Monitoring indicator	Responsible organization
		recovery	selected • To confirm whether proper construction sites to minimize land recovery are selected	• DARD
Non-structural measure of Option 1	Negative impacts: none Positive impact: • stabilization of farming	None None	• Production of crops	• DARD

4.6 Land Use Planning

Agricultural land use is affected by the availability of water resources and vice versa. In the coastal areas of Mekong Delta, the water resources are composed of fresh, saline and mixed ones, each of which affects what land use should be planned. The area where saline water is to be prevalent is simulated to enlarge according to the sea level rise under climate change. In this chapter, therefore, agricultural land use is formulated under the climate change Scenario B2[1]. In a course of planning process, three major issues are concerned; namely, 1) profitability of major commodities (paddy, shrimp, and fruits crops), 2) stability of major commodities in an economic term, 3) adaptability or suitability of major commodities to different types of environment, and relevant issues and constraints need to be considered for planning.

4.6.1 Profitability and Risks of Major Commodities

Based on a series of questionnaire surveys organized under the Project, expected profitability has been estimated for the major commodities: paddy, shrimp, coconuts, and fruit crops. Based on the findings derived from the questionnaire surveys, it was found that the profit of paddy cultivation is lower than other crops even if paddy is cultivated twice a year. The most profitable crop was found fruit crops conceiving a net income of 94,433,000 VND/ha[2], which is followed by coconut with a net income of 56,680,000 VND/ha[3].

Brackish shrimp culture comes to the third ranked, still higher than two-cropping of paddy cultivation. Taking a series of interviews made to some shrimp farmers into account, the resulted income level may seem a little understated. It may be because the results included a lot numbers of samples for extensive, extensive under rotation between shrimp-paddy, and semi-extensive cultures, all of which area practiced by common farmers and not by industrial farmers. Thus, as far as profitability of average year is concerned, fruit crops and shrimp culture maintain more economic potential than paddy. When land use is concerned, those commodities would be more preferable to the beneficial people in the area from economic point of view.

Table 4.6.1 Profitability of Major Commodities ('000VND/ha)

Commodity	Gross Income	Cost	Net Income	Area/ Household	Source
Paddy (1 cropping)	30,780	17,658	13,122	0.74ha	Agriculture and aquaculture questionnaire survey
Paddy (2 cropping)	61,560	35,316	26,244	0.74ha	Agriculture and aquaculture questionnaire survey
Brackish Shrimp	64,968	28,246	36,722	2.00ha	Shrimp culture questionnaire survey
Coconut	65,233	8,553	56,680	0.48ha	Agriculture and aquaculture questionnaire survey
Fruit Crops	140,586	46,153	94,433	0.64ha	Fruit production questionnaire survey

Source: JICA Project Team (2012) from a different set of questionnaire surveys.
Note: For the target year of coconut production, price was the highest in the recent years, which dropped to be around 30% in the next year (early 2012). Therefore, it is safer to consider the net income of coconut roughly half of it.

[1] Note that future Mekong River discharge under B2 scenario tends to give smaller amount of discharge during dry season than that of A1 scenario according to the simulation by MRC, whereby B2 scenario gives severer saline intrusion result for the coastal areas of Mekong Delta. Therefore, saline intrusion result simulated under B2 scenario is applied in this land use planning.

[2] In addition to the statistical data, it has been confirmed that profitability of fruit crops are generally higher than that of paddy (interview to Southern Horticultural Research Institute: SOFRI, 2012). For example, expected average income of mandarin and orange are 200-300 million VND/ha per year, which sometimes reaches even 500 million VND/ha per year in maximum despite some risk of loss to be 10 million VND or total loss as a minimum case due to disease.

[3] Note that the price of coconut for the year (2011) surveyed was quite high as compared to the recent years and had dropped to be 30% of it in the following year (2012). Therefore, it is safer to consider that presented value is the maximum case.

Risk factors of major commodities should also be taken into account in planning land use, and Table 4.6.2 summarizes comparative advantages and disadvantages of the commodities in terms of the stability of income levels. For example, risk of income reduction caused by temperature change is evaluated "middle" for paddy and shrimp and "low" for coconut and fruit crops. On the other hand, conceivable risk associated with saline water is "high" for paddy and fruits, "low" for coconut, and "no" noticeable risk for shrimp.

Table 4.6.2 Risk Factors and Their Impact on Major Commodities

Risk Factor	Paddy	Shrimp	Coconut	Fruits	Remark
1. Production Factors					
Temperature change	Mid	Mid	Low	Low	Quality of products is also affected
Saline water	High	Low (no)	Low	High	Ditto
Degree of technology	Low	High	Low	High	Ditto
Disease	Mid	High	Low	High	Ditto
Flood	Mid	Mid	Low	High	Ditto
2. Price Factors					
Price fluctuation	Low	High	High	High	
3. Other Factors					
High investment cost	Low	High	Low	Mid	
Length to first harvest	Low (short)	Low (short)	High (long)	High (long)	
Manageable size	Mid	Low (large)	Mid	Mid	Clarification of data needed
Count of High Risk	1	4	2	6	5 point/high risk
Count of Middle Risk	4	2	1	2	3 point/ middle risk
Count of Low Risk	4	3	6	1	1 point/ low risk
Total Score of Risk	21	29	19	37	

Source: JICA Project Team (2012) from a different set of questionnaire surveys.
Note: Evaluation of the risk was based on a discussion with SIWRP counterparts (no particular foundations to prove)

Total risk is now concluded through a simple evaluation of risk factor by giving different scores to each level of risk (5 point for high risk, 3 point for middle risk and 1 point for low risk). Note that no weight factor is considered among the risk factors, given no particular scientific foundation available for that. After all, total score was the highest (37 points), the most risky, for fruit crops despite the higher income level, which is followed by shrimp (29 points). Paddy and coconut were scored about the same: 21 points and 19 points respectively, which are less risky.

4.6.2 Suitability of Major Commodities

As for land use planning, suitability and adaptability of major commodities to various types of agro-ecological environment should be clearly understood so that appropriate commodities can be recommended suitable to particular areas. As a bottom line, minimum requirement of the commodities or threshold for biologically and economically acceptable for the commodities, should be identified.

1) Paddy

Generally, it is for paddy said that salinity contents should be kept less than 0.4% (4,000 PPM) for the production[4], which is considered the threshold for the salt tolerant varieties. In reality, however, salinity should be kept much lower than that for the economic production of paddy. For an example of a research in Japan, it is reported that effect of salinity starts at the salinity content of 500 PPM for the early stage (3 weeks after transplanting), by reduction of number of tillers[5]. At the point of 1,000 PPM, effect of salinity appears as a reduction of number of panicles.

2) Shrimp

Water salinity level plays an important role in shrimp culture. According to the Research Institute for

[4] Interview to Cuulong Rice Research Institute, 2011.
[5] http://www.pref.tottori.lg.jp/secure/563190/48-3-2.pdf (in Japanese)

Aquaculture No.2, salinity contents adaptable for shrimp are 8-40 PPT (8,000 – 40,000 PPM) for black tiger shrimp and 2-40 PPT (2,000 – 40,000 PPM) for white leg shrimp, of which those species best fit to ranges of 18-25 PPT for black tiger shrimp and 25-30 PPT for white leg shrimp. That is, white leg shrimp can adapt to a wider ranges of salinity but, for better production, range of targeted salinity is quite narrow (within 5 PPT points) and vice versa. In a view of cultivating shrimp with less salinity level, or with higher risk of flood or fresh water intrusion, white leg shrimp may be more adaptable.

Table 4.6.3 Suitable Salinity Contents for Shrimp Culture

Type of Shrimp	Best Fits	Adaptable	Remarks
Black Tiger Shrimp	18-25 PPT	8-40 PPT	Best-fit range is wider but minimum salinity level is higher.
White Leg Shrimp	25-30 PPT	2-40 PPT	Best-fit range is narrow but the adaptable at lower salinity content

Source: Research Institute for Aquaculture No.2 (2011)

3) Fruit Crops

In general, fruit crops are not truly suitable in such agro-ecological characteristics prevailing in the Mekong Delta: acid sulphate soils, saline soils, heavy clay soils, and flooded areas. However, there are a large block of fruit areas in the Mekong Delta where small-scale farmers who maintain less than 1.0 ha per household have traditionally cultivated various kinds of fruit crops such as mango, longan, citrus (mandarin, orange, and lemon), durian, rambutan, dragon fruit, pineapple, and banana.

In terms of tolerance fruit crops to salinity, mango, longan and citrus like mandarin and orange are relatively strong than other fruit crops, while durian is prone to salinity. Actually, new varieties of some fruit crops have been developed by the Southern Fruit Research Institute (SOFRI) and ready for the extension. In any case, however, tolerance of fruit crops to salinity (500-600 PPM) is generally lower than that of paddy (1,000-4,000 PPM) and thus they cannot be a good alternative to paddy for adaptation to salinity increment. As far as flooding or inundation is concerned, furthermore, fruit crops are relatively prone to water logging.

In the principle of land-use planning, therefore, fruits are not seen as strategic crops for adaptation to the forthcoming climate change in form of either salinity intrusion and/or flooding. Instead, it should be recommended in places where sandy soil prevails and water resources are relatively scarce, so that water conservation philosophy can be holistically pursued in case that water becomes scarce due to climate change or excessive development of water resources upstream the Mekong River.

4.6.3 Issues and Constraints Considered in Planning Land Use

For a rational planning of land use plan, some constraints should be taken into consideration, which may include negative impact to environment, policy framework, and marketability of the commodities produced in the area. That is, even if one particular commodity is suitable to a certain area in terms mainly of physical conditions of the area such as soil type, availability of fresh/brackish water and thus considerably low risk of losses, it may not be recommended due to upper level reasons. Considering all the potential constraints, the Project proposes three major principles applied in the planning process:

1) Self sufficiency of rice should be more than satisfied per province (political reason)
2) Existing mangrove forest and protection forest should be conserved (environmental reason)
3) Pace of change should be kept moderate (social consideration)

1) Political Consideration

As of a restriction in the re-arrangement of land use, current policy should be carefully and thoroughly

considered. 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, approximately an area of 70,000 ha of shrimp culture needs to be newly developed in the Mekong Delta by 2020. Considering the fact that shrimp culture is essentially only possible in the coastal areas, this projection should be applied to the Project area where the seven coastal provinces lie.

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 can be interpreted to a general direction that current paddy area should be kept as it is as whole nation. In fact, it was reported that a small-scale pilot project on fruits production in Tien Giang province was rejected as it was in a “paddy” area—policy of land use, especially for paddy production, is strictly enforced by the Government.

Hence, in this land use planning, utmost attention is given to paddy production area; current paddy area should be kept unless the area is to be negatively affected by the climate change, especially saline intrusion. For the area where climate change would make it difficult to carry out paddy production any more, the plan is to suggest changing of the types of land use from paddy to others e.g. brackish shrimp culture without reservation as far as it is considered rationale with reference to the simulation results for climate change in future.

2) Environmental Consideration

Environmental consideration should be given higher priority before setting a needs-based land use plan. As known as tragedy of commons, without proper regulatory arrangement, individual’s rational behavior sometimes causes devastating loss of environmental resources. Most famously in this regard, destruction of mangrove forest along the coastal areas of Thailand in the 1990’s had earned a national and international notoriety. It was concluded that such arrangement was not sustainable at all. To be comprehensively rational, therefore, mangrove forest and also conservation forest, of course, should be disregarded from the target areas of shrimp culture development in the land use plan.

3) Social Consideration

Particularly, for the social consideration listed as number 3, the Project proposes the limit of change not more than 20% of the size of area in the current land use for the projected year of 2020 and 30% for the year 2030 and also 2050. It is believed that the significant change of land use in a shorter time should cause some confusion to the farmers and fish/shrimp farmers concerned. For example, paddy reduction in a shorter period of time may force rice milers to close the factories or consumers to purchase paddy from other places at relatively higher price. For the shrimp farmers on the other hand, prices of inputs such as shrimp larvae, quality feed and aeration equipment may hike up due to rapidly increased demand and thus they may not be able to achieve the expected profit.

4.6.4 Principles and Procedure in Land Use Planning

In general, the most considerable effect of climate change among others was the increased saline intrusion coupled with elevated sea level. Prepared that the increase of saline intrusion would threaten production of paddy and other crops, the timing when the saline water brings about the most significant impact on the cultivation of paddy was chosen. As shown in Table 4.6.4, Summer-Autumn (SA) paddy production in the saline-prone areas starts in and around May, beginning of rainy season.

For the cropping system of paddy-shrimp rotation, May is usually a time for leaching salinity with a help of rainwater. To do proper cultivation of paddy, it is essential to start cultivation by June without any residual salinity in the field. In other word, such areas where saline water remains at a certain level even in June, it would become quite difficult to manage paddy production.

Thus, the first criterion in re-examining the land use plan is to see where there is certain amount of salinity in June. Paddy can be recommended in the area where less salinity is expected in June but the other commodities should be considered for the area where salinity is more than the certain level. Generally, it is known that paddy cannot grow well at a salinity level of 1,000 PPM and incurs severe damage at around 4,000 PPM. Consequently, the threshold is set at 4.0 g/l (4,000 PPM) for decision making whether or not paddy is recommendable.

Table 4.6.4 Typical Cropping Calendar in the 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		Critical for shrimp culture (salinity needed)				Critical for Paddy Cultivation (fresh water needed)	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					

Source: SIWRP (2012). Note: SA: Summer-Autumn crop; WS: Winter-Spring; RS: Rainy Season crop

Next, another criterion was considered to decide where shrimp cultivation can be sustainably operated. As shown as Table 4.6.4, shrimp culture, especially under intensive or semi-intensive system, commonly starts in late January or February. It is known that shrimp cannot usually grow in such environment where mean water temperature is 25 degrees Celsius or below. In January, daily mean air temperature sometimes go below 25 degrees, thus, it is not actually recommendable to start shrimp culture in January. To set the threshold for shrimp culture, therefore, salinity level of February is taken. That is, where the simulated saline content of February is 10 PPT (10,000 PPM) or less, shrimp culture would not be suitable.

In conclusion, two criteria were employed to evaluate the suitable location of paddy and shrimp, one for salinity level of June and another for salinity level of February. Note that saline intrusion is usually the greatest in and around March and April, but the most important seasons for decision making are those two months; namely June and February.

Yet, there are some areas where both paddy and shrimp are not suitable, that is, saline contents of February is significantly lower

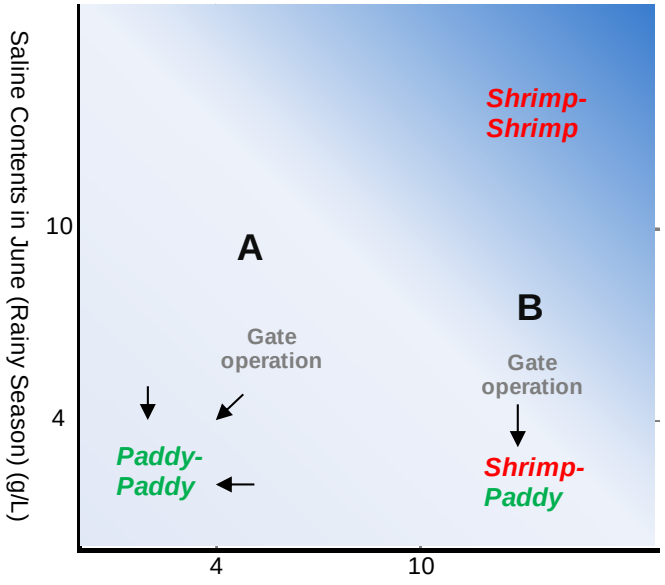


Figure 4.6.1 Concept of Land Use Criteria for Paddy-Shrimp Conversion

Note: Cropping pattern shows the combination between dry season and rainy season

than what is needed for shrimp culture (less than 10 PPT) but the salinity of June is considerably high (more than 4 PPT) for paddy cultivation. In such cases, current paddy production area should be protected within a means of control sluice gate in accordance with the government's policy. The criteria applied in the land use planning are conceptualized as Figure 4.6.1 and summarized in Table 4.6.5 specifically for the consideration of paddy and shrimp.

In the figure, X-axis shows the saline content in February (dry season) and Y-axis indicates the one in June (rainy season). Paddy-paddy (dry season - rainy season) can be managed in such an environment in which saline content is not more than 4g/L both in February and June (bottom left), while shrimp-shrimp can be conducted where saline contents exceed 10g/L both season (up right). Also, shrimp-paddy can be organized where saline content exceed 10g/L in February and reduced less than 4g/L in June (bottom right).

Meanwhile, there are some cases wherein saline contents of two seasons may not match to any of those cropping patterns. For example, saline contents in area "A" of the figure are not suitable both for paddy and shrimp. In such area, salinity should be controlled by gate operation to be suited to "paddy-paddy" pattern. Furthermore, saline content in area "B" is also difficult for paddy cultivation during rainy season. Thus, salinity control is required to enable "shrimp-paddy" pattern.

Based on this concept, concrete criteria are prepared as Table 4.6.5. In general, "paddy-paddy" pattern is applied where saline content is less than 10g/L both season, provided that salinity control is to be properly carried out at canal and on-farm levels. Then, shrimp-paddy pattern is applied where saline content exceeds 10g/L in February while it is less than 10g/L in June. Lastly, shrimp-shrimp pattern is applied where saline content exceeds 10g/L both seasons.

Table 4.6.5 Criteria for the Land Use Planning for Paddy and Shrimp

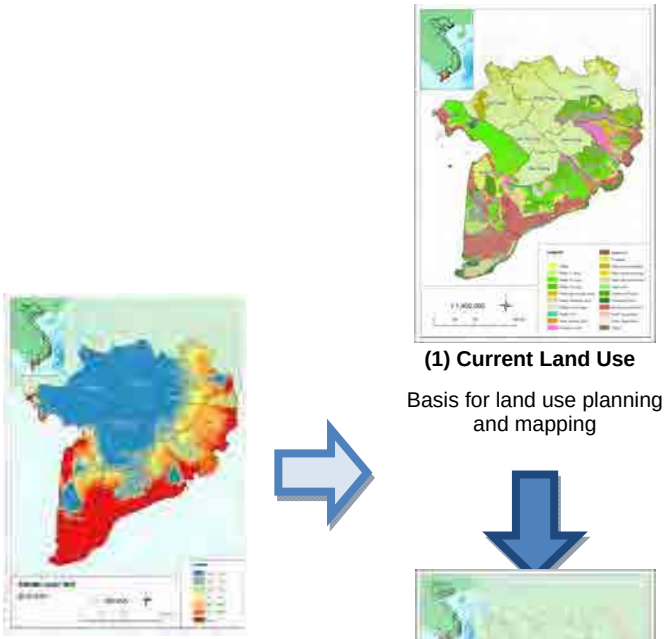
Criteria			Saline Intrusion in June		
			(A) 4g/L or less	**(B) 4-10g/L**	**(C) 10g/L or more**
			Suitable for paddy	Not suitable both for paddy and shrimp	Suitable for shrimp
Saline Intrusion in February	**(D) 4g/L or less**	Suitable for paddy	**(AD) Paddy-Paddy (No Change)**	**(BD) Paddy-[Paddy]**	**(CD) Paddy-[Paddy]**
	(E) 4-10g/L	Not suitable both for paddy and shrimp	**(AE) [Paddy]-Paddy**	**(BE) [Paddy]-[Paddy]**	**(CE) [Paddy]-[Paddy]**
	(F) 10g/L or more	Suitable for shrimp	**(AF) Shrimp-Paddy**	**(BF) Shrimp-[Paddy]**	**(CF) Shrimp-Shrimp**

Note: 1) Such condition is not likely that saline content in rainy season is higher than dry season (shown by sloped line)
2) Where saline content level is not suitable both for paddy and shrimp, paddy is given higher priority in accordance with the national policy.
3) For the cropping pattern where marked by [ ], infrastructural measurement is required to protect paddy (risk is considerably high).

For a particular procedure of the mapping process, first, based on the existing land use map for the year of 2009, a GIS base map was prepared for the geospatial analysis. Then, two isometric maps were prepared; one for the saline intrusion of June as to identify the area not suited for paddy production (more than 10g/L) and another for saline intrusion of February as to identify the area not suited for shrimp cultivation (less than 10g/L). Those two maps were originally obtained as TIF files having the geographic coordinates but no attributes of saline contents. Therefore, based on color data of the picture files (RGB format), GIS data are newly created.

Using the geospatial information of those two saline intrusion maps, paddy-related land uses on the original land uses map (2009) were further categorized into several suitability zones as shown in Table 4.6.5; 1) suitable for paddy production, 2) not suitable for paddy but suitable for shrimp, and 3) not suitable both for paddy and shrimp. Thereafter, those zones were categorized into: 1) paddy-paddy

area, 2) shrimp-paddy area, and 3) shrimp area. In so doing, saline-prone area for paddy cultivation was separately identified where saline intrusion in either rainy season (June) or dry season (February) is higher than 4g/L. Finally, newly categorized land uses were applied to the original land use map, to be the projected plan for the target years.



(1) Current Land Use

Basis for land use planning and mapping

(2) Saline Intrusion of June

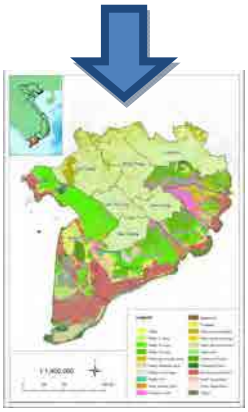
Justification of area not suited for paddy cultivation (more than 10g/L)

(3) Saline Intrusion of February

Justification of area not suited for shrimp cultivation (less than 10g/L)

(4) Identification of Area for the conversion

1) Convert from paddy to shrimp where salinity is suitable for shrimp but paddy
2) Protect paddy area where salinity is not suitable for both commodities



(5) Land Use Plan

Reflect the consideration on conversion of the commodities onto the current land use, which is to be the plan of the target year.

Figure 4.6.2 Procedure of Land Use Planning and Mapping

4.6.5 Current Land Use

Current situation of provincial agricultural land use in the Mekong Delta was made available by the Sub-national Institute of Agricultural Planning and Projection (Sub-NIAPP) for the year 2009. Based on the original GIS database, provincial data have been extracted and elaborated to be the basis of the land use planning under this Project. Table 4.6.6 shows the current land use pattern by province for the year of 2009, in which category of the land use was newly set/simplified by the JICA Project team. At large, brackish aquaculture shares the biggest share (23.3% of a total of 21 items), which is followed by double cropping of paddy (21.6%), and triple cropping of paddy (11.9%).

Table 4.6.6 Current Land Use by Province for the Year of 2009

No.	Category	Bac Lieu	Ben Tre	Ca Mau	Kien Giang	Soc Trang	Tien Giang	Tra Vinh	Total	Share
1	Paddy	21,168	0	977	43,850	13,317	0	7,735	87,048	4.5%
2	Paddy (1 crop)	10,208	18,082	43,483	41,183	0	0	0	112,956	5.8%
3	Paddy (2 crop)	11,157	1,928	29,304	235,611	93,910	19,144	31,237	422,291	21.6%
4	Paddy (3 crop)	22,314	21,040	0	6,729	38,084	83,797	59,555	231,519	11.9%
5	Paddy and annual crops	0	0	0	0	0	0	4,845	4,845	0.2%
6	Paddy-Brackish aqua	20,753	0	0	12,073	0	0	14,687	47,513	2.4%
7	Paddy-Fresh aqua	13	0	0	0	17,311	0	4	17,327	0.9%
8	Paddy-Fish	7,015	0	8,213	803	0	0	454	16,484	0.8%
9	Other annual crops	1,153	6,940	318	2,861	15,697	4,874	1,884	33,728	1.7%
10	Perennial fruits	159	59,828	0	10,352	9,581	25,912	8,642	114,475	5.9%
11	Sugarcane	0	5,368	0	0	0	0	0	5,368	0.3%
12	Pineapple	0	0	0	0	0	10,140	0	10,140	0.5%
13	Sugarcane-pineapple	0	0	0	1,262	0	0	0	1,262	0.1%
14	Other perennial crops	4,865	32,364	6,275	47,643	5,276	9,643	199	106,265	5.4%
15	Other agricultural land	0	0	51,979	7,013	6,405	114	0	65,511	3.4%
16	Grass land	6	49	11	0	0	0	13	79	0.0%
17	Productive forest	118	0	75,787	49,860	10	14,824	13,983	154,582	7.9%
18	Protected forest	4,630	5,540	23,070	17,422	5,442	1,496	3,778	61,379	3.1%
19	Brackish aquaculture	102,700	36,834	184,340	64,476	45,875	4,351	16,734	455,309	23.3%
20	Fresh aquaculture	0	0	0	0	0	68	0	68	0.0%
21	Other aquaculture	1,121	0	0	0	0	0	2,877	3,998	0.2%
	Total of Above	**207,380**	**187,975**	**423,756**	**541,138**	**250,910**	**174,362**	**166,628**	**1,952,149**	**100.0%**
	Share in the Total	**83%**	**80%**	**79%**	**85%**	**76%**	**70%**	**73%**	**79%**	
22	**Others**	**42,770**	**48,045**	**109,404**	**93,492**	**80,270**	**74,058**	**62,882**	**510,921**	
	Total Land Area	**250,150**	**236,020**	**533,160**	**634,630**	**331,180**	**248,420**	**229,510**	**2,463,070**	

Source: JICA Project Team based on Sub-NIAP (2012)
Note: Based on the GIS data for the entire Mekong Delta region, provincial data were extracted by the Project Team. In so doing, some error data were adjusted.

For easier understanding, this land use is further aggregated to be a shorter list as shown in Table 4.6.7. As shown in the table, paddy shares 44.0% of the total land use area (excepting "others") which is actually composed of single, double and triple cropping of paddy. From the table, it is understood that nearly half of land use of the Project area (seven provinces) is being shared for paddy production. By provicne, the compositions of land use types totally differ.

As shown in Figure 4.6.3, "paddy" shares more than 50% in Kien Giang, Soc Trang, Tien Giang, and Tra Vinh, while "brackish aquaculture" shares about half in Bac Lieu and Ca Mau. On the other hand, "perennial crops" shares nearly half in Ben Tre provicne, which are fruits including coconuts.

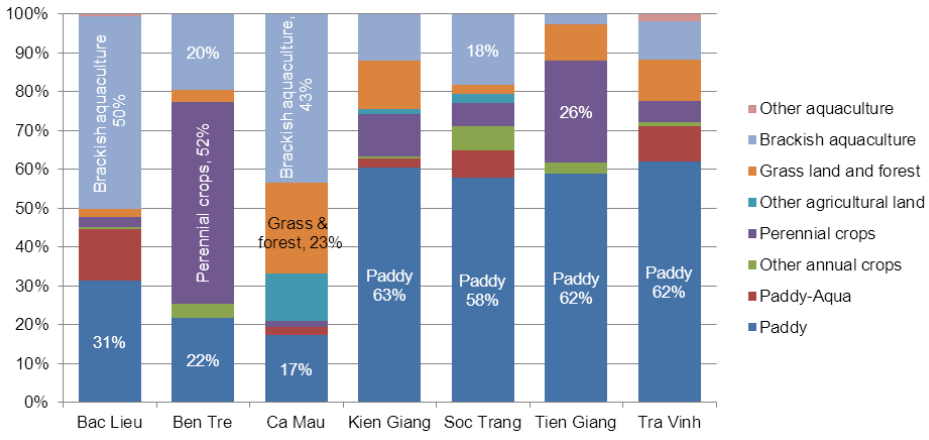


Figure 4.6.3 Composition of Current Land Use by Province
Source: JICA Project Team based on Sub-NIAP (2012)

Table 4.6.7 Current Land Use by Province for the Year of 2009 (Abstract)

No.	Category	Bac Lieu	Ben Tre	Ca Mau	Kien Giang	Soc Trang	Tien Giang	Tra Vinh	Total	Share
1-5	Paddy	64,848	41,049	73,765	327,373	145,312	102,941	103,372	858,659	44.0%
6-8	Paddy-Aqua	27,781	0	8,213	12,875	17,311	0	15,145	81,324	4.2%
9	Other annual crops	1,153	6,940	318	2,861	15,697	4,874	1,884	33,728	1.7%
10-14	Perennial crops	5,024	97,561	6,275	59,257	14,857	45,695	8,841	237,510	12.2%
15	Other agricultural land	0	0	51,979	7,013	6,405	114	0	65,511	3.4%
16-18	Grass land and forest	4,755	5,590	98,868	67,282	5,452	16,320	17,774	216,041	11.1%
19	Brackish aquaculture	102,700	36,834	184,340	64,476	45,875	4,351	16,734	455,309	23.3%
20-21	Other aquaculture	1,121	0	0	0	0	68	2,877	4,066	0.2%
	Total of Above	**207,380**	**187,975**	**423,756**	**541,138**	**250,910**	**174,362**	**166,628**	**1,952,149**	**100.0%**
	Share in the Total	**83%**	**80%**	**79%**	**85%**	**76%**	**70%**	**73%**	**79%**	
22	**Others**	**42,770**	**48,045**	**109,404**	**93,492**	**80,270**	**74,058**	**62,882**	**510,921**	
	Total Land Area	**250,150**	**236,020**	**533,160**	**634,630**	**331,180**	**248,420**	**229,510**	**2,463,070**	

Source: JICA Project Team based on Sub-NIAP (2012)
Note: Based on the GIS data for the entire Mekong Delta region, provincial data were extracted by the Project Team. In so doing, some error data were adjusted.

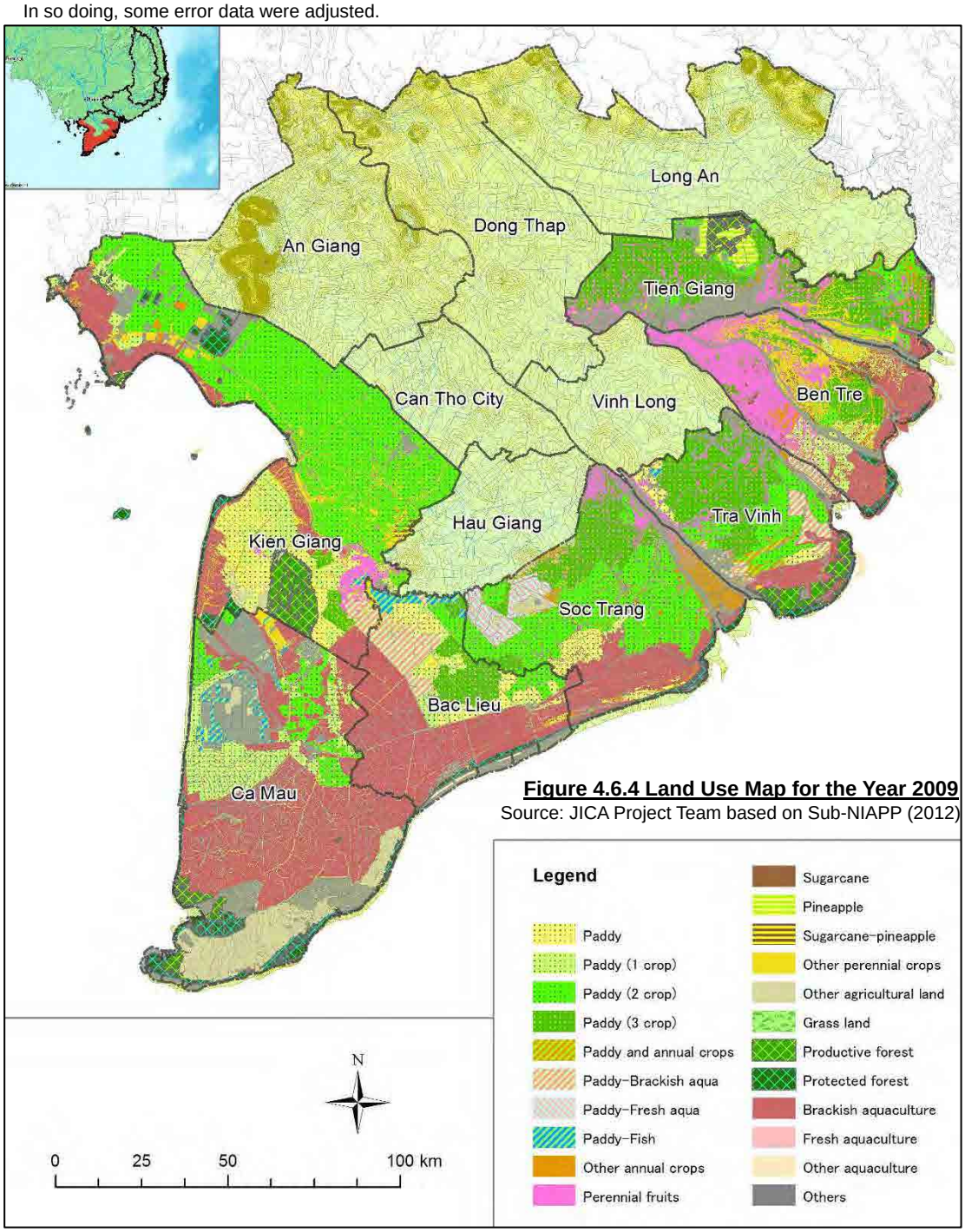


Figure 4.6.4 Land Use Map for the Year 2009
Source: JICA Project Team based on Sub-NIAPP (2012)

4.6.6 Land Use Plan in Years 2020, 2030 and 2050

1) Change in Conversion Area and Protection Area in the Three Target Years

Three land use maps were projected based on the current land use pattern and simulated saline intrusion for the time series of year 2020, 2030 and 2050. As a summary, Table 4.6.8 shows areas for protection of paddy-oriented land use as saline prone area and also area for conversion from paddy-oriented area to "paddy-brackish aquaculture" and "brackish aquaculture." As shown in the table, saline-prone area where paddy-oriented cultivation can be continued with protection measures (4-10g/L in either rainy season or dry season) shares 19% in 2020 but gradually reduces as time goes.

Table 4.6.8 Summary of Protection Area and Conversion Area (2020, 2030 and 2050)

Category	Current Land Use	Area for Protection of Paddy (Saline Prone)			Area for Conversion to Paddy-Brackish Aquaculture			Area for Conversion to Brackish Aquaculture		
		2020	2030	2050	2020	2030	2050	2020	2030	2050
Paddy	87,048	21,490	19,866	21,257	125	9,451	8,801	37,369	27,719	28,221
Paddy (1 crop)	112,956	31,299	26,106	27,365	258	15,721	12,535	37,613	21,607	25,334
Paddy (2 crop)	422,291	62,605	42,170	45,053	654	11,050	7,815	42,886	31,914	36,355
Paddy (3 crop)	231,519	49,080	13,806	18,931	34	2,511	1,455	4,363	1,868	3,314
Paddy & annual crops	4,845	1,854	1,769	1,767	25	2,056	10	2,305	240	2,327
Paddy-Fresh aqua	17,327	94	189	91	0	0	0	0	0	0
Paddy-Fish	16,484	2,545	2,309	2,567	0	0	0	0	0	0
Total	**892,471**	**168,968**	**106,217**	**117,031**	**1,096**	**40,789**	**30,616**	**124,536**	**83,349**	**95,552**
	100%	**19%**	**12%**	**13%**	**0%**	**5%**	**3%**	**14%**	**9%**	**11%**

Source: JICA Project Team based on Sub-NIAPP (2012)

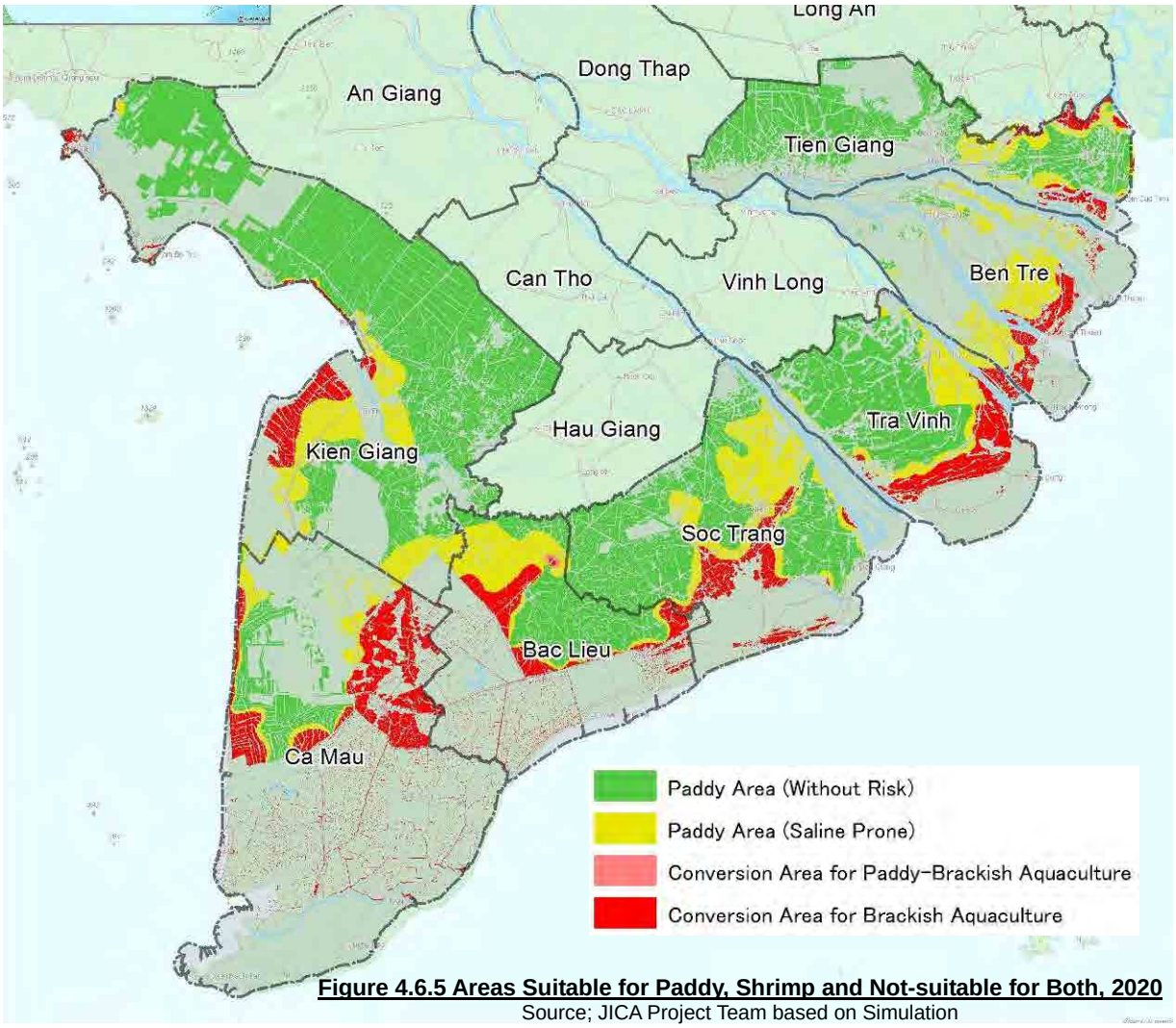


Figure 4.6.5 Areas Suitable for Paddy, Shrimp and Not-suitable for Both, 2020
Source; JICA Project Team based on Simulation

Note that why saline intrusion comes up almost to the maximum level in the short term (2020) and also the area for protection of paddy shows the biggest area in the 2020 can be explained by the projected future discharge of Mekong River under CC scenario B2. Though the sea-level rises in 2030 and 2050 become bigger, of course, than that of year 2020, the future Mekong discharge simulated by MRC increase as year goes by and therefore the discharge of year 2020 is relatively smaller than those of future years. For example, discharges of May, affecting the salinity level of June the most, are 3,399 m^3/s, 6,976 m^3/s and 3,459 m^3/s for years of 2020, 2030 and 2050.

Area necessary to convert from paddy-oriented pattern to "paddy-brackish aquaculture" stays 5% or below throughout the period (0% in 2020, 5% in 2030 and 3% in 2050). On the other hand, area necessary to convert to "brackish aquaculture" once reach 14% in 2020 and then becomes lower 9% in 2030 and 11% in 2050. In summary, projected "conversion areas" for shrimp culture already reaches 14% in the year 2020, the short-term target year—this fact suggests that saline intrusion would come up almost to the maximum level in the short term. That is, necessary size of area for the conversion from paddy to brackish aquaculture, such as shrimp culture, should be achieved as early as the year 2020.

2) Land Use Plan Concluded for the Target Year 2050

In conclusion, land use plan is finalized for the target year of 2050. To be the basis of the land use plan, projected land use of 2050 should be chosen with three major reasons: 1) it is better to present the ultimate picture of the adaptation endeavor to the simulated climate change in the final target year of 2050 defined for this Project; 2) size of estimated land areas necessary for conversion from paddy to shrimp are about the same among the three target years; and 3) fluctuation in the saline-prone area for paddy cultivation does not affect the land use planning since it is defined as "paddy" area.

In addition, two issues should be taken into account. First, conversion from paddy cultivation to brackish aquaculture is restricted in Ben Tre province due to the fact that the self-sufficiency of paddy production is considerably lower than other provinces (295kg/capita as compared to 1,260kg/capita on an average of Mekong Delta for the year 2010, GSO). Although production per capita is kept enough for self-consumption, this level of production should be maintained by any means, considering the government's policy favored to paddy production. As a result, originally projected areas as "conversion" area are replaced to paddy production areas.

Second, coastal area of Tien Giang province is converted to the area for shrimp culture. According to DARD of Tien Giang province, farmers on the east coast of the province are willing to start shrimp culture given abundant brackish water. In fact, there is a plan and already on-going construction work to set back the prevention of sea water intrusion from the upfront coastal line to about several hundred meters inwards (in most cases, 400m set back), so that the opened area for saline intrusion can be utilized as shrimp culture area. As a result, small band areas along the coastal line, approximately about 400m width band, are planned as "brackish shrimp culture."

After all, finalized land use plan for the target year of 2050 is presented in Figure 4.6.6 and summarized in Table 4.6.9 to Table 4.6.11. As also shown in Table 4.6.11, it is planned to convert a total of 116,401 ha of paddy areas to either brackish aquaculture or paddy-brackish aquaculture, which accounts for 14% of decrease in the area of paddy cultivation. Of the paddy-oriented areas, 11,115 ha is to be converted to paddy-brackish aquaculture and 105,297 ha to brackish aquaculture, which account for 23% and 23% of increase from original seize of its areas, respectively.

As per province, Ca Mau has the biggest areas to decrease from paddy to other commodities; 40,893 ha, which accounts for 55% of original paddy area. In terms of the change rate, Tien Giang province projects 120% of increase in brackish aquaculture, although the targeted size of area itself is the smallest (except Ben Tre where no change is planned): 5,235 ha. Of the total area projected for Tien

Giang province, 576 ha is additionally projected along the coastal area based on the needs assessment as described above.

For Ben Tre province, no change was planned, following the government's policy toward self-sufficiency of paddy. Yet, it actually means that a lot of efforts are required to keep the current paddy area as well as the fruit production areas to be cultivated in the future too. Because, as once projected, 157,599 ha is projected as saline-prone area where brackish aquaculture will be much more suitable by the target year 2050, given no particular implementation of infrastructural projects. On top of this, given no infrastructure, a lot of areas of fruits will be severely damaged especially in March and April where the salinity level is usually the highest.

Lastly, projected increase of area in brackish aquaculture (105,297 ha) is, in fact, about 50% bigger than the government current plan - 70,000 ha by year 2020. Though the projected increase of the brackish aquaculture under this Master Plan Project is for year 2050, the increase should come in as early as 2020 as the saline intrusion does not change much by year. That is, if forthcoming climate change—in terms of the increase in saline water intrusion—is considered, much more significant adaptation strategies should be taken; otherwise countermeasure works against salinity intrusion mostly by means of infrastructure establishment would be required.

Table 4.6.9 Land Use Plan for the Year 2050 (Abstract: FINAL)

No.	Category	Bac Lieu	Ben Tre	Ca Mau	Kien Giang	Soc Trang	Tien Giang	Tra Vinh	Total	Share
1-5	Paddy	54,903	41,049	32,871	299,715	129,226	94,759	89,735	742,258	38.0%
6	Paddy-Brackish aqua	16,557	0	5,107	23,277	344	2,957	10,385	58,628	3.0%
7-8	Paddy-Fresh aqua	7,027	0	8,213	803	17,311	0	458	33,812	1.7%
9	Other annual crops	1,153	6,940	318	2,861	15,697	4,874	1,884	33,728	1.7%
10-14	Perennial crops	5,024	97,561	6,275	59,257	14,857	45,695	8,841	237,510	12.2%
15	Other agricultural land	0	0	51,979	7,013	6,405	114	0	65,511	3.4%
16-18	Grass land and forest	4,755	5,590	98,868	67,282	5,452	16,320	17,774	216,041	11.1%
19	Brackish aquaculture	116,840	36,834	220,126	80,929	61,618	9,586	34,674	560,606	28.7%
20-21	Other aquaculture	1,121	0	0	0	0	58	2,877	4,056	0.2%
	Sub Total	**207,380**	**187,975**	**423,756**	**541,138**	**250,910**	**174,362**	**166,628**	**1,952,149**	**100.0%**
		83%	**80%**	**79%**	**85%**	**76%**	**70%**	**73%**	**79%**	
22	Others	42,770	48,045	109,404	93,492	80,270	74,058	62,882	510,921	
	Total Land Area	**250,150**	**236,020**	**533,160**	**634,630**	**331,180**	**248,420**	**229,510**	**2,463,070**	

Source: JICA Project Team based on Sub-NIAP (2012)

Table 4.6.10 Land Use Plan for the Year 2050 (Complete: FINAL)

No	Land Use	Bac Lieu	Ben Tre	Ca Mau	Kien Giang	Soc Trang	Tien Giang	Tra Vinh	Total	%
1	Paddy	17,685	0	767	23,068	3,623	0	4,882	50,025	2.6%
2	Paddy (1 crop)	6,355	18,082	22,101	36,026	0	0	0	82,563	4.2%
3	Paddy (2 crop)	8,690	1,928	10,003	233,891	87,518	13,370	22,800	378,201	19.4%
4	Paddy (3 crop)	22,174	21,040	0	6,729	38,084	81,389	59,545	228,961	11.7%
5	Paddy and annual crops	0	0	0	0	0	0	2,508	2,508	0.1%
6	Paddy-Brackish aqua	16,557	0	5,107	23,277	344	2,957	10,385	58,628	3.0%
7	Paddy-Fresh aqua	13	0	0	0	17,311	0	4	17,327	0.9%
8	Paddy-Fish	7,015	0	8,213	803	0	0	454	16,484	0.8%
9	Other annual crops	1,153	6,940	318	2,861	15,697	4,874	1,884	33,728	1.7%
10	Perennial fruits	159	59,828	0	10,352	9,581	25,912	8,642	114,475	5.9%
11	Sugarcane	0	5,368	0	0	0	0	0	5,368	0.3%
12	Pineapple	0	0	0	0	0	10,140	0	10,140	0.5%
13	Sugarcane-pineapple	0	0	0	1,262	0	0	0	1,262	0.1%
14	Other perennial crops	4,865	32,364	6,275	47,643	5,276	9,643	199	106,265	5.4%
15	Other agricultural land	0	0	51,979	7,013	6,405	114	0	65,511	3.4%
16	Grass land	6	49	11	0	0	0	13	79	0.0%
17	Productive forest	118	0	75,787	49,860	10	14,824	13,983	154,582	7.9%
18	Protected forest	4,630	5,540	23,070	17,422	5,442	1,496	3,778	61,379	3.1%
19	Brackish aquaculture	116,840	36,834	220,126	80,929	61,618	9,586	34,674	560,606	28.7%
20	Fresh aquaculture	0	0	0	0	0	58	0	58	0.0%
21	Other aquaculture	1,121	0	0	0	0	0	2,877	3,998	0.2%
Sub Total		**207,380**	**187,975**	**423,756**	**541,138**	**250,910**	**174,362**	**166,628**	**1,952,149**	**100.0%**
		11%	10%	22%	28%	13%	9%	9%	100%	
Others		42,770	48,045	109,404	93,492	80,270	74,058	62,882	510,921	
Total Land Area		**250,150**	**236,020**	**533,160**	**634,630**	**331,180**	**248,420**	**229,510**	**2,463,070**	

Source: JICA Project Team based on Sub-NIAP (2012)

Table 4.6.11 Change in Land Use from 2009 to 2050 (FINAL)

No.	Category	Bac Lieu	Ben Tre	Ca Mau	Kien Giang	Soc Trang	Tien Giang	Tra Vinh	Total
1-5	Paddy	-9,944	0	-40,893	-27,658	-16,086	-8,182	-13,638	-116,401
6	Paddy-Brackish aqua	-4,196	0	5,107	11,205	344	2,957	-4,302	11,115
7-8	Paddy-Fresh aqua	0	0	0	0	0	0	0	0
9	Other annual crops	0	0	0	0	0	0	0	0
10-14	Perennial crops	0	0	0	0	0	0	0	0
15	Other agricultural land	0	0	0	0	0	0	0	0
16-18	Grass land and forest	0	0	0	0	0	0	0	0
19	Brackish aquaculture	14,140	0	35,786	16,453	15,743	5,235	17,939	105,297
20-21	Other aquaculture	0	0	0	0	0	-11	0	-11
Change in Paddy		**-15%**	**0%**	**-55%**	**-8%**	**-11%**	**-8%**	**-13%**	**-14%**
Change in Paddy-Brackish Aqua		**-20%**	**-**	**-**	**93%**	**-**	**-**	**-29%**	**23%**
Change in Brackish aquaculture		**14%**	**0%**	**19%**	**26%**	**34%**	**120%**	**107%**	**23%**

Source: JICA Project Team based on Sub-NIAP (2012)

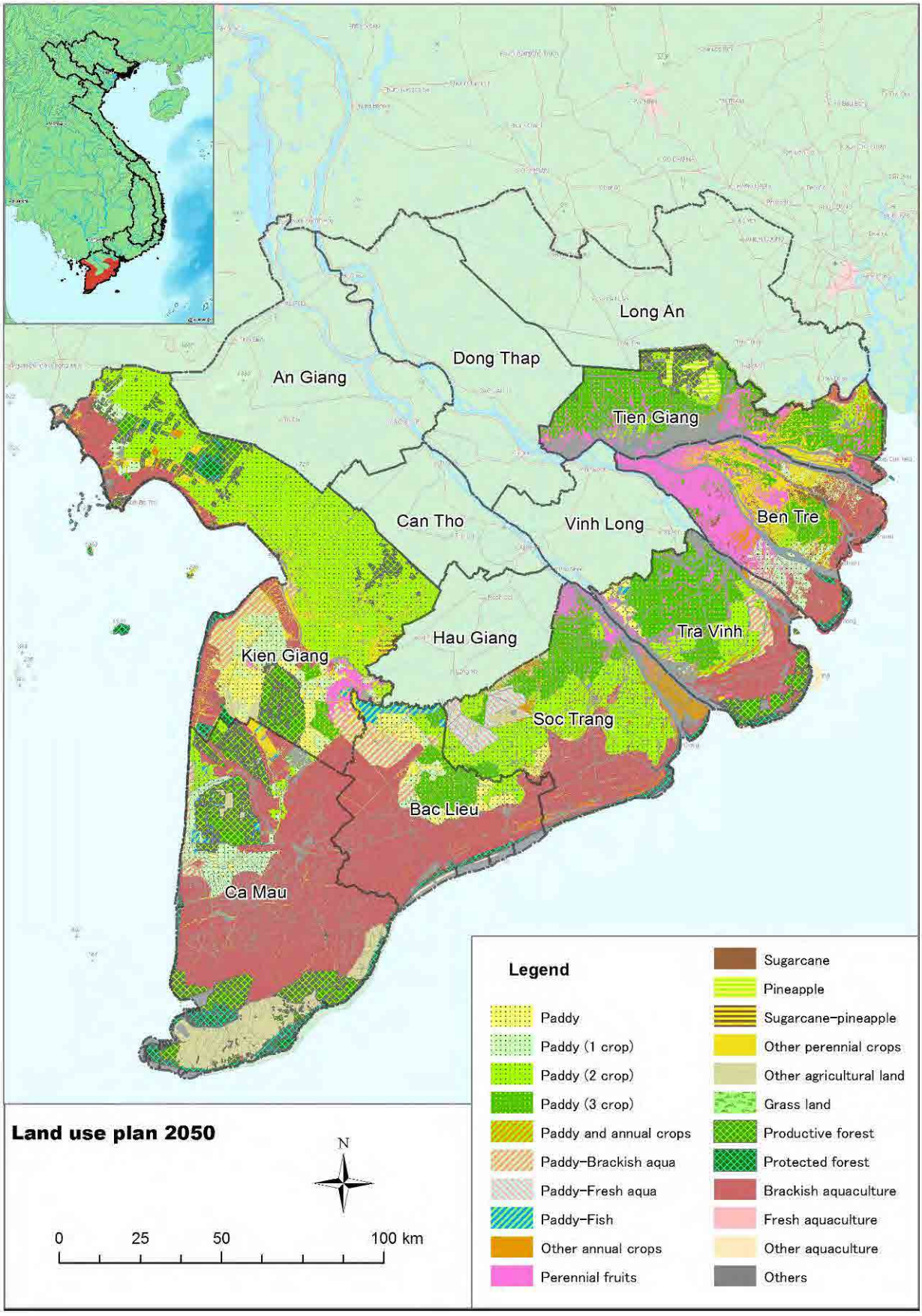


Figure 4.6.6 Land Use Map for the Year 2050 (FINAL)
Source: JICA Project Team based on Sub-NIAP (2012)

4.7 Development Framework and Projects

Development planning in this Project is based on a series of participatory workshops inviting government officers and held at village level. Summing up all the works done in the workshops together with contributions by the JICA Team, a prioritized development framework is finally presented together with project/program description in a simplified project design matrix (PDM).

Development framework can be a guide when and where the Vietnamese government should carry out development activities in the coastal areas of Mekong Delta because the framework provides with concrete development components, those priorities by issues related to climate change and by area (province) at which what projects should be carried out. In addition, any organizations which work in the Mekong Delta can refer to the framework, with which they can know where to carry out their development intervention with what priority. In this way, the frameworks can also work as a development platform where all the concerned development partners can make concerted efforts.

4.7.1 Priority Setting on Climate Change Issues

Setting of priority issues refers, at first, to the priorities provided by the 7 provinces and the climate change related issues identified at village workshop. Table 4.7.1 summarizes the priority issues by provincial government officers in the left column and the ones identified during the village level workshop in the right column. From the table, development/intervention priorities in the context of climate change are;

1) Saline water intrusion and drought are the top priority issues; the former was ranked as the first priority by the officers while it came to the 2nd position by villagers, and the latter is vice versa.

2) What had followed during the village workshops are inundation, flood tide, and heavy rainfall whose priorities were more or less same and those three issues were also identified during the government officers' workshop (inundation at No.5 priority, flood tide relates to No.5 priority of flood, heavy rainfall at No.4 priority as frequent storm).

3) In addition to those issues, erosion for seas dyke was No.3 priority issue for the government officers, which may be caused by high tide and also by frequent storm which was ranked at priority No.4 by the government officers.

4) Rainfall pattern change was prioritized at No.6 priority whereby they see now rainfall during dry season. In fact, about 10% of the annual rainfall falls during rainy season but they said rainfall more than before is now falling during the dry season, damaging winter-spring paddy due to the low temperature.

5) As a high temperature and drought related issue, forest fire was ranked at No.7 priority by government officers. To establish the framework, the priority issue should be set on causes rather than effects. It means, for example, instead of forest-fire temperature rise or drought should be set as a climate change priority issue.

Setting of the priority further refers to the priority projects recommended by the provinces during the government officers workshop as well as those projects recommended in the master plan (SIWRP, 2011) prepared in the context of climate change. Note that those projects are not exclusively related to climate change only. Table 4.7.2 counts the priority projects proposed by the provincial officers by type of work in the 2nd column from the left, and the 3rd and 4th columns summarize the number of projects to be implemented by 2015 and by 2050 by type of work. The table indicates;

1) Provincial officers proposed sea dyke project the most, followed by sluice gate and then river dyke. This would imply that they think sea-level rise and/or storm rainfall are so severe that a

measure to cope with should be introduced, i.e. sea dyke construction.

2) Likewise, the sluice gate construction is obviously required for the prevention of sea water intrusion. It may be understood that sea water intrusion is an acute issue, so that the sluice gate construction project was proposed. River dyke construction is for flood protection whereby it may imply heavy rainfall and also sea-level rise being an acute issue.

3) SIWRP master plan (2011) listed the project of canal rehabilitation/improvement the most. By year 2050, as many as 105 projects are proposed. In fact, canal rehabilitation/ improvement has been a part of annual work since a lot of sedimentation takes place due to the silt contained water reducing canal capacity, and navigation causes wave whereby erosion takes place on the slope. Though canal rehabilitation/improvement may not be directly related to climate change, this kind of projects is in fact needed.

4) In the SIWRP master plan (2011), what comes next to the canal rehabilitation/improvement are sluice gate construction and then river dyke construction, and further sea dyke construction. It means that SIWRP may have placed priority on these climate change issues of saline water intrusion, flood, sea-level rise and also storm heavy rainfall.

From above review, the common priorities can be placed on the saline water intrusion, drought, and sea-level rise causing erosion of sea dyke, inundation and/or flood often associated with high tide, heavy rainfall or change of rainfall pattern in general term which in turn amplifies inundation, and temperature rise. Following climate change issues are taken into the framework with the priority from the top taking into account the discussions aforementioned:

1) Saline Water Intrusion
2) Drought
3) Sea level Rise
4) Flood
5) Change of Rainfall Pattern
6) Temperature Rise

Table 4.7.1 Summary of the Priority Issues related to Climate Change

Order	Priority Issues by Government Officers	Priority Issues by Villagers
1	Saline water intrusion	Drought (lack of fresh water during dry season)
2	Drought, Lack of fresh water	Saline intrusion
3	Erosion, Damage of sea dyke	Inundation (associated with heavy rain)
4	Frequent storm	Flood tide (flood/inundation worsened by high tide)
5	Inundation, Flood (caused by heavy rainfall)	Heavy rain
6	Rainfall in dry season (rainfall pattern change)	Note: Above inundation, flood tide and heavy rain are ranked at same order.
7	Forest fire (associated with temperature rise and drought)	
No Order	Ecosystem change	
	Livelihood change	
	Worsening of public health	
	Damage of infrastructure	
	Decrease of mangrove forest area	

Source: Workshop supported by JICA Project Team

Table 4.7.2 Summary of the Number of Projects Proposed by Provinces and SIWRP

Major Work	By Provinces	By SIWRP (Short term -2015)	By SIWRP (Long term -2050)	Priority Category
Civil Work				
Sea dyke	9	4	18	+++
Sluice gate	8	19	63	+++
River dyke	7	11	48	+++
Canal rehabilitation/improvement	4	26	105	+++
Fresh water recruitment	4	Included above canal rehabilitation		++
Drainage	1			+
Pumping station	1	1	1	
Ring dyke	1	2	4	+
Rural water supply	1	4	9	+
Reservoir	-	1	1	
Aquaculture structure	-	5	5	+
Non-civil work				
Capacity Develop.	7			++
Forestation	3			+
Saline tolerant variety research	2			
Others	5			

Source; For the provinces workshop results held on October 27, 2011 were summarized and the number of projects by SIWRP was summarized with reference to the Master Plan (2011) in the context of climate change.

4.7.2 Development Framework

Development framework is a kind of guide that shows us the tangible way of reaching the development vision aforementioned. It shows climate change issues and strategies sought to achieve the development vision, as well as intervention activities that are called development project or development programme. The framework should also have the priority at different levels of, e.g. climate change issue, strategy, project/ programme, with which we can consider that which development intervention should be put in implementation first taking into account limited resources.

The Project area covers 7 coastal provinces, and therefore the framework should also relate those projects/ programmes with the province. It could be of great help for those who are participating in development activities in the Mekong Delta. This means that given the relationship we can know which project/ programme should be implemented in which province with first priority, 2nd priority, and so on, making development intervention sound according to the nature of the provinces and increasing the efficiency in fund allocation as well.

Framework can be presented in several ways, and here presented is a tree structure which starts with development vision, and is cascaded to climate change issue, adaptation and/or coping strategy and finally down to the project/ programme. The climate change issue should of course refer to the aforementioned priority given by the government officers' workshop, at the village workshops, and based on the proposed projects by the government officers and by SIWRP.

An example of development framework is shown below schematically. With this framework, SIWRP and MARD can know what climate change issues they should tackle, to tackle the issues what adaptation/coping strategies they should take, and accordingly what project/ programme they should carry out. Also, related with the project/ programme is the provinces illustrated at the most right hand column. Given, as an example, marks putting different priorities, we can know which projects/ programmes should be carried out in which province with how much priority being given.

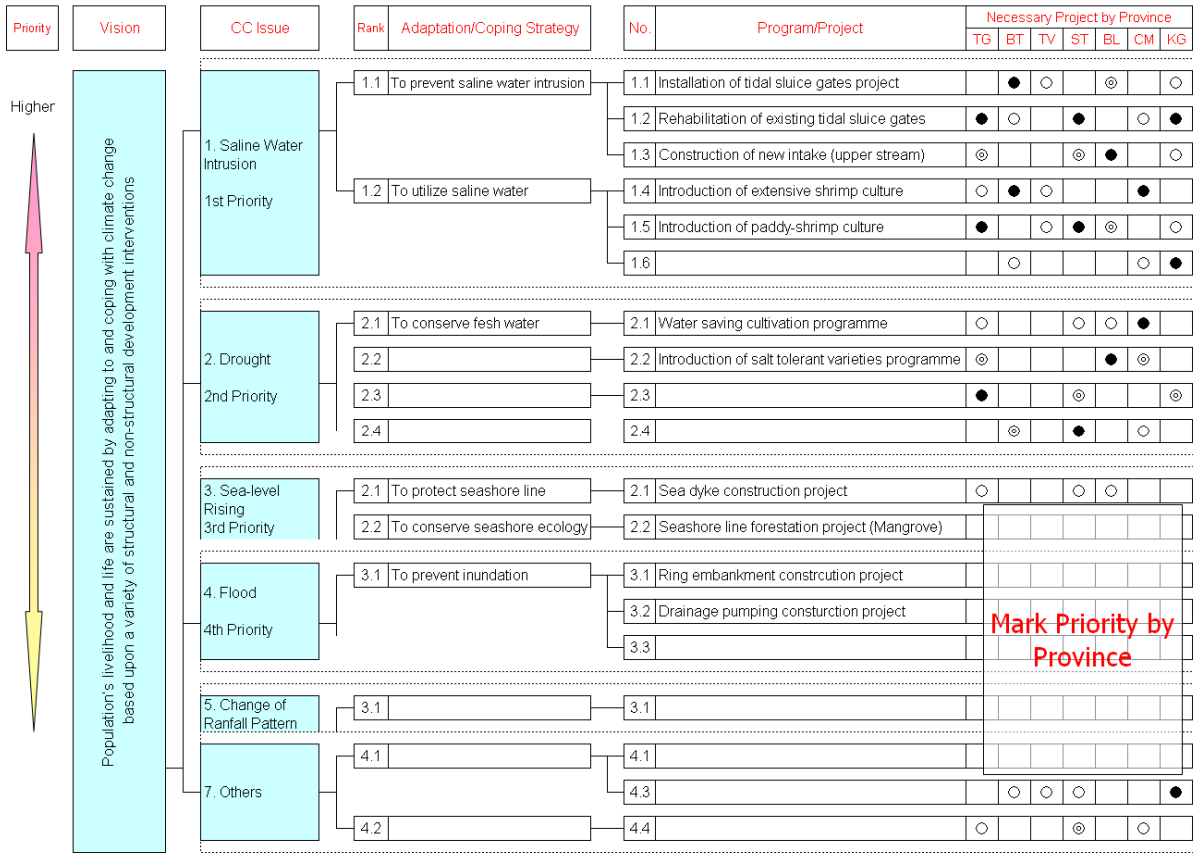


Figure 4.7.1 An Example of Development Framework

Development framework was once drafted in late 2011, and finalized through a series of discussions and confirmation with relevant DARD officers and also SIWRP counterparts. The issues identified are: Saline Water Intrusion, Drought, Sea level Rise, Flood, Change of Rainfall Pattern, Temperature Rise, which are all related to climate change and arranged according to the priority from the top to the bottom of the framework. In addition 'Common Issues' is at the bottom row of the framework. Under 'Common Issues', such projects dealing with cross cutting issues, e.g. capacity building, are proposed. Also, some projects may not fall under any of climate change issues but still be needed according to the people's need. These projects are also listed under 'Common Issues'.

At the right side from the list of the programs/projects, there is a matrix table having such symbols as ●, ◎, ○. This matrix shows the guidance of which projects/ programs should be carried out in which province with how much of priority. The prioritization in the matrix was done by cross cutting from top to bottom by the province, for example 1) half of the projects/ programs in each province are prioritized with the symbol of ○ (high priority), out of which again half are prioritized with the symbol of ◎ (higher-priority), and further out of which half are prioritized with the symbol of ●, the highest (top) priority.

After having placed the aforementioned 3-level priorities, draft framework was once provided to relevant DARD officers during interim report presentation. They mostly agreed upon the draft with some comments. The comments undertaken to finalize the framework are summarized as follow:

1) Tien Giang province emphasized that flood protection is important issue there. In Tien Giang, No.18 "ring levee construction project" to mitigate flood and inundation should therefore be given the top priority because this project is the highest priority in Tien Giang. For Tien Giang province, there are 61,000 ha of orchard along Tien River. If this orchard area is inundated, about 500,000 people whose life is based on these orchards (statistic of 2011) will be affected seriously.

In addition, in connection with project No. 15 “mangrove forestation/rehabilitation”, Tien Giang province is already suffering from loss of mangrove forest for 3 km in length; and therefore Tien Giang should also be listed in No. 15 project “mangrove forestation/rehabilitation” of the framework.

2) Ben Tre province usually suffers from high tide, saline intrusion and rising sea level. Sea dyke is therefore necessary in 3 coastal districts of Thanh Phu, Binh Dai and Ba Tri. In the framework, top priority should be given to project No.13 “sea-shore protection and improvement project”. On the other hand, Cho Lach, Mo Cay Nam, Mo Cay Bac and Thach Phu districts in North Ben Tre area have similar natural conditions with Tra Vinh province and a part of Vinh Long province. Therefore, the province suggested putting top priority on protection dyke, saline intrusion prevention gate, and fresh water recruitment as similar as Tra Vinh province.

3) Tra Vinh province suggested that project No.13 “sea-shore protection and improvement” should be given the top priority since sea level rise causes seashore line erosion every year. Project No.1 saline intrusion prevention sluice gate rehabilitation project should also be given top priority together with No.3 gate operation improvement project. Most of the saline prevention sluice gates in the province belong to South Mang Thit Project and were completed in 2003. Some of the gates are now broken and rusty because of saline water. Moreover, at the design period, climate change and seas level rise were not considered. Therefore, the existing sluice gates do not ensure their functions. Tra Vinh province further recommended mid priority to such projects as No.17 “river dyke construction/rehabilitation project”, No.18 “ring levee construction project”, and No.15 “mangrove forestation/rehabilitation program”.

4) Soc Trang province recommended priorities should be given to project No. 7 “early saline intrusion warning system establishment program”, No. 9 “groundwater development (domestic use)”, and No. 16 “sustainable shrimp culture promotion program” for Vinh Chau District. In Soc Trang province, there are many shrimp areas where difficulty is the shrimp disease due to pollution of water. Therefore, “sustainable shrimp culture promotion program” was raised as one of top priority projects.

5) Bac Lieu province suffers from shortage of fresh water in dry season; therefore, project No.8 “fresh water recruitment project” in the framework should be given the top priority. In addition, top priority of Bac Lieu province should be given to No.14 “sea embankment rehabilitation” as well.

6) Ca Mau province raised that the project, project No.13 “seashore protection and improvement” is very important because, if the seashore is damaged, it directly affects peoples’ life and agriculture and aquaculture productions. In this province, length of shoreline reaches approximately 120 km; as a result, expected size of areas to be affected is significant. There are some coastal villages receiving severe impact of high tide (twice a month), of which 20,000 ha has been already affected. It is expected that no-rehabilitation of present sea dykes will cause about 90,000 ha of severe saline intrusion in September and October together with impact of strong storm and wind. In line with this, project No. 15 “mangrove forestation/rehabilitation program” should also be given the top priority.

7) Ca Mau further recommended project No. 9 “groundwater development (domestic use)” as one of priority projects since the present water source from Hau River can serve only for the northern part of the province. There are still big areas left behind without water source at southern part of the province for about 300,000 ha. Therefore the province gave mid priority to the groundwater development project. In addition, No. 17 “river dyke construction/rehabilitation” was also raised to have mid-priority due to its important role. Further, No. 6 “sustainable shrimp culture

promotion program" was said to be the most important one.

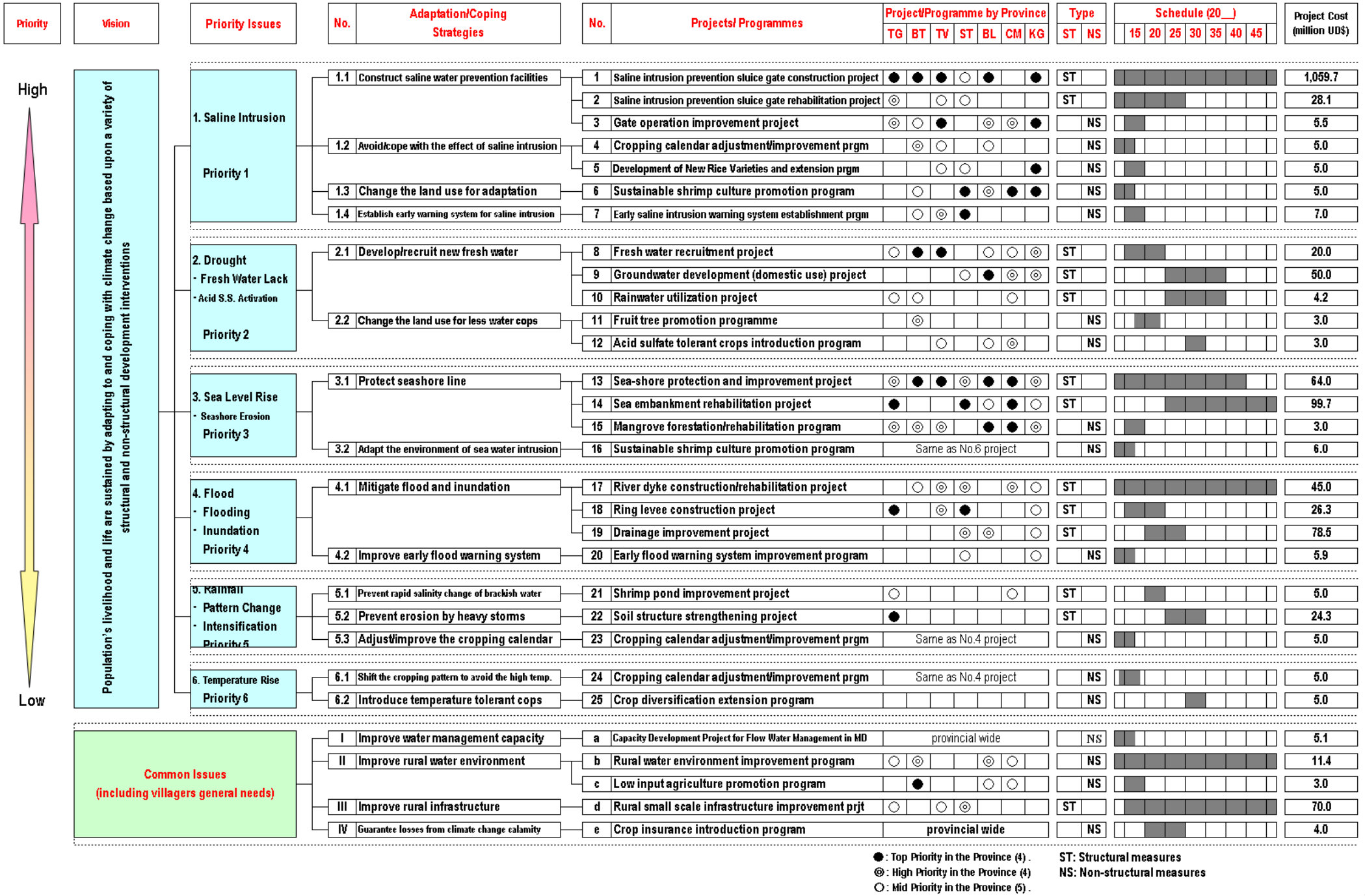
8) Kien Giang province suggested that No.1 "saline intrusion prevention sluice gate construction project" shall be given the top priority. In fact, there are six gates to be constructed in the Long Xuyen quadrangle, of which four gates are located in Rach Gia city of Kien Giang along the rivers of An Hoa, Kenh Nhanh, Song Kien, and Rach Soi. Those rivers are already affected by severe saline intrusion. Therefore, without those sluices, saline intrusion in this area will become quite serious. Besides, No.9 "groundwater development (domestic use) project" should be given the second priority because there are two districts, An Bien and An Minh, where people are suffering from lack of freshwater.

Given the aforementioned comments from relevant DARD officers, the project priority by province was finalized as attached in Figure 4.7.2, and it further indicates; 1) nature either by structural or by non-structural, 2) project implementation period, and 3) project cost. Note that since the listed projects/programs are at the level of master planning, the project costs are indicative only.

4.7.3 Project Description (Simplified Project Design Matrix)

Projects/ programs summarized in the Development Framework are elaborated in a simplified project design matrix (PDM). The PDM constitutes of project title, priority in the province, target group, implementing agency, collaborators, objectives, rationale why the project is in need, implementation period, expected outputs and relevant activities, cost and expected fund sources, project risk and environmental assessment in 3 levels of; A (highly expected), B (little expected), and C (not expected).

Figure 4.7.2 Climate Change Adaptation Framework (Vision, Issues, Strategies, and Projects/Programmes)



Project No.1

Project Title	**Saline Intrusion Prevention Sluice Gate Construction Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	●	●	●	○	●		●
Target Groups	Paddy cultivation farmers, Fruit cultivation farmers						
Implementing Agency	DARD, MARD						
Potential Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To prevent the saline water from getting into farming areas.

Rationale: Saline water intrusion is the first priority issue among others under climate change according to a government officers' workshop, and also it was ranked at 2nd priority during village level workshops among the climate change related issues. Saline intrusion takes place at the end of dry season, say March and April, when the Mekong River discharge is minimal, and worsened by high tide. An example is in Tra Vinh, in 2011 dry season about 70% of paddy harvest was lost in an area of 8,000 ha to which saline water came in. In addition, in another area of 3,000 ha about 20 – 70% of harvest loss took place. A simplest way to prevent the sea water intrusion into inland areas is to construct a sluice gate at the confronting point to the Mekong River. When the saline water has reached the estuary of canals, the gate is shut, so that the saline water can not get in. There are numerous canals in the Delta, among which those canals located from lower mid part to downstream part of Mekong River do need this sluice gate according to the upcoming of saline water.

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

Expected Outputs	**Development Indicators**
・ Farmers' income is secured. ・ Winter-spring paddy production is protected. ・ Fruits production is protected. ・ Sluice gates are established.	・ Farmers' income is kept same as before the saline water came. ・ Paddy production is kept same as before. ・ Fruit production is kept same as before.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Tendering is done, whereby construction starts. ・ Necessary surveys and designs are done. ・ Priority sluice gates are identified (also refer to the list of the sluice gates prepared in the SIWRP master plan (2011-2025)	Depending upon the size of the sluice gate; average investment is; about 16.04 million USD per 10m width. Total cost is about 1,090.8 million USD	MARD, Donors

Project Risk: Dry season Mekong river discharge might increase in future due to the operation of hydropower dams, which are planned in upstream of the River. Hydropower dams are operated by storing water aside from generating electricity during rainy season while releasing it during dry season to again generate electricity. It means that in most cases dry season discharge is augmented, more downstream river water than what used to be in the river without hydropower dams. With the augmented dry season discharge, the investment for sluice gate might result in vain. In order to avoid this happening, monitoring of not only discharge but also saline level shall be made and accordingly the construction of sluices shall be reviewed every year and re-arranged for the future as needed. It is not recommended to stick on the original plan but review shall be done every year according to the development in the upstream riparian countries of Mekong River whereby the discharge of dry season. It is also recommended that MRC shall work in tracking the development projects in the catchment area and share the information with all the related counties on time.

Environment Assessment (B): Sluice gates are constructed in the most downstream of canals, drainages and river channels. Very few people reside in these areas whereby re-settlement will not take place at greater extent. Yet, still some people may reside in such areas, who may be vulnerable people, like landless people, difficult to access farmlands. Where there are such people who need to be re-located, compensation shall be done according to the Government regulation. It is also recommended during designing stage positioning of sluice gates shall be so made that it can avoid people's settlement areas as much as possible. Aside from this, construction may cause air pollution and some noise. However, with reference to the past experiences such negative impacts are expected not to the level where environment is greatly harmed. In anyway, contractors shall fully be in compliance with relevant laws and regulation governing construction.

Project No.2

Project Title	**Saline Intrusion Prevention Sluice Gate Rehabilitation Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	◎		○	○			
Target Groups	Paddy cultivation farmers, Fruit cultivation farmers						
Implementing Agency	DARD, MARD						
Potential Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To prevent the saline water from getting into farming areas.

Rationale: As mentioned in the Project No.1 'Saline Intrusion Prevention Sluice Gate Construction Project', saline water intrusion is the first priority issue among others under climate change according to a government officers' workshop, and also it was ranked at 2nd priority during village level workshops among the climate change related issues. Saline intrusion takes at the end of dry season, say March and April, when the Mekong River discharge is minimal, and worsened by high tide. To prevent the saline water intrusion, a simplest way is to construct a sluice gate at the exist point to the Mekong River. As is so expected, the Government has already constructed number of sluice gates at the downstream areas of Mekong Delta including the 7 coastal provinces, the target area of this Master Plan Project. Though these sluice gates are well operational to date, some of them are getting dilapidated especially affected by high level of salinity. Gates shall be well maintained and also at a time shall be replaced. Likewise, rehabilitation and/or renewal of those already constructed sluice gates shall be done every 20 to 30 years according to the age of the facilities.

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

Expected Outputs	**Development Indicators**
・ Farmers' income is secured. ・ Winter-spring paddy production is protected. ・ Fruits production is protected. ・ Sluice gates are established.	・ Farmers' income is kept same as before the saline water came. ・ Paddy production is kept same as before. ・ Fruit production is kept same as before.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Tendering is done, whereby construction starts. ・ Cost estimation is done and then budget allocation is secured. ・ Necessary surveys and designs for the rehabilitation and/or renewal are done. ・ Priority sluice gates which require rehabilitation/renewal are firstly identified	Depending upon the size of the sluice gate and the work of rehabilitation/renewal; average investment is 408,000 US$ per sluice, and total cost is 28.1 million US$ for 69 sluices.	MARD, DARD, Donors

Project Risk: The work planned under this project is rehabilitation or renewal of the existing facilities, which means strengthening of existing aged facilities or replacement of existing dilapidated facilities to maintain the designed functions. Therefore, by its nature pertaining to the construction work, no noticeable project risks are expected. However, should the dry season Mekong river discharge increase in future due to the operation of hydropower dams planned in the catchment areas of the Mekong River, renewal work might result in vain. In this sense, if there could be a trend for the Mekong River discharge to increase, renewal work should be deferred as much as possible, and rehabilitation should be given higher priority. This is because saline prevention sluice gates might not be much needed in case the dry season Mekong discharge is augmented by the operation of hydropower dams. It is therefore recommended that the MARD shall work in collaboration with MRC in tracking the development projects in the catchment area and regularly monitor the discharge of the Mekong River.

Environment Assessment (B): The work planned under this project is rehabilitation and/or renewal, so that environmental impacts are to be minimal. In fact, no resettlement of people is expected, nor does additional land acquisition. Expected negative impacts will take place only during construction stage. Construction may cause air pollution and some noise. However, with reference to the past experiences such negative impacts are expected not to the level where environment is greatly harmed. In anyway, contractors shall fully be in compliance with relevant laws and regulations governing construction.

Project No.3

Project Title	**Gate Operation Improvement Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	◎	○	●		◎	◎	●
Target Groups	Staff of DARD in each Province						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To increase effectiveness of gate operation (for fresh/saline water intake/prevention)

Rationale: Lots numbers of sluices have been constructed in Mekong delta in order to prevent saline water intrusion into inland canals. Swing type gate is used for the most of sluices, and sluice operation (open and close) depends on water level difference between inside and outside of the gate. Expansion of saline intrusion area affects this operation system to be malfunctioned because saline intrusion may start earlier than water level increase by tide regime change. In fact, it is reported that saline water comes up along Mekong river earlier than ever before in recent years. Then, monitoring of salinity level will be a key to prevent saline water from the intrusion near future especially under climate change.
This project aims to improve gate operation system coupled with monitoring on saline content of the water and water level in Mekong Delta. The first step of this project is to survey present condition in order to grasp saline water intrusion phenomenon along each river or canal system, and then, to group canal networks to identify the main sluices to be controlled. Monitoring results will be mainly applied to these main sluices to conduct on-time controlled gate operation.

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

Expected Outputs	**Development Indicators**
・ Officers for water resource utilization are trained. ・ Control point establishment for the project ・ Best-suite gate operation system is established with the guidelines prepared. ・ Monitoring system is established for priority canal groups.	・ 100% of officers for water resource utilization are trained. ・ Water flow control point map is established. ・ Proposed water flow diagram is prepared and procedures of this preparation are described in a guideline. ・ Draft water flow diagram is prepared.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Gate operation rules are established with guidelines, and put into practice. ・ Control points are identified. ・ Priority canal networks are identified (also refer to the list of the sluice gates prepared in the SIWRP master plan (2011-2025). ・ Installation of monitoring system, and monitoring team/system is established.	・ Total cost is about 5.5 million US$ ・ Expert: 4.3 million US$ ・ Equipment: 0.5 million US$ ・ Training: 0.2 million US$ ・ Activities: 0.5 million US$	MARD, Donors

Project Risk: Complicated land use requires different water demand in quality and volume. In some areas farmers require saline water for their shrimp farming while fresh water is required by other farmers for their paddy cultivation. Canal system grouping is the first step to commence this project because it can identify water use pattern and its quality with certain time frame such as by week or by season. In shrimp farming, suitable saline content is different between shrimp variety such as *P. monodon* and *P. vannamei*. *P. monodon* is well known shrimp in Mekong delta as “black tiger” which prefers relatively low saline content (18 – 25 PPT). Farming of *P. vannamei* has been increased in Mekong Delta recent years and it prefers relatively high saline content (25 – 30 PPT). There will be some other issues on water quality, so that identification of water quality and water use is a key for this project.

Environment Assessment (B): Since this project is implemented on non-structural approach, any resettlement and negative environmental impacts are not identified and expected. Unifying water quality by canal network grouping will be established, and whereby controlling the water quality may become quite simple by area and by season. This is only the point to be a positive issue on the environmental concern.

Project No.4, No.23, No.24

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. In order to avid this happening, all the concerning the farm block sharing same canals should be in agreement.

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.

Project No.5

Project Title	**Development of New Rice Varieties and Extension Program**						
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 Univeristy, 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 among the issues related to climate change. 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 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). To cope with conceivable saline intrusion in the future, introduction of saline-tolerant varieties is required in such areas where saline content is influential but not to the extent that shrimp is more suitable, say 500 PPM to 4,000 PPM. 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 nearby shrimp cultivation areas; and where paddy is cultivated under the rotation system with brackish shrimp. Development of new traits is being carried out by Cuulon Rice Research Institute. Yet, application of modern technologies and the extension of such varieties remains as a bottleneck due to insufficient development capacity both for equipment and human resources, limited capacity of extension officers, and inadequate coordination among research and development institutes. 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. ・ Saline tolerant 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.

Project No.6, No.16

Project Title	**Sustainable Shrimp Culture Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		○		●	◎	●	●
Target Groups	Extension officer and laboratory staff of DARD, Extensive shrimp farmers, Paddy-shrimp farmers and Mangrove-shrimp farmers						
Implementing Agency	DARD, MARD, RIA No2.						
Potential Collaborators	International Donors						

Objectives: To develop extension structure for shrimp farming model in consideration of climate change impacts.

Rationale:
Disease outbreak and low quality of seed are one of major constraints for shrimp culture development in Mekong Delta, especially coastal areas. In addition, negative impacts on rearing environment are also expected due to climate change. On the other hand, farmers who convert their paddy field to shrimp pond due to saline intrusion associated with climate change have little shrimp culture experience. Therefore, it is required to develop the shrimp farming extension system including the development of farming models and disease monitoring system. The Programme could alleviate the impacts of known diseases through the strengthening of diagnostic capacity of DARD laboratories.

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

Expected Outputs	**Development Indicators**
・ Conversion from paddy farm to shrimp ponds is conducted. ・ Disease monitoring is implemented, and DARD monitors shrimp farmers' activities. ・ Shrimp farmers' cooperatives are established, and cooperative activities are implemented. ・ Shrimp disease monitoring system is organized.	・ Land use plan for converting paddy field to shrimp pond is prepared. ・ DARD laboratories obtain capacity for shrimp disease diagnosis and monitoring. ・ Pilot cooperative is well functioned.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Shrimp farming models and training modules are developed. ・ Disease monitoring system & referral system is developed. ・ Shrimp farmers cooperatives are organized. ・ Equipment is procured for DARD laboratories.	Total US$ 5.0 million Experts: US$ 2.0 million Equipment: US$ 1.0 million Trainings: 0.5 million Pilot activities: 1.5 million	RIA No.2, MARD, Donors

Project Risk:
It is required to get Government's approval for converting paddy fields to shrimp ponds. Therefore, the land use plan should be revised and approved by the Government for smooth conversion of farming lands, otherwise actual conversion from paddy field to shrimp field cannot take place.
Rearing condition of shrimp is vulnerable to disease since most of shrimp farms utilize same irrigation channels for water intake and drainage. Land use plan should be revised for renovation of channels where possible, or otherwise once disease takes place it may be spread to wider areas easily. This situation may not facilitate the farmers to convert from their paddy culture into shrimp culture.
Farm gate price of shrimp has been decreased since processing factories imported frozen shrimp as processing materials from neighboring countries. And inputs for shrimp farming will be increased as farmers are requested to improve the farming facilities (i.e. increasing the height of bank and strengthening the banks, deepening the pond, etc) for adapting to climate change impacts. Necessary costs for improvement should be borne by shrimp farmers. If this arrangement is hardly done, expected outputs from the programme can hardly be seen.

Environment Assessment (B):
Though rearing water is drained into canals, impact is negligible since extensive culture keep shrimps with low density and does not use artificial diets, one of the main factors of damaging the water environment. Other negative impacts are not expected.

Project No.7

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.

Project No.8

Project Title	**Fresh Water Recruitment Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	○	●	●		○	○	◎
Target Groups	Paddy cultivation farmers, Fruit cultivation farmers						
Implementing Agency	DARD, MARD						
Potential Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To avail of fresh water in lieu of existing water being salinized by saline intrusion.

Rationale: Drought, or simply saying lack of fresh water, was placed at the 2nd priority issue among others related to climate change through government officers' workshop and also village level workshops. Drought or lack of fresh water tends to take place or tends to worsen in parallel with the saline intrusion. When the saline water comes to the point of what has been used as the intake point of fresh water, the beneficial area would lose the source, whereby the beneficiaries would be suffering from the water shortage. Saline intrusion takes place during dry season with March and April being the severest months. Therefore, winter-spring paddy and also fruits which are perennial crop will be affected by this water shortage. To cope with the problem, a new fresh water source shall be explored by; e.g., extending the intake canal to upstream areas from what has been working as the original source. The intake point shall simply be moved towards upstream side, free from saline intrusion.

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

Expected Outputs	**Development Indicators**
・ Farmers' income is secured. ・ Winter-spring paddy production is protected. ・ Fruits production is protected. ・ Canal extension/widening are implemented, whereby additional fresh water is ferried to the beneficiary areas.	・ Farmers' income is kept same as before the saline water came. ・ Paddy production is kept same as before. ・ Fruit production is kept same as before.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Tendering is done, whereby construction starts. ・ Necessary surveys and designs are done, with notice of the possibility of resettlement of the people who may live alongside the canal. ・ Priority fresh water recruitment canals are identified, in cases together with saline water prevention sluice gate construction sites.	Upon the size of the extension/widening of canals; e.g. US$ 10 million on the May Phop canal extension in Tra Vinh, US$ 20 million on the Ba Lai upstream reach in Ben Tre.	MARD, Donors

Project Risk: Dry season Mekong river discharge might increase in future due to the operation of hydropower dams, which are planned in upstream of the River. With the augmented dry season discharge, the investment for extension of intake canals might result in vain. In order to avoid this happening, monitoring of not only discharge but also saline level shall be made and accordingly the extension of canals shall be reviewed every year and re-arranged for the future as needed. The extension should be designed where possible step by step. It means for example that shifting existing intake point to nearer upstream canal where freshwater is still available, not to extend far too upstream at once. Step-by-step extension of the fresh water intake point towards upstream is recommended.

Environment Assessment (B – A): This project includes canal extension work towards upstream areas. The canal extension is firstly planned by tracking existing stream, canal, and water channel whatsoever there is water way in order to minimize land acquisition. In most cases, however, there have to be number of houses/settlers alongside existing water channels. Those people will be relocated by the extension of the canal which also requires widening of the existing water channel in most cases. People and houses to be relocated, and land which will be acquisitioned shall be surveyed during planning stage, e.g. feasibility study stage, and the resettlement plan shall be established, and fully informed to those people in order not to forcibly relocate them. Compensation shall fully be explained to those people and agreed prior to the commencement of the construction according to the relevant laws and regulation in Vietnam.

Project No.9

Project Title	**Ground Water Development (Domestic Use) Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
				○	●	◎	◎
Target Groups	Inhabitant in saline dominant area						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To secure fresh water supply in Ca Mau peninsula, and in Bac Lieu province

Rationale:

Due to long distance from Mekong river, fresh water cannot be conveyed to Ca Mau peninsula through canal system. Blackish shrimp farming is popular business in this area and fresh water has been obtained by ground water development. It is reported that saline intrusion into tube wells for domestic use is expanding in Ca Mau peninsula mainly because sudden increase of ground water demand for intensive shrimp farming.

There is no exact datum and information about this issue; however fresh water shortage is often reported from these areas. This project aims to establish rural water supply system in Ca Mau peninsula and to improve accessibility to safe fresh water. Before implementation of this project, detailed survey on the present condition shall be done not only to identify fresh water shortage areas but also to find out water resources for future development. Water resources for this project shall not be affected by saline water intrusion and have enough aquifer storage.

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

Expected Outputs	**Development Indicators**
・ Fresh water supply is secured. ・ Ground water supply system is established. ・ Potential aquifers are identified for domestic use. ・ Ground water monitoring system is established	・ Number of beneficiaries: 100,000 H/H ・ Number of water supply system: 1,200 nos. ・ Development of groundwater monitoring map ・ Aquifer cross section and monitoring well points are plotted in drawings.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Construction of deep wells are started, and put into operation. ・ Necessary surveys and designs for well construction are done. ・ Hydro-geological survey is carried out, ・ Monitoring system is established.	Total cost is about 50 million US$; average drilling depth is estimated and calculated as deep as 180-200m.	MARD, DARD, Donors

Project Risk:

Ground water development is very common investment for intensive shrimp farming in Ca Mau peninsula but ground water balance between consumption and recharge is not sure at this moment. Over-consumption of groundwater has a risk of land subsidence as in the case having taken place in Bangkok, so that it can also happen in Ca Mau peninsula area and to some lesser extent in Bac Lieu province. In nowadays Vietnam, groundwater development requires obtaining permission from the Ministry of Natural Resources and Environment; however continuous monitoring after starting water use has not been implemented. Measurement of land subsidence has not yet done in wide area, and therefore detail situation at this moment is unknown factor. Without monitoring of ground water condition in terms of water quality, water volume, and seasonal changes, this project will face difficulty for its sustainability.

Environment Assessment (B):

Since this project deals with groundwater development, necessity of any resettlement is not expected. Regarding environmental issues, over-pumping up groundwater may damage aquifers by water quality and/or available water volume of preceding projects or existing tube wells for family use. Water balance survey in wide area is therefore required before implementation of the project. Over-use of ground water sometimes causes land subsidence in coastal area such as Bangkok and Tokyo. Rechargeable water resources and its quantity shall also be identified before implementation of the project. During construction period, some waste water may flow out from the construction site but it will be negligible impact to the surrounding area.

Project No.10

Project Title	**Rainwater Utilization Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	○	○				○	
Target Groups	Inhabitant in Ca Mau peninsula						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To increase fresh water resources in dry season Ca Mau peninsula

Rationale:

Sand and silt are main material of shaping Ca Mau peninsula at the ground surface, and rain water will run off from this area during rainy season. Water pots of quite big size can be seen in this area which can keep rain water during rainy season and it is utilized in dry season. Annual rainfall in this area is not so small; 2,500mm – 3,500 mm of annual rainfall is recorded in the last two decades. This rainfall sometimes causes inundation of Ca Mau center and the places of its vicinity, however utilization of the rain water is not sufficient at this moment.

On the other hand, sea level rise under climate change is expected and changes have been observed in the last two decades exactly and steady. Continuation of this sea level rise will make water supply condition more difficult, with which people in Ca Mau peninsula are now trying to draw water from Mekong River through canals. Increase of water demand is also expected in future because increase of shrimp farming requires more fresh water to make brackish water available for shrimp farming. Thus, this project aims to utilize rainfall water as much as possible by means of underground water pit construction where the pit will be placed in nearby or just beneath of houses or public buildings. External water tanks can also contribute to this purpose, whereby large scale water tank made by plastic materials and/or glass fiber are considered.

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

Expected Outputs	**Development Indicators**
・ Fresh water during dry season becomes more available. ・ Water tanks are installed. ・ Rainwater is harvested. ・ Types of water resources in dry season are increased.	・ Decrease of water fetching from canals (<10%). ・ Number of water tank: 5,000 numbers in a district in Ca Mau. ・ Harvested water volume in rainy season is 90,000 tons. ・ Available water resources increase total 3 types or more.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Tank provision/construction starts. ・ Necessary surveys and designs are done. ・ Pilot project before implementation of the main project is carried out as show case. ・ Governmental assistance to individual households is made.	Total Cost is 4.2 million US$, Ca Mau (400nos: 1.8 million US$), Tien Giang (200nos; 0.5 million US$, Ben Tre (200nos; 0.5 million US$), other cost is 1.4 million US$	MARD, Donors

Project Risk:

Since a water tank will be a property of individuals, project cost sharing will be one of the issues for implementation of this project. Vietnamese government may bear some percentage of project cost but it will be not enough to cover all required cost. Loan arrangement for individual household may be required and establishment of loan policy will be required. As for installation of water tank in or nearby public buildings, design shall be done together with the design of the building and budget for it shall be prepared in advance.

Environment Assessment (B):

Since water tank installation is supplemental activity with house construction or building construction there is no serious environmental issue. During construction stage, excavated soil has to be disposed to some places at the nearby construction site. Ca Mau peninsula is well known area of lowland and embankment material is required at allover the area. If excavated soil can be disposed at vicinity of such construction site, there is no impact by such construction waist.

Project No.11

Project Title	**Fruit Tree Promotion Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		◎					
Target Groups	Current paddy farmers/ fruits farmers						
Implementing Agency	DARD, MARD						
Collaborators	SOFRI (Southern Fruits Research Institute)						

Objectives: To promote fruits crops in drought prone areas (fresh water shortage areas)

Rationale:

Drought is seen as one of the problematic consequences to be induced by climate change especially at the mid to lower part of the Mekong Delta. Fruits crops are generally better suited to drought prone areas as compared to paddy which dominates the planted area of the Project area. In addition, fruits crops are estimated to produce as much as 103,333,000VND/ha as compared to 13,122,000 VND/ha for paddy based on questionnaire household surveys. Thus, fruits crops can be strategically placed in consideration with the high risk of paddy production in drought-prone areas.

Lack of freshwater is caused not only by drought but also by such water management that tries to control saline intrusion; blocking saline intrusion would sometimes result in a lack of freshwater itself. Therefore, promotion of fruits crops should be also considered in such particular areas where it is difficult to secure enough amount of freshwater due to water management of canal systems. Furthermore, introduction of coconut tree can also be a part of the strategy. Although coconut is not as profitable as other fruits crops, it can be grown in wider range of agro-ecological areas including saline-prone zone and flood prone-zone. Thus, as for adaptation to forthcoming climate change, coconuts can be a good alternative of paddy or other fruits crops.

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

Expected Outputs	**Development Indicators**
・ Livelihoods of farmers are secured. ・ Fruits production is promoted. ・ New land use plan is authorized ・ Strategic locations for fruits production are identified. ・ Suitable fruits crops are identified. ・ Drought-prone areas are identified	・ Fruits crops are newly cultivated in drought-prone areas (70% of identified area that are drought prone) ・ Livelihoods of farmers are secured; 103 million VND/ha of income level is achieved in drought-prone areas

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Fruits production is promoted. ・ Extension modalities are examined and re-structured for horticulture promotion. ・ Suitable types/varieties of fruits crops are identified. ・ Strategic locations for fruits production are identified	A total of US$3,000,000 (US$1,000,000/year) ・ Chief advisor/ horticulture ・ Agricultural extension ・ Short-term experts as required (disease control, fruits cultivation technology)	MARD, Donors

Project Risk:

As stated, paddy is given the first priority by the government among all the major agricultural and aquacultural commodities including fruits. Given the fact, specific locations of the project should be strategically selected; otherwise it would conflict with the government policy favored to paddy production. In addition, increment of fruits production area would not guarantee the increase of income for individual farmer households. Fruits production is first affected by the level of farmers' techniques and exposure to diseases, and then disturbed by the price fluctuation. "Greening disease," for example, is known as one of the destructive diseases of citrus fruits spreading in the Project area. Therefore, fruit promotion shall be carried out with well orchestrated horticulture extension services.

Environment Assessment (C):

This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no necessity of particular social and environmental concerns is foreseeable.

Project No.12

Project Title	**Acid Sulfate Tolerant Crops Introduction Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
			○		○	◎	
Target Groups	Current paddy farmers/ fruits farmers						
Implementing Agency	DARD, MARD						
Collaborators	SOFRI, Cuulong Rice Research Institute						

Objectives: To promote plantation of acid sulfate tolerant crops

Rationale:

Impact of climate change entails many different aspects such as seawater rise, saline intrusion, flood and drought, which may become severer and milder according to the topographic, hydrological and social characteristics of particular areas. One of the issues negatively anticipated is an increased damage of acid water derived from acid sulfate soil covering widely in the area. It is known that acidity becomes extremely high once acid sulfate soil is exposed to the air, which sometimes reaches down to pH 2.0 or around. In such places, no agricultural crops can be grown without application of tremendous amount of calcium and magnesium for neutralization of acidity.

After a fundamental improvement of soil acidity through repeated exposures to air and continued leaching by irrigated/rain water, then, it is the time to consider introducing acid-tolerant crops such as improved varieties of rice and fruit trees or Melaleuca (aka Tea Tre). Melaleuca has been the most suited crop in acid soil areas of Mekong Delta, which has been supported increasing demand for construction materials in urban areas. However, it is also predicted that the demands for Melaleuca materials will be soon or later replaced by the concrete piles. Therefore, promoting plantation of Melaleuca in acid-soil zones on one hand, it is also needed to develop other effective usages of Melaleuca woods on the other hand. After all, introduction of acid tolerant crops including paddy and fruit trees is a basic but effective approach to cope with to-be increasing areas of acid soils due to change in hydrological movement in the wider range of the area.

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

Expected Outputs	**Development Indicators**
・ Livelihoods of farmers are secured ・ Acid tolerant crops are identified and planted in acid prone areas. ・ Locations of acid prone areas are identified through simulation analysis and field observations.	・ Acid tolerant crops are newly cultivated more than 50% of identified acid-prone areas ・ Livelihoods of farmers are secured at the same level as paddy farmers (13 million VND/ha) in the same agro-ecological zones.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Acid tolerant crops are promoted through extension services. ・ Guideline for the promotion of acid-tolerant crops is prepared. ・ Experimental research is carried out for identifying acid tolerant crops. ・ Survey to identify acid prone areas are carried out.	A total of US$3,000,000 (US$1,000,000/year) ・ Chief advisor/ agronomy ・ Agricultural extension ・ Short-term experts as required (forestry, horticulture, soil analysis)	MARD, Donors

Project Risk:

As stated acidity of the soil derived from acid-sulfate soil is extremely high (2.0pH or around) and even acid-tolerant crops may not be able to survive in such condition without application of neutralizers or improvement of acidity through repeated leaching. To make the best use of such crops or varieties, the approach will have to be a little complicated for farmers, which will be associated with a risk of failure for promotion in the wider range of areas. To make sure, comprehensive approach should be tried that enable farmers well understand the benefit and limitation of the acid tolerance crops.

Environment Assessment (C):

This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no necessity of particular social and environmental concerns is foreseeable.

Project No.13

Project Title	**Seashore Protection and Improvement Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	◎	●	●	◎	●	●	◎
Target Groups	Inhabitant living in and nearby coastal areas						
Implementing Agency	Institute of offshore and coastal engineering, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To protect coastal areas from erosion, tide, and monsoon disaster

Rationale:

Basin area development of Mekong river is now widely progressing and water resource development is also going on by upstream countries. Increase of dam reservoir and water use in upstream area will reduce sedimentation load in downstream area, whereby coastal areas nearby Mekong river estuaries will have to face shortage of sedimentation. This shortage will amplifies erosion instead of sedimentation, so that the shorelines at coastal area will be eroded. Serious erosion is recorded and reported along coastal shorelines and it reaches about 5m per year in average in places. This erosion destroys natural resource environment especially at mangrove forest along coastal line. Mangrove is important not only for natural creatures but also human; people nearby coastal lines have been utilizing the mangrove for firewood purpose and many people in Mekong Delta depend on this energy for their daily cooking. Erosion at mangrove area will cut a chain of natural renewable function of mangrove, and therefore protection of coastal line is essential for natural environment and human activities.

Reforestation and mangrove plantation will therefore contribute erosion protection and it can secure lives of creatures in this area. Riprap arrangement for coastal area shall also be conducted and/or some embankment with riprap works shall be newly constructed with these plantation works; plantation and the riprap works can protect each other, and enough knowledge and techniques are available for this project.

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

Expected Outputs	**Development Indicators**
・ Erosion rate at coastal area is reduced. ・ Reforestation at coastal area. ・ Mangrove plantation at coastal area. ・ Project plan map is formulated.	・ Erosion area is reduced by 50% of present situation ・ Reforestation is completed along 430.5km of coastal area ・ Mangrove plantation; total 11.5km in length ・ Project plan maps at 7 coastal provinces

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Coastal line is protected from erosion. ・ Mangrove plantation at coastal area. ・ Reforestation at coastal area. ・ Necessary surveys and designs are done.	Total cost is about 64.02 million US$, Reforestation and mangrove planting is about 4.02 million US$, riprap works cost is about 60 million US$	MARD, Donors

Project Risk:

Length of coastal line is quite long and project will not be completed within short period. Some dykes constructed will be damaged during project period and it is necessary to repair and rehabilitate it even though it is during construction period. Continuous monitoring and maintenance are usually required for this kind of public works, and therefore continuous budget allocation is essential to protect coastal areas. This continuous budget allocation is the biggest project risk, whereby sufficient budget plan is required.

Environment Assessment (B):

Since this is a protection work for coastal areas, and people living in the erodible area is not expected. During construction period, there will be some construction waste but dominant waist material will be soils. Soils are necessary for mangrove bed therefore negative impact on environment will not be so serious. Thus, environmental issue of this project is negligible.

Project No.14

Project Title	**Sea Embankment Rehabilitation Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	●			●	○	●	○
Target Groups	Inhabitant living in and nearby coastal areas						
Implementing Agency	Institute of offshore and coastal engineering, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To recover function of sea embankment in coastal area

Rationale:

Advantage of sea embankment is the availability of material for construction; most of construction material for sea embankment can be obtained at the area nearby construction site. Only rock material may have to be transported from far places. On the other hand, such easy available material has erodible features and not so stable against impact of waves and rainfall. Further, sandy material becomes sometimes a base of sea embankment in the sea and this material is affected by hydraulic phenomenon of ocean flow; the base of sea embankment is scoured and collapsed accordingly.

Technique and technology for sea embankment has been improved for coastal areas of Mekong Delta because information of such collapse has been collected and countermeasures for it have been applied in recent years. Knowledge and experiences from outside, mainly by and from donor countries, have been imported, employed, and applied. Consequently, some promising methods are considered to be available for the coastal areas of Mekong Delta. With this background mentioned herein, this project aims to rehabilitate existing sea embankments, which shall be replaced by concrete dike because these shorelines have already been eroded, collapsed, or weakened. Some supplemental techniques, such as reinforce concrete structures and appropriate shape of concrete structure, will be also used together with present technique in order to secure rehabilitation effect.

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

Expected Outputs	**Development Indicators**
・ Remaining vulnerable embankment is replaced by concrete structure. ・ Reinforce concrete dike is constructed at the most vulnerable coastal zone. ・ Classification of heavily eroded seashore line for rehabilitation with priority. ・ Detailed coastal maps on present condition is prepared	・ 100% of remaining embankment is replaced by concrete dike. ・ 100% of reinforce concrete dike is constructed ・ Priority chart of eroded seashore line is prepared ・ Detailed coastal map with present condition

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Rehabilitation of embankment according to priority. ・ Protection zone map is prepared and rehabilitation work is done. ・ Rehabilitation plan is prepared. ・ Detailed site survey on coastal erosion	・ Total cost is 99.74 million US$ ・ Concrete dike construction cost is 12.24 million US$ ・ Reinforced concrete dike is 87.5 million US$	ICOE, MARD, Donors

Project Risk:

Length of coastal line is quite long and some areas have difficulty for human approaching because of tidal regime and little existence of access roads. Construction works may have to be done from sea side not from land side, and therefore technical difficulty and project cost increase are expected. Invisible risk of existing embankment collapse is also expected because it is not easy to understand portent of collapse in comparison with concrete structure. These points may cause budget shortage after commencement of the project.

Environment Assessment (B):

Since this is a protection work for coastal areas, and people living in the erodible area is not expected. During construction period, there will be some construction waste but dominant waist material will be soils. Soils are necessary for mangrove bed therefore negative impact on environment will not be so serious. Thus, environmental issue of this project is negligible.

Project No.15

Project Title	**Mangrove Forestation/Rehabilitation programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	◎	◎	◎		●	●	◎
Target Groups	Villagers living in and nearby coastal area						
Implementing Agency	DARD, MARD, DoNRE, MoNRE, DoST						
Collaborators	International Donors (GIZ, AusAID, JICA)						

Objectives: To plant mangrove and rehabilitate forests for protection of the coasts.

Rationale:

Mangrove forests are salt-tolerant forests that grow in coastal belts between land and sea, with at least 27 of the 39 known species in Vietnam. They grow in tidal areas along the coast, and as fringing stands along the canals, especially near the sea entrances. Mangrove forests have multiple functions: as barriers against sea incursion especially with rising sea levels, against increasing numbers of severe storm events and saline water intrusion, as carbon sinks in plant biomass and soil and sediments, provision of timber, and maintenance of marine animal biodiversity, especially as a nursery for fish, prawns, shrimps and crabs.

Mangrove forests are being lost allowing the sea to break through and cause soil erosion, which will continue to get worse with climate change. Mangrove forests protect households, sea protection dykes and agricultural land from destruction. They provide many ecosystem services besides coastal protection, including spawning and breeding grounds for aquatic animals especially fish and shrimps. Provision of these environmental services will increase incomes, support coastal protection and rehabilitation and improve adaptation to climate change. The increased mangrove forest growth will also mitigate the effects of climate change by reducing greenhouse gas emissions. And then, mangrove forests along the shoreline are needed to break the force of waves and storms that would otherwise erode them. Rehabilitation of mangroves all threatened coastal shorelines are required urgently.

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

Expected Outputs	**Development Indicators**
・ Coastal forests are diversified and rehabilitated to increase biodiversity and enhance the protection of the coasts from climate change impacts such as sea level rising and erosion. ・ Peoples' consciousness on forest conservation is increased ・ Eco-tourism is realized as a new source of income.	・ Area of mangrove forest in the project area is kept as the beginning of the program. ・ Coastal line is kept same as the beginning of the program. ・ Biodiversity is kept same as before the project starts in terms of the number of species.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Afforestation of mangrove is carried out. ・ The management of protected areas and coastal forest is improved. ・ Areas to rehabilitate and re-plant mangrove is identified.	A total of US$3,000,000 (US$600,000/year) ・ Chief advisor/ mangrove forestry ・ Agricultural extension ・ Short-term experts as required (forestry, land use planning, biology)	MARD, MoNRE, Donors

Project Risk:

There is possibility that mangrove plantings are often unsuccessful. In severe erosion areas, all the planted mangroves are lost within one year. One of the main reasons for this catastrophic loss is the lack of protection of young plants from wave action and seasonal sediment movement following planting. Strong wave movement strips the seedlings of their leaves, pushes the plants over and uproots them. Seasonal sediment movement also uproots and buries seedlings. To cope with these happenings, protection of the young mangrove shall be introduced.

Environment Assessment (C):

This program is not associated with construction of any infrastructure or resettlement of local people. Therefore, no necessity of particular social and environmental concerns is foreseeable.

Project No.17

Project Title	**River Dyke Construction/Rehabilitation Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		○	◎	◎		◎	○
Target Groups	Villagers, especially who reside near Mekong River						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To prevent the flooding coming from Mekong River, and/or from upstream provinces

Rationale: Climate change is to intensify rainfall in future, resulting in flooding more often taking place. The floods come from the Mekong River at the primary source, augmented by heavy rainfall. Also, upstream provinces such as Dong Thap, An Giang, etc. carry over the flood water down to the neighboring provinces. For example, Tien Giang province receives flood water not only from the Mekong River but also through Dong Thap province. At worse, the province receives flood water caused by rainfall from north-eastern catchment area out of the province. Near to the coastal areas, the flood coming from the Mekong River is backwatered by sea-level rise, intensifying flooding in those areas. To protect the population as well as the people's asset including public infrastructure, there should be river dikes along the River and in cases ring dykes inland areas to be free from inundation.

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

Expected Outputs	**Development Indicators**
・ People's life is secured. ・ Rainy season crops, e.g. summer-autumn paddy, are protected by floods. ・ Perennial crops, fruits, are protected by floods. ・ Shrimp can be kept in ponds (shrimp escapes when the water level of the ponds rises too much up to the top elevation of bank. ・ Priority zone map for implementation is prepared	・ People's life is kept same as before the floods come. ・ Paddy production is kept same as before. ・ Fruit production is kept same as before. ・ Shrimp production is kept same as before. ・ Priority zone map for 7 coastal provinces

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Construction and rehabilitation are completed. ・ Rehabilitation of dyke is done. ・ Dykes are constructed in freshwater area. ・ Dykes are constructed near coastal line. ・ Priority areas for river dykes are identified (also refer to the list of the river bank and ring levee are prepared in the SIWRP master plan (2011-2025).	Total Cost 45 million US$; 300km for newly proposed embankment, 300km for rehabilitation Construction; 30 million US$ Rehabilitation; 15 million US$	MARD, Donors

Project Risk: Rainy season Mekong river discharge might decrease in future due to the operation of hydropower dams, which are planned in upstream of the River. Hydropower dams are operated by storing water aside from generating electricity during rainy season, reducing the rainy season discharge. Though sea level will rise most probably whereby the Mekong River water is back-pushed, the potential decrease of rainy season discharge of the Mekong River may balance the flood level as to what has been so far. Therefore, the step-by construction in river dyke establishment is recommended; e.g. till year 2020, 2 meters height of embankment is tried and then another one meter in between 2020 and 2030.

Environment Assessment (B – A): This project includes earthen embankment alongside the Mekong River. Since the bank is made of soil, the slope of the bank can not be so steep, resulting in wider areas of occupation for the bank foundation. There are lots number of people residing alongside the River. In fact, there is a government regulation by which people are not allowed near the River but some people still do. Those people shall be listed up and re-settlement plans shall be firstly formulated. Upon the acceptance from the to-be-relocated people, the construction should commence. Also, it is recommended that the provincial government should deliver the message that the people should not live close to the River, very much vulnerable for floods.

Project No.18

Project Title	**Ring Levee Construction Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	●		◎	●			○
Target Groups	Villagers, especially who reside near Mekong River						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To prevent the flooding coming from Mekong River, and/or from upstream provinces

Rationale: Climate change is to intensify rainfall in future, resulting in flooding more often taking place. The floods come from the Mekong River at the primary source, augmented by heavy rainfall. Also, upstream provinces such as Dong Thap, An Giang, etc. carry over the flood water down to the neighboring provinces. For example, Tien Giang province receives flood water not only from the Mekong River but also through Dong Thap province. At worse, the province receives flood water caused by rainfall from north-eastern catchment area out of the province. Near to the coastal areas, the flood coming from the Mekong River is backwatered by sea-level rise, intensifying flooding in those areas. To protect the population as well as the people's asset including public infrastructure, there should be ring levee around the housing area to protect lives and properties of the people.

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

Expected Outputs	**Development Indicators**
・ People's life is secured. ・ People are protected from loss to live and properties. ・ People are free from inundation ・ Priority zone map for implementation is prepared	・ People's life is kept same as before the floods come. ・ Damage cost by the flood becomes less than 10% in comparison to last 10 years average. ・ Percentage of evacuation in a year becomes less than 10% in comparison with last 10 years average. ・ Priority zone map for 7 coastal provinces

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Construction and rehabilitation are completed. ・ Rehabilitation of levee is done. ・ Ring levees are constructed around the housing areas. ・ Priority areas for ring levee are identified (also refer to the list of the river bank and ring levee are prepared in the SIWRP master plan (2011-2025).	Total Cost 26.25 million US$; 200km for newly proposed embankment, 125km for rehabilitation Construction; 20 million US$ Rehabilitation; 6.25 million US$	MARD, Donors

Project Risk: Decrease of inundation area may increase inundation depth because water spread area will be decreased by the project. Drainage improvement is not so easy for the area of "Plain of reed" because of flat topographic condition. Then, construction of many levees will accelerate increase of inundation depth where levees have not yet been constructed. This increase of inundation depth also results insufficient embankment height which will be constructed under this project. This is vicious cycle of flood inundation. To avoid this cycle, river training and canal training shall be implemented simultaneously with this project in order to improve drainage condition of flood water.

Environment Assessment (B – A): In advance of levee construction, land acquisition shall be done nearby housing area. This acquisition may require voluntary resettlement of some houses and residential areas. If embankment height becomes high, the land acquisition area will increase more. Earthen embankment will be the main works in this project and it will be done around housing areas. Since the bank is made of soil, construction of levees will scatter soils and rocks nearby the housing areas. Construction noise may be noisy for the people living nearby construction site during construction period. Insufficient number of detour may affect people to be in difficulties of transportation.

Project No.19

Project Title	**Drainage Improvement Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
				◎	◎		○
Target Groups	People who has been affected by inundation (farm land and living area)						
Implementing Agency	MARD, Ministry of Transportation						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: to drain and to control flood water as required

Rationale: Plain of reed is well known area with flood and it is also said "depression area". There are many places where drainage condition is not good; it is a lowland area along canals, it may be on a drainage course from flood area, or it is a place near seashore. Long period inundation damages agricultural product or properties of peoples, and in such cases prompt drainage is required. On the other hand, flood brings fertile soils from upstream; Mekong delta has been receiving benefits from flood. Thus, drainage improvement shall have two functions; one is to drain water caused by flood, rainfall, or spring tide, the other is to keep water when water/flood is necessary. In urban areas of Mekong Delta, prompt drainage is required, and therefore drainage facilities together in case with pumping system shall be planned. At a depression place of paddy area, land leveling or drainage system construction will be applied. Along the course of flood drainage like Kien Giang province, enlargement of canals and protection system for flood inundation are necessary works to avoid flood damage.
The most effective method for drainage improvement is canal enlargement but it may require much numbers of house resettlement along the canal banks. The second place is pump drainage but it requires cost for pump operation and maintenance; it is recommended to confirm budgetary arrangement condition and responsible organization which owns these cost. Sluice gates are the most popular and wide expanded method for water control; for effective drainage, it requires integrated water management with obtaining real time information of water level from several numbers of locations for targeted area. Gate operation will be done based on the real time information. Simulation and its feed back are essential for the project purpose.

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

Expected Outputs	**Development Indicators**
・ Drainage canals can drain flood more than before. ・ Pumping stations are operated ・ Embankment is constructed ・ Design reports are prepared ・ Survey maps are prepared	・ Drainage canal improvement: 150 km is carried out ・ Pumping station: 80 places are completed ・ Embankment: 125 km is completed ・ Design report on drainage ・ Survey maps at coastal 7 provinces.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Canals are enlarged. ・ Pump drainage system is constructed ・ Sluice, pump, canal rehabilitation design and operation manual are formulated. ・ Necessary surveys for designs are done.	Total cost: 78.5 million US$ Canal: 15 million US$ Pump station: 60 million US$ Embankment: 3.5 million US$	MARD, Donors

Project Risk: Since flood plain occupies large area of Mekong delta and inundation depth is so deep, water drainage from inundated area is not easy. Inundation sometimes continues a month or more in vast places. Prompt drainage may be impossible in such areas without constructing pumping station with large capacity size. Construction of such huge size facility is usually not feasible from the view point of economic investment since drainage pumping stations usually operate at a shorter period of time, only during high flood season. It is therefore necessary to conduct and decide priority areas to be protected by the project. Without this prioritization, project may fail.

Environment Assessment (B – A): In case of canal course training, resettlement will be necessary and detailed environmental assessment will be required. In other case, not much environmental affect is expected.

Project No.20

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.

Project No.21

Project Title	**Shrimp Pond Improvement Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	○					○	
Target Groups	Extensive shrimp farmers, extension officers for shrimp farming						
Implementing Agency	Institute for aquaculture, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						
Objectives: To decrease shrimp diseases and to decrease investment cost for shrimp farming							

Rationale:

It is supposed that rearing condition of shrimp pond will be worse i.e. increasing temperature and rising sea level due to climate change. Therefore, it is recommended to modify the pond design to retain the good rearing condition. In addition, most of the extensive shrimp farms release post larvae (PL) to rearing pond directly. Although the quality of seed should be monitored for disease control, it is difficult to monitor the condition of PL due to low density (1 to 2 PL/m2).

Therefore, modification of pond design i.e. making evacuation spaces (shadow area, deeper bottom, etc) from high temperature water and introducing nursery pond for initial stage of rearing period should be considered for improving the rearing condition. For take instance, mangroves in the rearing pond functions as sun shade. And it also contributes to rehabilitation of coastal forest zone too.

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

Expected Outputs	**Development Indicators**
・ Trainings for farmers are conducted. ・ Extension offices obtain necessary skills for the trainings. ・ Guideline of improved shrimp farming is established. ・ Models of improved shrimp pond are developed.	・ Trained farmers obtain necessary knowledge for using the improved shrimp ponds. ・ All extension officers in the target district are trained. ・ Operation manuals of the improved shrimp ponds are prepared. ・ Models of improved ponds such as paddy-shrimp pond, mangrove-shrimp pond and nursery pond are developed.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Training of farmers. ・ Extension manual is established. ・ Training of extension officers. ・ Suitable shrimp farming method is established	Total project cost is estimated as 5.0 million Experts: US$ 4.3 million Equipment: US$ 0.1million Trainings: 0.3 million Pilot activities: 0.3 million	RIA No.2, MARD, Donors

Project Risk: Construction work for shrimp pond improvement and extension work by extension officers shall be done simultaneously for this project. There will be some other risks to disturb this technique extension; quality of PL introduced, safe water for water intake, continuous monitoring for temperature, etc. Without paying attention on these issues, famers may misunderstand the purpose of the pond improvement.

Environment Assessment (B): Some mud water will be created during pond improvement. This project uses natural materials as much as possible therefore any significant environmental issues are not expected in this project.

Project No.22

Project Title	**Soil Structure Strengthen Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	●						
Target Groups	People in rural area						
Implementing Agency	DARD, MARD						
Collaborators	International Donors (ADB, WB, JICA, Netherlands)						

Objectives: To rehabilitate and strengthen rural soil infrastructures.

Rationale:

Due to materials used for construction of rural infrastructure, erosion occurs in soil structures after heavy rainfall especially in coastal area. Availability of rock material is limited, and consequently silt and sand materials are usually used for soil structures in such; road embankment, river embankment, and sea dykes. Sand and silt are well known about its non-cohesiveness material and they are erodible against rainfall. At the slope of embankment, glass plantation is effective to strengthen and protect from erosion. At the top of embankment, pavement is effective to weaken impact of raindrop in heavy storm. Asphalt pavement costs a lot but gravel pavement does not require so much budget. Taking into consideration these points, this project aims to strengthen soil infrastructures by using available and economical materials in and around rural area, and transfer such technology to rehabilitate it by villagers.

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

Expected Outputs	**Development Indicators**
・ All necessary strengthen works are completed. ・ Damaged and weaken embankment is rehabilitated. ・ Villagers can rehabilitate soil structures. ・ Project area map and design are formulated	・ Soil surface pavement: District Road; 35km, Communal Road; 210km ・ 100% of surface of district road is strengthened. ・ Rehabilitation plan of communal road is 100% carried out ・ Project design report

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Construction of embankment and rehabilitation are carried out. ・ Contractor for each project is selected. ・ rehabilitation works for communal road is carried out. ・ Necessary surveys and designs are done.	・ Total cost:24.3 million US$ ・ District Road: 14.9 million US$ ・ Communal Road: 9.4 million US$	MARD, Donors

Project Risk:

This project cannot deal with heavily damaged soil structures because it needs specific rehabilitation and treatment for proper function. On the other hand, simple work for strengthening soil structure can be done easily and promptly without waiting for construction companies which will require tenders and other complicated procedures. Small volume of construction work does not fit to apply such tendering works and sometimes quick strengthening and rehabilitation are necessary. Judgment on project demarcation between this project and others will be the key for this project implementation.

Environment Assessment (B):

Since this project is for strengthen and rehabilitation of soil infrastructures in rural areas, any environmental issues cannot be found for conducting assessment.

Project No.25

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 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.

Project No. a

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.

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

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.

Project No. b

Project Title	**Rural Water Environment Improvement Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	○	◎			◎	○	
Target Groups	Paddy farmers						
Implementing Agency	Environmental Observation Centre (Department of Natural Resources & Environment) , MARD-PPD (Plant Protection Department) and DARD						
Collaborators	-						

Objectives: To conserve rural water environment

Rationale:

Given that quantity of pesticide application at paddy fields is increased in these days, people have concerns about quality of their drinking water during the dry season, which is taken from water canals where irrigation water is drained. In this connection, the Center of Water Quality and Environment took water samples at three sites, namely, Ba Lai sluice (inside), An Hoa and Giao Hoa Chet Say in Ben Tre Province monthly from April to June, 2012. According to the results of water quality check, no phosphorus and chlorine agrichemical was not detected in all of the water samples, therefore, the people do not have to have much concern. It can be said that people have groundless fear due to the insufficient data and its publication and explanation. Therefore, to wipe out their worry, it is important to share the water quality check results and to promote their understanding. It is also necessary to make an effort to promote crop production at minimum chemical application to reduce adverse effect on the surrounding environment as much as possible.

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

Expected Outputs	**Development Indicators**
・ People reduce quantity of pesticide application without production decrease. ・ Water quality check of canals is implemented and the results are opened to the people regularly. ・ The people understand water quality of their drinking water. ・ The people can depend on canal water for domestic use.	・ Pesticide application is decreased by 10 %. ・ Regular water quality monitoring of major canals is implemented 2-4 times annually. ・ One-third people understand the situation of water quality of canals. ・ People who can depend on canal water for domestic use are increased by 20%.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Data collection of current chemical application ・ Dissemination of Implemented Pest Management (IPM) and Good Agricultural Practice (GAP) targeting farmers is promoted. ・ Regular water quality check is done. ・ All results of water quality check are opened to the people and sufficient explanation to promote their understanding	US$ 300,000 is required per year, and 2 year total cost is US$ 600,000. Most of the activities should be incorporated into the recurrent agriculture extension activities, so that additional costs are mostly for sampling check, and logistics for of IPM and GAP promotion.	DARD, MARD-PPD and Department of Natural Resources & Environment

Project Risk:

In this programme, it focuses on people's awareness and environmental friendly agriculture, which follows trend of the times and needs. The project aims at environmental conservation, therefore, there is a very low possibility that mood of people will change, which leads to project risks.

Environmental Assessment (C):

This programme aims to relieve people's anxieties in terms of their health and living environment and does not propose any construction which accompanies resettlement and land recovery, therefore, no environmental negative impacts by the proposed activities mentioned above are expected. The programme can improve not only their living environmental conditions but also eco-system in the paddy fields through decrease of pesticide application.

Project No. c

Project Title	**Low Input Agriculture Promotion Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
		●			○	○	
Target Groups	Paddy Farmers						
Implementing Agency	DARD, MARD						
Collaborators	Can Tho Univeristy,						

Objectives: To promote low input agriculture for minimizing the deterioration of water quality

Rationale:

An impact of climate change will appear as a form of deterioration of water quality. For example, protection of saline intrusion by gate control will hinder the movement of canal water, which will then impede the provision of fresh water. As a result, any matters in the water remain and be concentrated. Stagnant water also makes it difficult to dilute any materials such as acid water or alumni derived from sulphate soil. In fact, a questionnaire household survey revealed that 9% of the respondents had problem of alumni water in their well and a couple of respondents experienced a bad smells. The deterioration of water quality will be worsened by over application of agricultural inputs like fertilizer. In fact, paddy farmers in the area tend to apply considerable amount of chemical fertilizers to keep up the high productivity for two to three times a year. Over application of fertilizer coupled with stagnant water will threaten the quality of irrigated water and drinking water from wells. Therefore, in an expectation of climate change and resulted difficulty in water control, it is recommended to minimize the use of agricultural inputs, which will make the agricultural production systems more sustainable.

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

Expected Outputs	**Development Indicators**
・ Water quality is kept at an appropriate level. ・ Use of agricultural inputs, such as chemical fertilizers, is minimized. ・ Farmers have understanding about negative impact of the use of agricultural inputs ・ Low input sustainable agriculture guideline is prepared	・ An average amount of chemical fertilizer used in the area is reduced (80% of the original) ・ Water quality is kept within the range of national standard ・ Low input sustainable agriculture systems are introduced more than 80% of the target areas. ・ Appropriate extension modalities are identified (two effective modalities recommended)

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Uses of fertilizer are monitored. ・ Low input sustainable agriculture (LISA) is promoted through new extension modalities (radio broadcasting, TV program, and farmer field schools) ・ On-farm trials are conducted at pilot farms ・ Research on LISA is done at experimental plots ・ Guideline for fertilizer application coupled with other cultivation technologies is prepared.	A total of US$3,000,000 (US$1,000,000/year) ・ Chief advisor/ sustainable agriculture ・ Agricultural extension ・ Short-term experts as required (water quality, environment, marketing information education and communication)	MARD, Donors

Project Risk:

Farmers are always situated in making decisions for more profitable and stable agricultural production and marketing. The concept of low input and sustainable agricultural system is however more favored to conservation of environment widely surrounding the farmers' working places. Therefore, it is sometimes quite challenging to persuade farmers driving toward more broader and comprehensive concept for the future. As a result, farmers' behavior would not like to change until they see the actual problems by their own.

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.

Project No. d

Project Title	**Rural Small Scale Infrastructure Improvement Project**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	○		○	◎			
Target Groups	Villagers, especially the Poor						
Implementing Agency	DARD, MARD						
Potential Collaborators	International Donors (IFAD, ADB, WB, JICA)						

Objectives: To improve rural infrastructure for better service provision to the rural population.

Rationale: Climate change will intensify rainfall in future, resulting in not only wide spread flood originating in Mekong River but also localized flooding. Such floods will damage rural small scale infrastructure, e.g. commune roads and bridges. These infrastructure should be improved by means of asphalt/concrete paving, raising the embankment, upgrading the structure, etc. Also, paddy fields, fruit gardens, vegetable gardens as well as shrimp ponds will be damaged by the floods. Commune level drainage pumping stations may be required to drain out inundated water within a shorter time. Further, communes may need fund to construct sluice gates at tertiary level canals in order to prevent saline introduction into their areas. Hence, rural infrastructure improvement is due required in order to cope with future rainfall intensification, inundation intensification etc. under climate change.

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

Expected Outputs	**Development Indicators**
・ Public services to rural population are secured. ・ Rural people's livelihood is secured. ・ Rural infrastructure is protected by floods. ・ Farm lands are protected by saline intrusion. ・ Commune representatives are capacity-developed in identifying rural infrastructure project, preparing proposal for funding, etc.	・ Rural people's life is kept same as before. ・ Rural infrastructure stands against floods, whereby public services are kept under inundation. ・ Paddy production is kept same as before. ・ Fruit production is kept same as before. ・ Shrimp production is kept same as before.

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Tendering is done for designing and construction, whereby construction starts. ・ Project proposals are scrutinized, and approved for funding. ・ Commune or communes prepare for project proposal to acquire funding for the rural infrastructure. ・ Priority rural infrastructure are identified at commune level, e.g. commune road, bridge, small sluice gate, drainage pumping station, earthen band, etc.	One commune receives, as standard, maximum US$ 50,000 and in case there is inter-commune project, the maximum should be US$ 250,000 per project. Total fund required for 5 year term is 10 million US$ (US$ 2 million per year).	MARD, Donors

Project Risk: This project is meant to implement in Tra Vinh and Soc Trang provinces with the highest priority. These 2 provinces have relatively big number of minority ethnic groups, for example, the share of Khmer is 31.6% and 30.7% for Tra Ving and Soc Trang provinces respectively while the ratio in other coastal provinces ranges only from 0% (Tien Giang and Ben Tre) to 12.5% (Kien Giang) according to 2009 Vietnam Population and Housing Census. The project should consider these minority people, namely priority funding should be made in improving the rural infrastructure in those areas where the minority reside. Otherwise, social gap between the major ethnic group and the minority will be widened.

Environment Assessment (B): The components of this project are of small scale infrastructure, so that re-settlement will not be basically expected. However, new construction of earthen band to prevent floods, new construction of sluices at tertiary level canals, construction of drainage pumping stations will require land acquisition. The land acquisition shall be discussed within the commune and fully agreed between the land lease holders and the commune representatives, and necessary compensation shall fully be made in accordance with government regulation.

Project No. e

Project Title	**Crop Insurance Introduction Programme**						
Priority in Province	Tien Giang	Ben Tre	Tra Vinh	Soc Trang	Bac Lieu	Ca Mau	Kien Giang
	In common						
Target Groups	Paddy cultivation farmer, fruit cultivation farmers						
Implementing Agency	DARD, MARD						
Collaborators	International Donors, Private Insurance Companies, Ministry of Finance						

Objectives: To mitigate farming risk from unpredictable weather condition.

Rationale: Agriculture and fishery sectors are highly vulnerable to unpredictable weather condition. It appears that weather fluctuation has occurred more often than before because of the climate change. This condition leads to increase risk in farming in Mekong Delta. In fact, farmers in the village workshop pointed out that they feel weather pattern has fluctuated and it becomes more difficult to predict. For example, unexpected rainfall and flood have increased, and temperature has changed suddenly. In addition, agriculture in Mekong Delta is quiet diverse such as fruits farming, triple paddy farming, and combination of paddy and shrimp farming. This situation indicates that risk mitigation method at individual farmer's level is also important to correspond to this diversity of agricultural sector in this region. One of individual risk mitigation methods is to introduce insurance scheme against crop loss to be caused by climate change. Although there are few agencies which provide non-life insurance services to farmers and fisheries, insurance scheme has not yet been developed in agriculture and aquaculture sectors. Introducing effective agricultural insurance scheme is necessary for further development of agricultural sector in Mekong Delta.

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

Expected Outputs	**Development Indicators**
・ Farmers' resilience against natural disaster is enhanced. ・ Farmers' accessibility to insurance is increased. ・ Insurance scheme against climate change is identified (i.e. type of insurance and covering risks). ・ Improve capacity for crop insurance providers and insurance intermediaries	・ Number of insurance products for farmers ・ Indemnity amount for crop loss ・ Number of Insurance covering farmers ・ Number of local insurers which provide agricultural insurance

Major Activities with the Expected Outputs	**Total Cost (US$)**	**Expected Sources**
・ Needs assessment and situation analysis are conducted, and creating insurance business environment. ・ Designing insurance product and pilot testing are done. ・ Marketing of insurance product to farmers, strengthening insurance distribution channels, and enhancing farmers' insurance literacy. ・ Conducting risk assessments and insurance design with local insurers and holding capacity building workshops	Depending upon replication cycle of insurance product, and its target number of farmers. Two years replication expects US$1.5 ～ 2 million.	Donors, Private Insurance Companies

Project Risk:
There are three main concerns; lack of farmers' understanding toward insurance, lack of regulatory framework, and government policy direction. It will take time for farmers to understand the importance of insurance and how it works; thus, insurance literacy program is also necessary. Lack of regulatory framework is also one of the main concerns because premium rate, delivery channel, and other insurance business environment depend on specific regulations in the country. Creating appropriate business environment is a key to success. Finally the government should clarify policy direction regarding insurance scheme. Especially, subsidies and other government interventions are necessary to be reviewed.

Environment Assessment: (C)
No negative impact with expected

CHAPTER 5 PRIORITY PROJECT SELECTION

This Chapter 5 discusses the selection criteria about priority projects and those selected ones. Taking into account the results of vulnerability assessment on the climate change, results of in-depth studies, discussions with relevant officers, etc., total nine priority projects are firstly recommended as long listed projects. Out of the nine priority projects, total four projects are further elaborated as short listed projects at the feasibility study level (for the feasibility examination, see another volume of the Report), and the rests are presented at a conceptual planning level).

5.1 Priority Project Selection

5.1.1 Selection Criteria

In selecting the priority projects, following criteria should be considered:

1) Priority projects should be in accordance with those projects proposed and given higher priorities in the framework of the Master Plan of this Project,

2) Priority projects should primarily refer to those ones already identified/planned by relevant provinces as priority project, and also refer to the projects proposed in the water resources master plan 2011 (SIWRP),

3) Priority projects should primarily be of model, which represents measure(s) of adaptation to and/or coping with issues induced by climate change,

4) Priority projects should be planned in view of examining not only structural measures but also non-structural measures, and

5) Priority projects should be viable in financial term and economic term, and also justified from different view points, i.e. technical soundness, institutional soundness in the areas of operation and maintenance, social and environmental soundness.

Concerning the selection criteria No.1, the framework presented in the Master Plan is the core of the Plan where all the issues related to climate change are incorporated with proposed projects which are meant to adapt to and/or cope with the climate change issues. The framework also shows what projects should be implemented in which places whereby it can be a platform for not only the government but also development partners. The framework presents priorities by issue whereby by project, and also by province. Therefore priority projects should, at the first stage, be selected in line with the contents of the framework, especially with reference to those priorities attached to each project summarized in the framework.

The issues in the framework were in fact prioritized through government officers workshop, community level workshops and also with reference to the existing plans. The issue given the highest priority is Saline Intrusion, followed by Drought (or Fresh Water Lack), Sea Level Rise, Flood, etc. Therefore, priority projects are supposed to be the ones which can adapt to and/or cope with, e.g., saline intrusion, drought, sea level rise, and flood in its priority order in principal. The basic ideas of how to adapt to and cope with those issues are summarized in Table 5.1.1 below;

Table 5.1.1 Adapting and Coping Measures to Climate Change Issues

Issue	Adaptation Measures and Coping Measures
Priority 1; Saline Intrusion	1. Sluice gates should be constructed at the exits of channels and canals to Mekong River in order to prevent saline intrusion from coming into the inland areas. Since saline intrusion is coming up towards upstream of Mekong River over long period of time, one by one construction towards upstream shall be applied in keeping with the pace of the saline intrusion. 2. Saline intrusion becomes the severest in March and April, which fall in the end of dry season. This season is corresponding to latter stages of Winter – Spring paddy (heading, uniformity

	heading, and ripening periods). The paddy will be very much affected by the saline water intrusion. In order to avoid this situation, the paddy should be cultivated before that time, which means the paddy should be planted earlier than what is practiced now or otherwise short maturity variety, for example 90 days paddy, should be introduced instead of 105 – 110 days paddy. Note that one of the effects of climate change is to increase the rainfall at the end of rainy season, causing deeper inundation at around the end of rainy season. This deep inundation will delay the planting of winter – spring paddy, so that the option of early plantation of the paddy may not be possible. Also, another option may be to introduce saline tolerant variety of paddy, though the variety cannot compete in terms of the yield as other varieties (usually about 3 tons/ha is the common yield at maximum for such saline tolerant variety). 3. As an alternative option, farmers may prefer to introduce brackish shrimp cultivation utilizing saline water to come. During dry season, farmers where saline water intrusion takes place can cultivate the shrimp, and if the salinity level is high even during rainy season enough to keep shrimp growing, they can explore year-round shrimp cultivation. Otherwise, the farmers cultivate shrimp only during dry season while in rainy season they can put the fields back into rainy season paddy. This kind of rotational land use is already taking place in Mekong Delta's coastal areas.
Priority 2; Drought (fresh water lack)	1. As saline water is coming into inland area through channels and canals, the area will need alternative fresh water source for crop cultivation, which should be supplied from upstream areas still free from the saline intrusion. It means that facing the saline water intrusion, new intake point shall be arranged at an upstream area which is still free from the saline intrusion. Fresh water shall thus be ferried from the upstream area to the current paddy areas. 2. Fruits are known to consume less amount of water than paddy. Facing the fresh water shortage, therefore, the introduction of fruits trees or alternation from paddy to fruits trees can be one of the options of coping with fresh water lack. Fruits are generally very susceptible to salinity but coconut can be a little tolerant to salinity as evidenced in Ben Tre province. Fruits usually yield much higher profit than paddy, so that from the economic point of view as well, this option should be considered. However, note that in general soils in Mekong Delta are very fine and of silt and clay, so that by nature fruit production does not meet the soil characters in Mekong Delta.
Priority 3; Sea Level Rise	1. To cope with seas level rise, dykes should be constructed along with seashore line. Areas where tidal effect is not so strong, soil embankment can be applied with mangrove forestation according to the condition. Areas, on the other hand, where tidal effect is so strong and erosion is taking place, concrete structures to prevent seashore erosion should be considered. In addition, the river water level will keep up increasing corresponding to the sea level rise, so that topping up of the existing river banks and/or construction of the banks will be needed.
Priority 4; Flood (inundation)	1. Heavy rain during rainy season causes increasing of the water level of Mekong River, further causing large areas of inundation. This situation is worsened in combination with sea level rise. To cope with the flooding and inundation, river dykes should be constructed so that the flood from the River can be prevented. The river dykes should be connected to the sea dykes at the end points. 2. In some of the inland areas, long lasting inundation takes place; for example in Bac Lieu centre there is inundation when heavy rain falls at the same time of high tide. In Soc Trang province, there is an extent of lowland areas where inundation takes place during rainy season causing the damage to paddy cultivation. In Tien Giang province as well, it is reported that fruit gardens are affected by inundation caused by heavy rains. In order to protect the areas from those flooding and inundation, sluice gates which prevent high tide coming into inland areas, ring levees for the protection of lowland areas and also drainage facilities should be considered.
Priority 5; Rainfall (pattern change, intensification)	1. Rainfall pattern will change in future; for example the rainfall at the end of rainy season will much increase. The increase will work in deepening the inundation at the end of rainy season, which in turn will delay the planting of winter-spring paddy. The winter-spring paddy, if going into March and April, will also be affected by high temperature and saline intrusion which tend to take place in those months. To cope with these issues, the cropping pattern of winter-spring shall be changed or introduction of short maturity variety should be considered. 2. Farmers are reporting rainfall pattern change, e.g. heavy intensive rain tends to take place more often than ever. Intensive rainfall over shrimp cultivation areas would reduce the salinity level of the brackish culture ponds, whereby survival rate of shrimp will decrease. Standard design of those ponds may have to be changed to cope with the issue, for example deepening the depth of the ponds, e.g. in a form of trench along inside the surrounding levee. In addition, soil structures like earthen embankment, earthen rural roads, etc. should also be strengthened to cope with heavy rainfalls.
Priority 6; Temperature Rise	1. As reported, paddy yield decreases under high temperature especially during pollination period, in which 0.6 to 1.0 ton/ha of yield loss would take place by 1.0 Celsius degree increase over the condition of 35 Celsius degrees (seer reference 1). Also, the vulnerability assessment aforementioned found that approximately 10% yield reduction for winter-spring paddy would take place by 1.0 Celsius degree temperature increase. To avoid this yield reduction for winter – spring paddy, the cropping calendar should be moved earlier, or short maturity variety should be introduced. In addition, IRRI has invented a new variety, which flowers early morning time to evade from high temperature. Such new variety should also be considered.

	2. There is a report that yield of brackish shrimp will decrease by 0.7 ton/ha under 1.0 Celsius degree temperature rise in March (see reference 2). To avoid this shrimp loss, the water depth in this season should be kept deeper, so that the effect of temperature rise can hardly attack the shrimps. Also, more often water change is recommended in order to keep the water temperature moderate.

Source: JICA Project Team (Reference 1: Rice Production and Global Change: Scope for Adaptation and Mitigation Activities, R. Wassmann, SVK Jagadish, SB Peng, K Sumfleth, Y. Hosen, and Bo Sander, Reference 2: Impacts of Weather Variability on Rice and Aquaculture Production in the Mekong Delta, Dang Kieu Nhan, Nguyen Hieu Trung and Nguyen Van Sanh)

On the selection criteria No.2 above, projects in Vietnam are usually planned at the provincial level, in many cases, lobbied by local people who are facing some difficulties. Provincial DARD, for example, prepares project documents and submits them to the central MARD for approval. Upon approval, necessary fund arrangements for the succeeding stages, e.g., feasibility study, basic and detailed designs, implementation, etc, are to be made by the central government. DARDs have thus their priority projects which are also incorporated in the framework. The priority projects under this Master Plan should therefore refer to the priority projects already identified or planned by relevant provinces, whereby priorities at local level can be taken up.

With regard to selection criteria No.3, priority projects should be able to be a model whereby the approach and methodology to adapt to and/or cope with climate change issues can be replicated in other areas of the Mekong Delta. Though all the projects should be tailor-made taking into account the local conditions, there could be over-arching approaches and methodologies which can be applied to in adapting to and/or coping with climate change issues. Therefore, the priority projects should be selected from those candidate projects which can tackle prevalent climate change issues over extended areas.

Concerning the selection criteria No.4, most of the projects so far planned in the Mekong Delta and the Project area were based on structural measures, i.e. construction of sluice gates to prevent saline intrusion, improvement of canal bank to protect farmlands from flood, etc. Those structures have been well working; yet, there could be non-structural measures as well in which adaptation to the environment should be sought first rather than coping with. One of examples is brackish shrimp culture which is now well adapted in saline water intrusion areas. Changing the crops, introducing new crops, and also adjusting cropping patterns can be alternative measures in adapting to climate change. Therefore priority projects should take into account non-structural measures as well.

On the criteria No.5, priority projects should, of course, be feasible in terms of financial and economic aspects. The benefit accrued from the projects should be more than the project cost as an investment rule. EIRR should be more than that of opportunity cost in Vietnam, 12%. In addition, priority projects should be judged sound from technical point of view, institutional point of view, and social and environmental points of view. If negative impacts are to be expected, mitigation measures should be a part of the project.

5.1.2 Long Listed Priority Project Selection

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

As aforementioned, structural projects are further categorized into sub-sector targeted project and regional (area specific) project. If a project undertakes canal improvement, limiting the project

component to dredging, improvement of embankment and gate rehabilitation for example, in spite of the place where the canal is located, it falls into 'sub-sector' targeted project. This approach does not target a specific area but specific component. What comes first is the component, and whereby there are usually lots number of places where the specific component is to be implemented. This approach is in line with so-called sector loan approach or sector investment approach.

On the other hand, regional (area specific) projects are designed to target specific area on contrary that the sub-sector target project undertakes a specific component irrespective of area. An example is that if a project targets the improvement of paddy cultivation in a specific area by means of, for example, improvement of irrigation system and also introduction of saline intrusion prevention sluice gate, it is categorized as regional project.

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

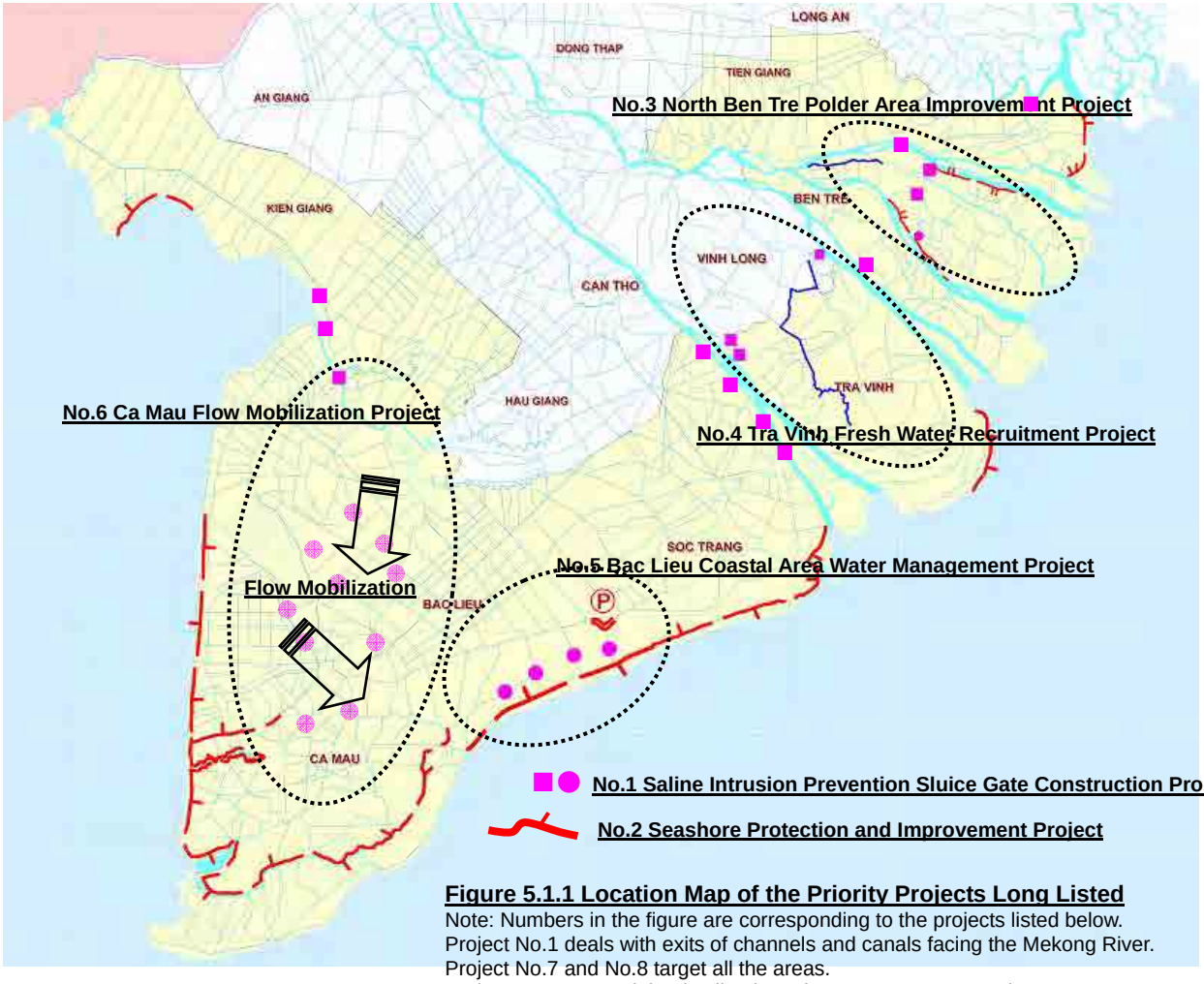


Figure 5.1.1 Location Map of the Priority Projects Long Listed
Note: Numbers in the figure are corresponding to the projects listed below.
Project No.1 deals with exits of channels and canals facing the Mekong River.
Project No.7 and No.8 target all the areas.
Project No.9 targets inland saline intrusion areas, near coastal areas.

Sub-sector targeted Project (Structural):

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

Regional Project (Structural):

3) North Ben Tre Polder Area Improvement Project
4) Tra Vinh Fresh Water Recruitment Project

5) Bac Lieu Coastal Area Water Management Project

6) Ca Mau Flow Mobilization Project (including water management non-structural measure)

Non-structural Project:

7) Cropping System Improvement Program toward Climate Change Adaptation

8) Capacity Development Project for Flow Water Management in Mekong Delta

9) Sustainable Shrimp Culture Promotion Program

5.1.3 Short Listed Priority Project Selection

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

Structural (Sub-sector and Regional project):

1) Saline Intrusion Prevention Sluice Gate Construction Project (sub-sector project)

4) Tra Vinh Fresh Water Recruitment Project (regional project)

Non-structural Project:

7) Cropping System Improvement Program toward Climate Change Adaptation

8) Capacity Development Project for Flow Water Management in Mekong Delta

Figure 5.1.2 refers to the Mater Plan framework, which in addition shows the relationship with the short and long listed projects. Note that regional project (area specific project) are usually so designed as to having several components, e.g. saline intrusion prevention sluice gate construction and also extending irrigation canal to upstream side for recruiting fresh water in lieu of existing water source being salinized. Therefore, exactly same titles of the regional projects do not show up in the framework but broken down in some components. Based on the relationship shown in the figure, following are briefed as the rationale why the above 2 structural and 2 non-structural projects are recommend as short-listed priority projects;

1) It is noticed that Saline Intrusion Prevention Sluice Gate Construction Project is given the highest priority amongst all the projects in the MP framework. Also, this project can be a major component of many regional targeted projects aiming at saline water prevention such as 1) North Ben Tre Polder Area Improvement Project, and 2) Tra Vinh Fresh Water Recruitment Project, both of which are long listed. There are still lots number of gate construction needs to prevent the saline intrusion as identified during government officers workshop as well as parts of the relevant provinces' priority projects. Therefore, the Saline Intrusion Prevention Sluice Gate Construction Project shall be selected as one of the short listed priority project, which will undergo feasibility level study in the succeeding stage.

2) Tra Vinh Fresh Water Recruitment Project is mainly composed of 2 components such as; 1) three sluice gates construction to prevent saline water intrusion, and 2) canal extension/ enlargement to recruit fresh water from an upstream area still free from the saline intrusion. The first component is corresponding to the above short listed sub-sector project (sluice gate construction). The fresh water recruitment, one of the 2 major components, is placed at the first position in the 2nd prioritized issue of Drought (or Fresh water lack) in the MP framework. Fresh water recruitment will be required in many cases where saline water prevention measure is put in place. Therefore, being a model of freshwater recruitment, this Tra Vinh Fresh Water Recruitment Project is selected as one the short listed priority projects (Note that since basic design of the canal extension for the project had been done by the Tra Vinh DARD, this Master Plan Project will review the component providing some modifications as required, and rather center on the

feasibility study on the 3 sluice gates.

3) Cropping System Improvement Program toward Climate Change Adaptation (No.7) is in fact a comprehensive program composed of 3 programs identified in the framework; 1) Cropping Calendar Adjustment/ Improvement Program (No.4 in the framework), 2) Salinity Tolerant Variety Development and Extension Program (No.5), and 3) Crop Diversification and Extension Program (No.25). Of the three, the first one 'Cropping Calendar Adjustment/ Improvement Program' constitutes of the major part of the program. This program therefore falls in the project group placed under the top priority issue of saline intrusion in the MP framework. Also, the major part of the program shows up not only in the 4th position of the project list in the framework but also in the 23rd and 24th positions of the list. This program will deal with agriculture related issues such as change of the paddy cropping schedule in order to avoid inundation to be worsened at the end of rainy season under climate change, to evade from saline water intrusion as well as high temperature showing up in late dry season, and introduction and/or development of new variety of paddy to adapt to climate change, etc. Thus, this program represents agriculture sector's measure in dealing with climate change, and also given high priority in the framework. It is, therefore, short-listed as one of representative non-structural projects covering agriculture sector.

4) Capacity Development Project for Flow Water Management in Mekong Delta (No.8) covers all the Project area, and is meant to contribute to well fine-tuning the water management related measures to adapt to and cope with climate change impacts over all the Project area. This project is placed at the top position among the project group dealing with common issues (see the bottom row of the development framework). The project will undertake water management issues not only in fresh water area but also saline area as well as mixed (brackish water) area, covering such issues of eutrophication control, early flood warning system, early drought and saline intrusion warning system, etc., which all contribute to enhancing the water management in the Mekong Delta under climate change. It is therefore that the project is selected as another representative non-structural project covering water resources sector.

5) There may be discussions on the North Ben Tre Polder Area Improvement Project, why not selected as one of the short-listed priority projects. This North Ben Tre project is given very high priority by the Ben Tre Provincial DARD as well as MARD, and seeking fund to implement varieties of components after the project approval by the central government in 2005. Major components are saline intrusion prevention sluice gates construction, river bank establishment, and canal enlargement/ rehabilitation. Of the major components, highest priority is given to the construction of sluice gates to prevent saline intrusion, which require the major part of the investment. Basic design for the sluice gates has been already done in 2008/2009, and whereby the priority sluice gate component can be reviewed under the 'Saline Intrusion Prevention Sluice Gate Construction Project' being one of the short listed projects. Therefore, though this North Ben Tre Polder Area Improvement Project is not selected as one of the short-listed projects, the major component, which is the sluice gate construction, will be undertaken under the short-listed project of Saline Intrusion Prevention Sluice Gate Construction.

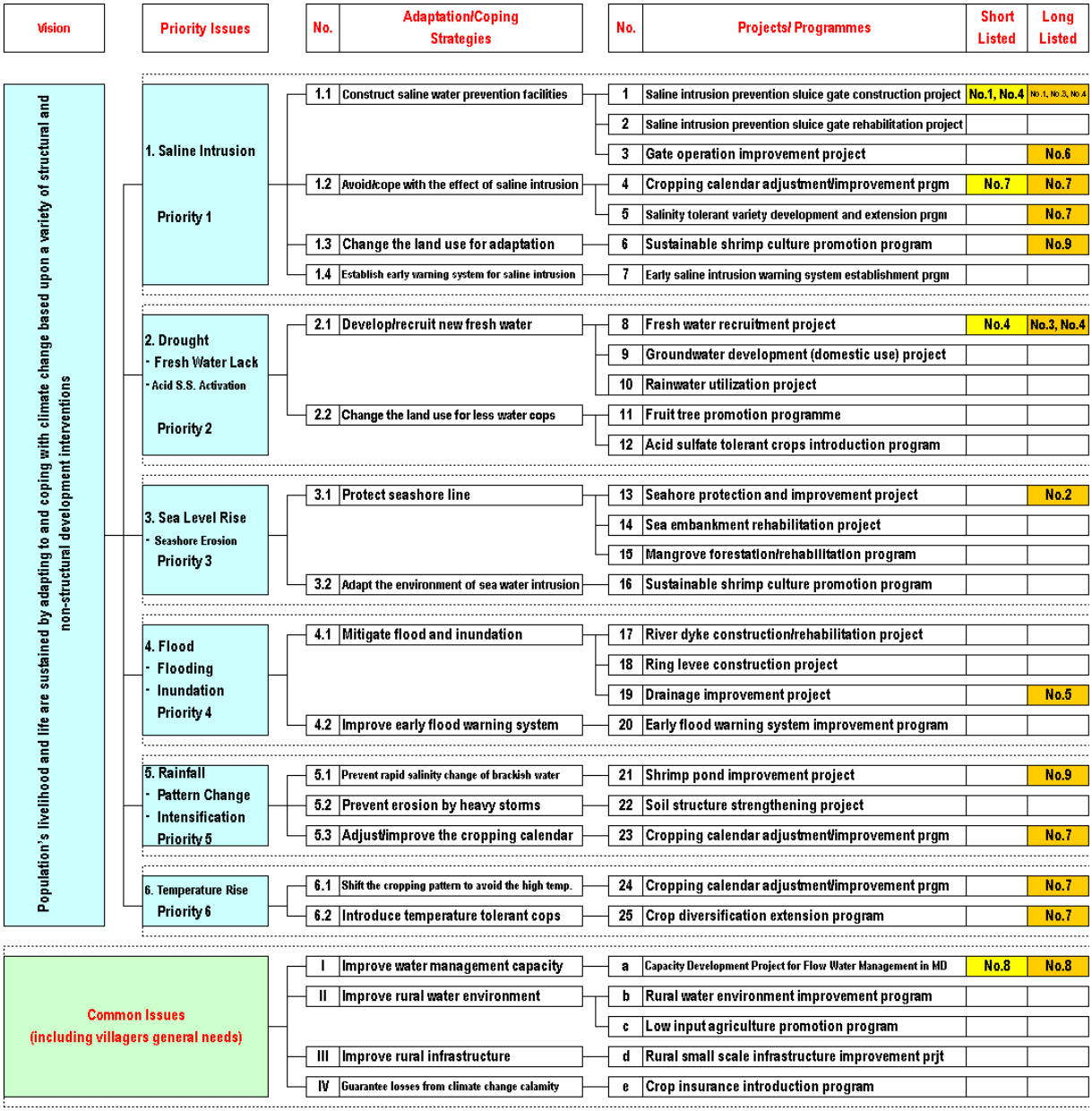


Figure 5.1.2 Relationship between MP Framework and Long/Short Listed Projects

5.2 Priority Project Description

As aforementioned, total 9 projects/programs were long-listed and of them 4 were further short-listed. Following are the brief description of all the long listed projects/programs, and in the next stage, the 4 short listed projects/programs are examined at feasibility study level (see another volume of Report, 'Priority Projects'):

5.2.1 Saline Intrusion Prevention Sluice Gate Construction Project (Sub-sector approach)

1) Present Status of the Area, and Rationale

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

dredging and canal embankment.

Being so, there is a lot of need to establish sluice gate, and in cases to rehabilitate existing sluice gates. In fact, saline intrusion along the Mekong River becomes severer over years coupled with sea level rise under climate change (see Figure 5.2.1 as an example of year 2050 with 30 cm sea level rise). The sluice gate shall therefore be installed one by one towards upstream of the River in keeping with the magnitude of the saline intrusion into inland areas, or saline intrusion will destroy the paddy field, fresh water aquaculture and fruits. Therefore, by bringing together all those sluice gates and by prioritizing among them, a sub-sector project which undertakes sluice gate construction/ rehabilitation is proposed as one of short-listed priority projects.

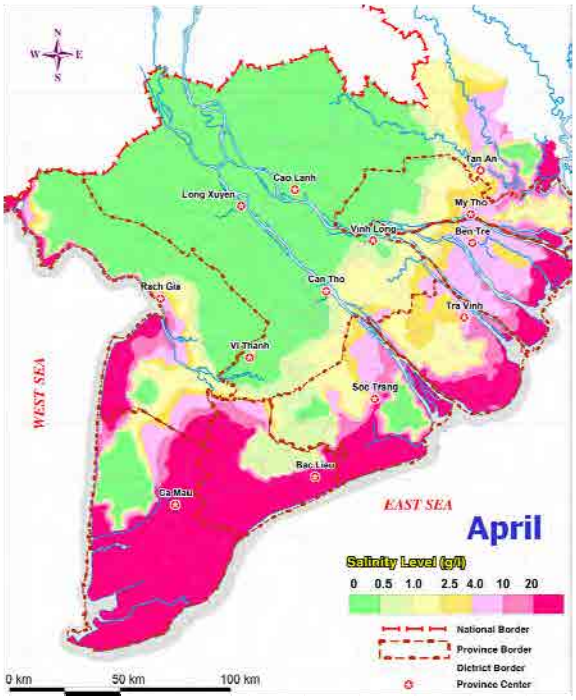


Figure 5.2.1 Intrusion of Saline Water with 30 cm Sea Level Rise expected in Year 2050

2) Major Project Component

Major project component under this sub-sector project is the sluice gate construction and in cases rehabilitation. Under this project, standard design with work quantities and cost estimation shall be prepared. Also with reference to the simulation results of saline intrusion under climate change, seamless construction schedule will be proposed over years according to the magnitude of saline intrusion.

For the design of gate, most conventional one applied in Mekong Delta is swing gate type sluice gate, which is operated automatically by the water level difference between front and behind the gate. This type of the gate is of simple structure and does not require power for the gate operation. Therefore the swing type will also be employed in this project as standard design. However, in some cases frequent operation of gate closing and opening will be required and in such cases this swing type gate can hardly cope with. Therefore, in addition to the conventional swing type gate, vertical sliding gate operated by motor will also be introduced under this project.

Left photo shows a typical sluice gate constructed in a canal to prevent saline intrusion from coming into inner lands, while the right photo shows a sluice gate constructed at the end point of a canal. The behind of the sluice gate is the West Sea, and this gate prevents sea water intrusion into the canal.

3) Expected Benefit

Sluice gates can protect fresh water livelihood such as paddy cultivation, fruit cultivation, freshwater

cultivation, and also they can reduce and mitigate inundation by stopping high tide from coming into inland areas.

5.2.2 Seashore Protection and Improvement Project (Sub-sector approach)

1) Present Status of the Area, and Project Rationale

The Vietnamese Government has been constructing sea dyke and allocating fund necessary for the construction of the dykes under Program 667[1], in cases, coupled with mangrove forestation. One of the priority projects that the coastal provinces think is sea-dyke construction in the context of climate change, e.g. sea-level rise as well as more frequent and stronger storms along coastal areas. Since seashore lien is long, say about 500 km for the 7 coastal provinces, there will be a great deal of works for the seashore protection and improvement including sea dyke construction. Since the work volume is very huge, this project can be implemented as sub-sector project.

2) Major Project Component

Major project component under this sub-sector project is sea dyke construction and in cases in conjunction with mangrove forestation. The sea dyke will need sluice gates in places where canals run open to the sea in order to control sea water intrusion. There are several kinds of sea dykes e.g., 1) earth embankment, 2) earth embankment with some protection work in the front, 3) concrete made dyke, 4) masonry (or gabion) made dyke, etc. Selection of the types is the most affecting factor in terms of the construction cost. Therefore, under this sub-sector project, the selection of the dyke type shall refer to the local condition whereby best suited seashore protection and improvement measures will have to be established.

3) Expected Benefit

Seashore protection and improvement project can protect the life and livelihood of the people who live in along the coastal lines. There are paddy fields in some places right down to the coastal line. These paddy fields are to be protected from saline intrusion, and also brackish shrimp culture can be protected too. Though the shrimp culture needs brackish water, the culture is directly affected by tidal fluctuation if there is no sea dyke with sluice gates. Bio-diversity will also be established especially when mangrove forestation is combined with.

Left photo shows a typical concrete strengthened sea dyke, and the right photo shows mangrove reforestation combined with wave dissipater constructed with concrete frame packed with stones.

[1] Program 667 is an approved project by the Government of Vietnam in May 2009 with the prime minister's decision of 667/QD-TTg. Under this project, construction and rehabilitation of sea dyke is directed covering up to 2010 over the country. The project is estimated roughly at US$ 1 billion, and most of the structure is earth embankment type.

5.2.3 North Ben Tre Polder Area Improvement Project

1) Present Status of the Area, and Project Rationale

North Ben Tre area is of polder area bordered by 2 big Mekong tributaries; Cua Dai and Ham Luong. This area is one of the most affected areas by saline water intrusion. As shown in the following figures, it is obvious that by year 2050 the almost whole Ben Tre province will be affected by high level of saline water, more than 4,000 PPM salinity level, in April. With the high level of salinity, fruits which are very famous product in this area (see right photo below) and also paddy will be seriously affected. In fact, the damage cost was estimated as the highest one among 7 coastal provinces based on the saline introduction simulation (see right figure below).

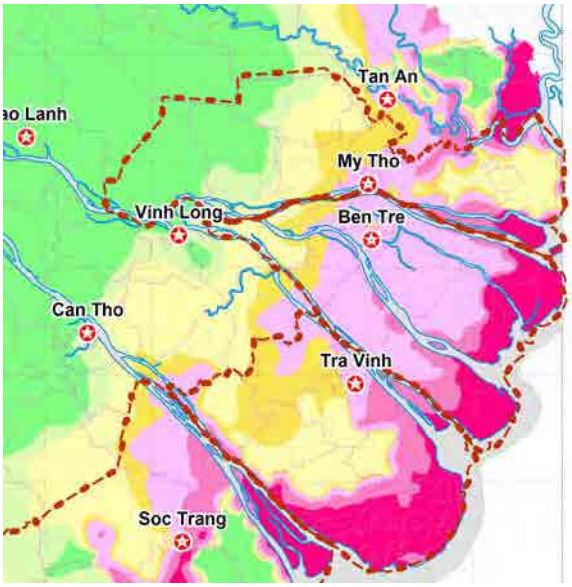


Figure 5.2.2 Saline Intrusion in April at Year 2050 with SLR 30 cm & DY 1998 MR Discharge

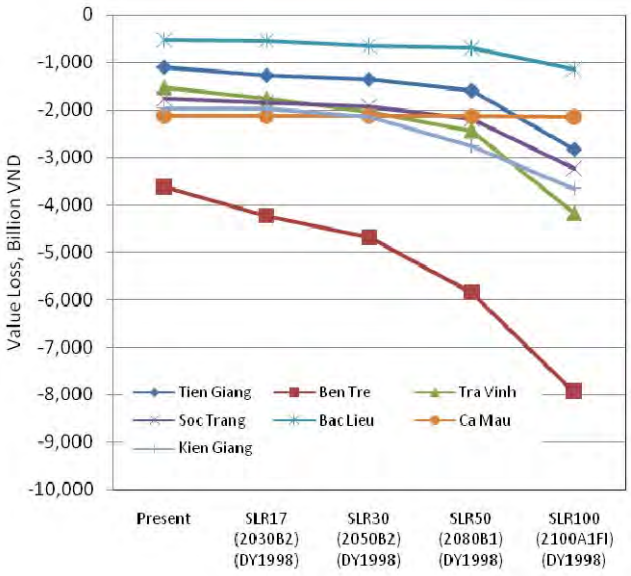


Figure 5.2.3 Damage Cost for Paddy, Vegetable, Fruit, and Tree at Year 2050 with SLR 30 cm & DY 1998 MR Discharge

Faced with saline water intrusion, the Government already constructed saline intrusion prevention sluice at almost end point of Ba Lai river flowing through the mid part of the North Ben Tre. Though the sluice gate has been working well to date, the saline intrusion is coming up combined with low flow of Mekong River and sea level rise. As the saline intrusion is coming up by year, the Government has constructed river embankment with some sluices along the river-lines facing the 2 rivers. However, the investment can not catch up with the saline water intrusion or the investment is simply beyond the financial capability of the Government.

Giao Hoa canal where a sluice gate is needed to prevent saline water from coming into North Ben Tre area

In northern and mid parts of Ben Tre province, there are lots of fruit gardens such as mango, citrus, durian, dragon, coconut, star apple, etc.

There are 2 big streams as Giao Hoa canal and Giong Trom river where large scale sluices are to be required. The width of the former sluice is estimated at about 130m (see left photo above) while that of Ben Tre sluice is about 70 m, further raising the investment cost. Also, water recruitment from further upstream side, e.g. from the most upstream point of the North Ben Tre polder area, is needed. Faced with the situation, the polder area needs associated interventions in order to cope with the saline intrusion.

2) Major Project Component

Project components are; sluice gates along the river-lines, 2 big sluice gates at the intake points of Giao Hoa canal and Giong Trom river, and canal excavation from the upstream point of the polder connecting Ba Lai river which is already under implementation as of 2012. Also, improvement, rehabilitation and new construction of river dykes along the 2 Mekong tributaries are required with sea dyke improvement. However, the river dykes and sea dykes can be implemented as stage-2 component given lower priority. Resettlement of the people may be required, who live at around sluice gate construction sites and also along the canal excavation area in the upper most reach of the North Ben Tre province.

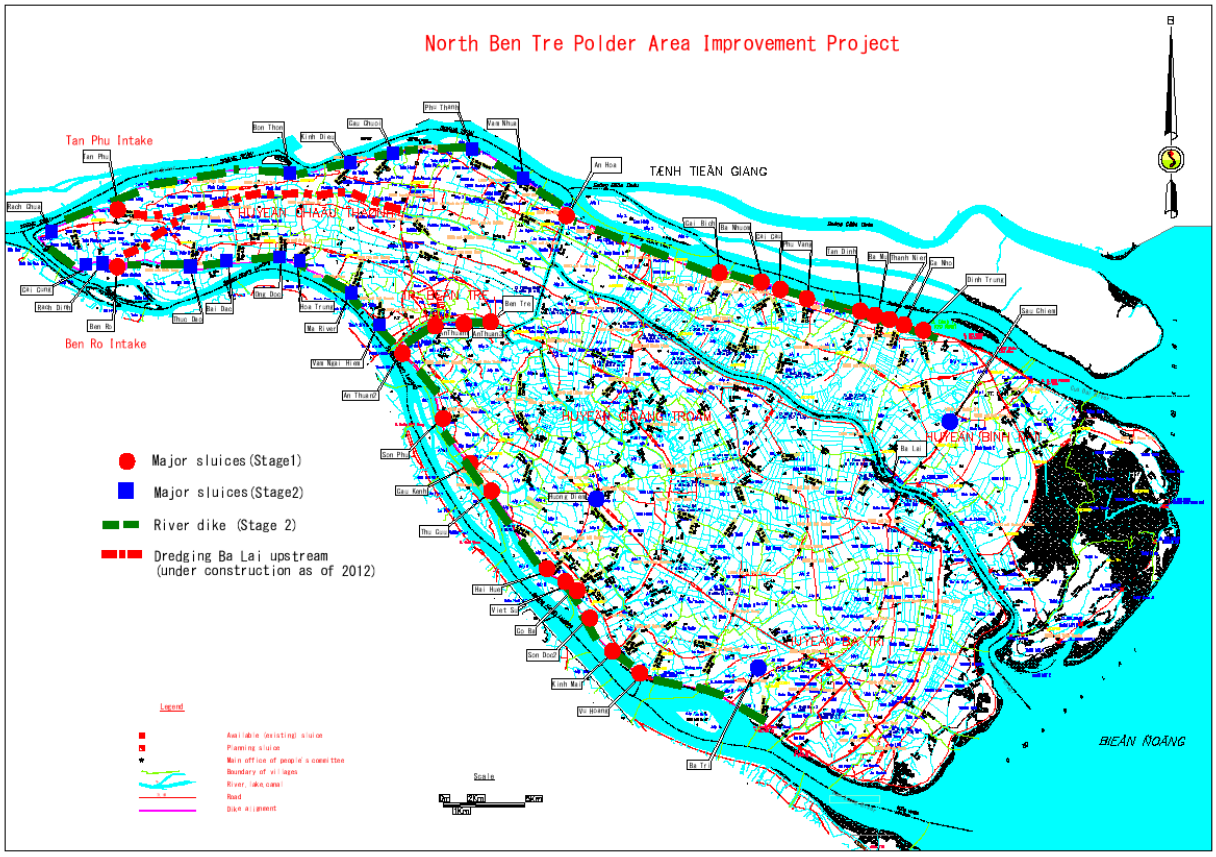


Figure 5.2.4 Plan of North Ben Tre Polder Area Improvement Project (divided in 2 Phases)

3) Expected Benefit

Ben Tre province is famous for its perennial crop production; coconuts and fruits including citrus, pomelo, mongo, dragon fruit, avocado, durian, mandarin, longan, star apple, pineapple, lemon, banana, rambutan, mangosteen, etc. These fruits are cultivated from the upstream tip to almost mid parts of the North Ben Tre with some paddy fields dotted in the fruit dominant area. From the almost mid part to downstream, paddy is mainly cultivated often combined with fresh water shrimp and fishes. Going further down to the seashore area, shrimp culture becomes dominant. The project is to protect the fruit production and also paddy production in the North Ben Tre polder area.

5.2.4 Tra Vinh Fresh Water Recruitment Project

1) Present Status of the Area, and Project Rationale

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

To protect the paddy area in the Tra Vinh province, construction of sluice gates at the mouths of channels (water supply and drainage canals) should be given the highest priority, and in fact there has been number of construction of sluice gates (see black circles as example in the following figure). In this province, there should also be canal extension towards upstream side, i.e. into Vinh Long province from which fresh water can be withdrawn not being affected by saline intrusion. The project should therefore be of combination of sluice gate construction and trans-boundary of fresh water recruitment, for which the freshwater is taken in the Vinh Long province and ferried to the downstream province, which is the Tra Vinh province.

2) Major Project Component

Project components are; sluice gate construction along the river-lines of Co Chien and Hau River to prevent saline intrusion into the paddy cultivation area of Tra Vinh province, and canal extension towards an upstream river in Vinh Long province from an existing major canal which runs within Tra Vinh province. There should be 3 sites where sluice gate is to be required in order to prevent the saline water intrusion; 1 at the Co Chien side and 2 at the Hau River side. The sites are called Vung Liem for Co Chien side and Tan Dinh and Bong Bot for the Hau River side. These 3 sites have been identified by the Tra Ving DARD but no survey was carried out so far. Therefore, necessary surveys including topographic survey and foundation survey shall be carried out as a part of the feasibility study.

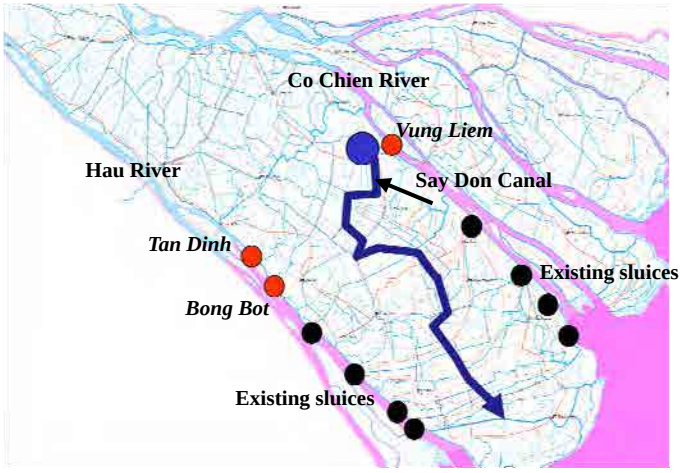


Figure 5.2.5 Conceptual Plan of Tra Vinh Fresh Water Recruitment Project

The fresh water recruitment point can be at downstream area of Vung Lien River in Vinh Long province where Vung Liem sluice gate is to be constructed. There is an existing water channel connecting Vung Liem River and canals in Tra Vinh province, called Say Don canal. The Say Don canal shall be enlarged in order to accommodate the fresh water required for Tra Vinh province. Basic design for the Say Don canal has already been done by Tre Vinh DARD in 2008. Therefore, the feasibility study on this Tra Vinh Fresh Water Recruitment Project will review the basic design of the Say Don canal, and rather center on the designing of 3 sluice gates.

3) Expected Benefit

Ben Tre province is famous for its three-paddy cropping in the upstream side and 2-paddy cropping in the mid to downstream areas of the province (further downstream area is dominated with shrimp culture). The project is expected to protect the paddy cultivation by preventing saline water intrusion

with 3 sluice gates and by recruiting fresh water from Vinh Long province.

Vung Lien river from which the fresh water is to be recruited. This river is located in Vinh Long province.

There are 2 and even 3 times paddy cropping areas in Tra Vinh province. The winter-spring paddy is now affected by saline intrusion.

5.2.5 Bac Lieu Coastal Area Water Management Project

1) Present Status of the Area, and Project Rationale

The coastal areas of the Bac Lieu province is not equipped with sluice gates yet in most of the channels. Therefore the area between the coastal line and the Kinh Ca Mau – Back Lieu navigation canal (or the national highway No.1 running along the navigation canal) is affected by tidal effect, causing acute fresh water shortage, inundation coupled with high tide, and also recruitment of much sedimentation coming from Ca Mau peninsula area (sand comes from Ca Mau peninsula area and gets into the canals in the area).

This situation further exacerbates the drainage condition of Bac Lieu center. In fact, Can Van Lan Street of the Bac Lieu centre is often inundated by 20-30 cm depth 2 times a month corresponding to high tidal time (source: Bac Lieu DARD). In addition, if the high tide is coupled with heavy rainfall (say more than 150mm per day), there will be as much as 50cm inundation within the centre once to as many as 5 times a year. To cope with this inundation situation and improve the water management for the sandwiched area between the East Sea and Kinh Ca Mau – Bac Lieu navigation canal, an intervention is required.

2) Major Project Component

Project components are; 4 major sluice gates along the coastal line of Bac Lieu province together with minor sluice gates to prevent high tidal sea water from intruding the area, embankment to protect Bac Lieu centre from inundation with improvement of existing drainage pumping stations or new additional construction of drainage pumping station(s). Dredging of existing canals is to be one of the components to rehabilitate the drain capacity. Also, navigation locks may be required in the Kinh Ca Mau – Back Lieu navigation canal (coming to the centre from western side) and also in the Rach Bac Lieu channel (coming to the centre from east side) in order to protect

One of the potential sites where sluice gate is to be installed. The sluice gate together with others is to prevent saline intrusion to the coastal areas.

Bac Lieu centre from inundation.

3) Expected Benefit

By controlling high tidal sea water intrusion, the shrimp culture practiced in the coastal areas of Bac Lieu province will be benefited. At present, during high tide specifically coupled with heavy rainfall, there happens that many farmers lose shrimp. When the brackish water in the area is well controlled with the help of sluice gates, they will improve the shrimp cultivation. In addition, Bac Lieu centre is to evade from inundation whereby economic activities and people's life will not be interrupted.

5.2.6 Ca Mau Flow Mobilization Project (including water management non-structural measure)

1) Present Status of the Area, and Project Rationale

Ca Mau peninsula can hardly receive fresh water from Mekong river (Basac river) since it is located furthest away from the river. Due to the fresh water shortage, there are a lot of brackish shrimp cultures in this peninsula. Though shrimp culture can bring about high income, it on the other hand is associated with high risk of diseases. Some farmers reported once in every 2 – 5 years, they have to face at least 20 percent to as much as almost total loss due to some diseases e.g. white spot virus, yellow head virus, etc.

One of the key issues to reduce such disease is to mobilize water circulation in order to prevent the waste emitted by shrimp culture from being settled in one place causing water pollution. It means that when the water is very static and dormant, the shrimps tend to get diseases and once it occurs, the diseases can infect all along the neighbor shrimp ponds. To reduce this risk, there should be mobilization of the water flow.

2) Major Project Component

Major project components are small to medium size sluice gates along canal networks with gate operation rules. In this area, sea water comes from western side of the peninsula and from the eastern side almost at the same circulation period according to the tidal fluctuation. When all those gates installed along the canal networks are to be operated one by one from one side (e.g. western side) to the other side (e.g. eastern side), one way water circulation may be established. In this regards, gate operation rule with monitoring system will be the key in this project.

In addition, Cai Lon sluice gate may be one of the major components of this project. Cai Lon river runs north of Ca Mau province wherein the Government has a plan to construct a big sluice gate in order to prevent sea water from coming into upstream paddy areas. The Cai Lon sluice gate is designed to be 390 m width. This sluice gate works not only in preventing sea water from intrusion but also in raising the water level in front of the gate. If the water level in the Cai Lon river is kept higher than the present, there may occur water mobilization from this Cai Lon river towards its south direction. Thus flow mobilization may be facilitated by this Cai Lon sluice coupled with the serious of gate operation aforementioned.

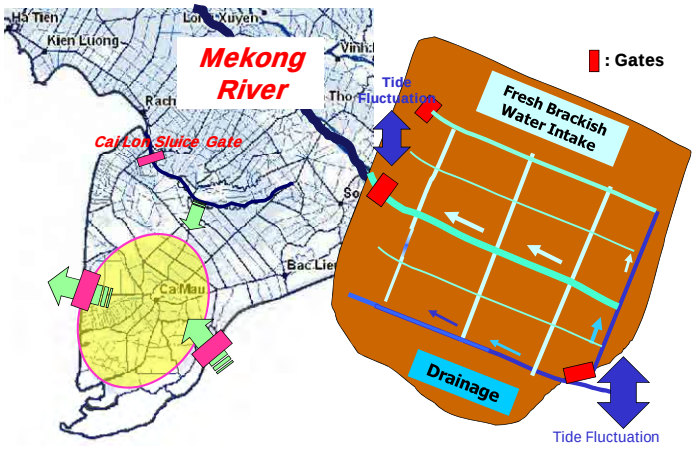


Figure 5.2.6 Conceptual Plan of Ca Mau Flow Mobilization

3) Expected Benefit

Shrimp farmers can reduce shrimp diseases whereby they can fetch more and/or stable income. In Ca Mau province, there are as much as 299,100 ha for aquaculture (Statistical Year Book, 2011, GSO), of which most areas are devoted to brackish shrimp culture. The production of the shrimp arrived at as much as 103,900 ton in 2010 (Statistical Year Book, 2011, GSO). If flow mobilization is established in this area, a great deal of benefit will be brought about to the shrimp farmers.

Shrimp culture is categorized into intensive and extensive culture, and further the intensive into semi-intensive and commercial intensive. The left photo shows commercial intensive culture while the right photo shows semi-intensive culture.

5.2.7 Cropping System Improvement Program toward Climate Change Adaptation

1) Present Status of the Area, and Project Rationale

Climate change increases the temperature, makes unstable the early rainy season's rainfall pattern, prolongs the rainy season, brings about some rainfall during winter season, causing sea-level rise inviting saline intrusion along the Mekong River according to simulation results carried out by MONRE and under this Master Plan project. The change of rainfall pattern in the rainy season will have to change the rainy season's cropping pattern. Saline intrusion usually takes places from March to late April. If there is still paddy in the fields (winter-spring paddy) waiting for harvest, it will be affected by the salinity. In order for the paddy to avoid the damage from saline intrusion, the winter-spring paddy growing season should be shifted. Thus, improvement on the present cropping system should be introduced based on experimental researches and through an agriculture extension programme.

2) Major Project Component

Major components of this project are 'experimental researches' and 'agriculture extension activities' through which appropriate adjustment of cropping patterns are to be developed and introduced. As indicated in the following figure, major improvement of the cropping system is to 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.

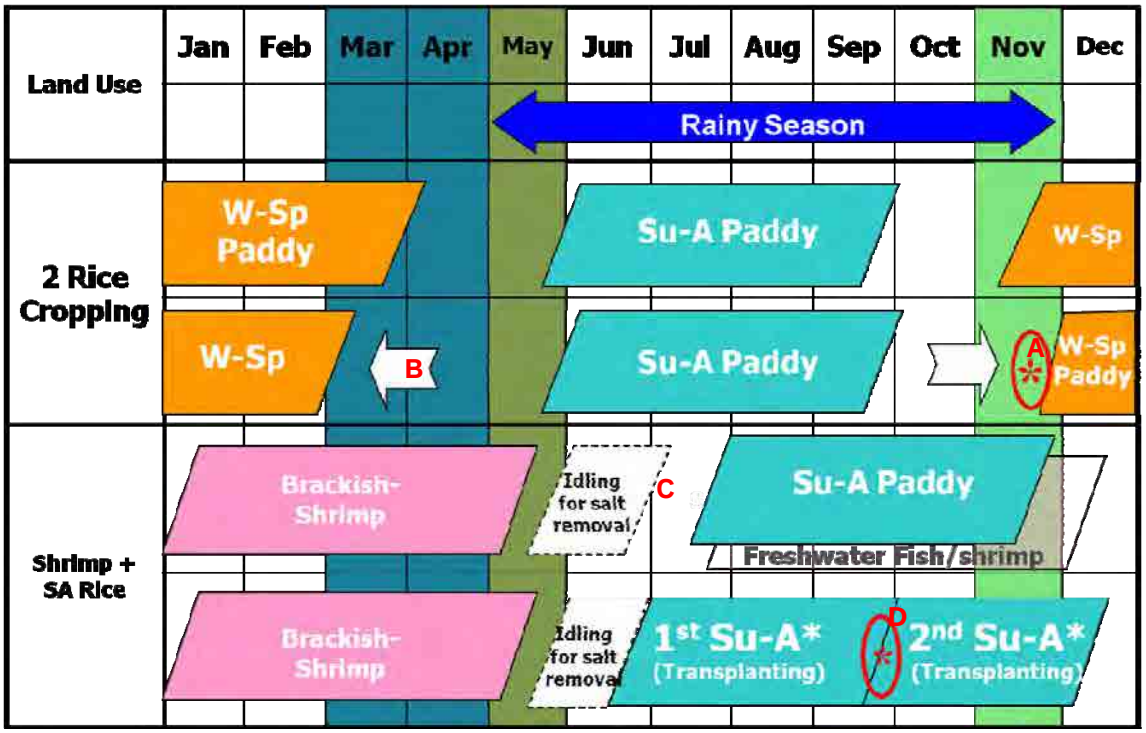


Figure 5.2.7 Recommended Adjustment for Cropping Patterns, Source: JICA Project Team

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. 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 be included in this program. 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 in an experimental plot.

3) Expected Benefit

Rainy season paddy and dry season paddy can be benefited by evading from the negative impact of climate change. Also, farmers who have introduced shrimp culture during dry season can benefit from the shrimp culture.

5.2.8 Capacity Development Project for Flow Water Management in Mekong Delta

1) Present Status of the Area, and Project Rationale

Hydrological and hydraulic data such as water level, flow velocity, flow rate, water quality and salinity in Mekong Delta are measured at some stations. However, these are sometimes not accurate; the result of observation can not be obtained immediately on time; the number of observation points is not enough to use for actual water operation. Therefore, new observation and analysis technology shall be installed to obtain accurate and real time data to improve the precision of water resources management and to enhance the capacity for establishment of water resources management plan.

Furthermore, early warning system for flood, drought and saline intrusion shall be established through utilization of real time observation data and also satellite observation data. Capacity for flow water management shall therefore be strengthened through examination of effective operation of barrages and sluice gates which are planned to install in near future. This project is to be carried out at an institute responsible for water resources management in the Mekong Delta, e.g. SIWRP and the output shall be shared with all the DARDs in the Delta.

2) Major Project Components

This project recommends following 5 components;

1) To utilize Doppler current meter, real time water gauge and salinity sensor to enhance capacity of planning for water resources management,
2) To enhance capacity for analysis of eutrophication and eutrophication control planning,
3) To enhance capacity for detailed analysis of water quantity and quality and water resources management planning in fresh water and saline water mixing area,
4) 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, and
5) 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.

3) Expected Benefit

Expected benefits are corresponding to above components; namely, 1) capacity of establishing flow water management plan will be enhanced, 2) capacity of analyzing eutrophication and planning of eutrophication control will be enhanced, 3) capacity of detailed analysis and planning of water quantity and quality in fresh water and saline water mixing area will be enhanced, 4) capacity of flood runoff and inundation analysis and early flood warning are to be enhanced by using satellite images, remote sensing data and real time data, and 5) capacity of low flow runoff analysis and saline intrusion analysis and drought and saline intrusion warning will be enhanced by using satellite images, remote sensing data and real time data.

5.2.9 Sustainable Shrimp Culture Programme

1) Present Status of the Area, and Project Rationale

Along the coastal areas, there are already lots of shrimp farms which are mostly extensive culture and to some extent family-level intensive and commercial level intensive culture. Shrimp culture can be a good and profitable adaptation measure to saline intrusion. As is well known, however, shrimp culture is associated with high risk of diseases especially such as acute hepatopancreatic degenerative necrotic syndrome (AHDNS) which provides a cause of mass mortality of shrimp, an epidemic in the Mekong Delta Area for shrimp.

In addition, it is anticipated that rearing environment such as water temperature and salinity level will be changed due to the climate change. In fact, with reference to the past records of temperature, the rate of increase was about 0.7 ^{o}C for annual mean over the period of about 30 years. According to simulation, 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. Salinity intrusion would be severe according to the sea level rise which are expected to increase by 31 cm at year 2050 and as much as 103 cm at year 2100 under scenario A2. These changes are to affect rearing environment for shrimp.

In fact, there is no measure found to cure the shrimp disease AHDNS at this moment though lots number of researches are under way. Therefore, it is recommended to expand the extensive shrimp culture, not pursuing intensive culture, since extensive culture could be away from the influence of diseases at least to some extent. In addition, following measures for improving present situation is required for sustainable development of shrimp culture in Mekong Delta.

- ✓ Developing / modifying extensive culture methods to adapt to and cope with the impacts of climate change,
- ✓ Improving disease diagnostic system to decrease the risk of disease, and
- ✓ Organizing the farmers into cooperative groups and then strengthening the organizational skills of shrimp farmers.

2) Major Project Component

Major components of this project consist of three parts such as:

- ✓ Conversion from paddy farm to shrimp ponds including introduction of new / modified extensive culture methods according to the saline intrusion,
- ✓ Strengthening the disease checking capacity of DARD laboratories, and
- ✓ Promotion of shrimp farmers' cooperatives.

Conversion of paddy field to shrimp firm is conducted with introduction of new/ modified extensive culture methods such as; 1) paddy-shrimp culture, 2) nursery pond introduction, and 3) mangrove-shrimp culture for farmers who have to convert their paddy field to shrimp farm due to the saline intrusion. One of the examples of paddy-shrimp culture is shown in the following photos. As shown in the photo left, shrimp is reared during dry season and then the salt accelerated during the shrimp culture is to be washed away by rainfall, following which paddy is planted as shown in the right photo. This rotational cultivation would give less negative load on the rearing environment, whereby sustainable culture could be promoted.

Left photo shows a paddy-shrimp farm plot after the shrimp has been harvested and is now washed away salt by rainfall, waiting for rainy season paddy cultivation. Shrimp stays in the ditch during hot hours of day. The right photo shows the rainy season paddy, and the ditches along the embankment is now filled with water, and sometimes fresh water fishes are together cultivated.

Figure 5.2.8 shows introduction of nursery pond, one of improved extensive shrimp culture. This improvement can be applied not only for extensive shrimp cultivation but also for shrimp-paddy rotational farming. Small area in the figure shown in below is for the place of larvae or finger shrimp. Density of shrimp is about double of large area for adult shrimp shown in below. The advantage of this arrangement is that larva affected by virus does not affect adult shrimp because they can separate each other. Note that if water in canal is affected by virus, however, this arrangement can not be effective as a matter of course.

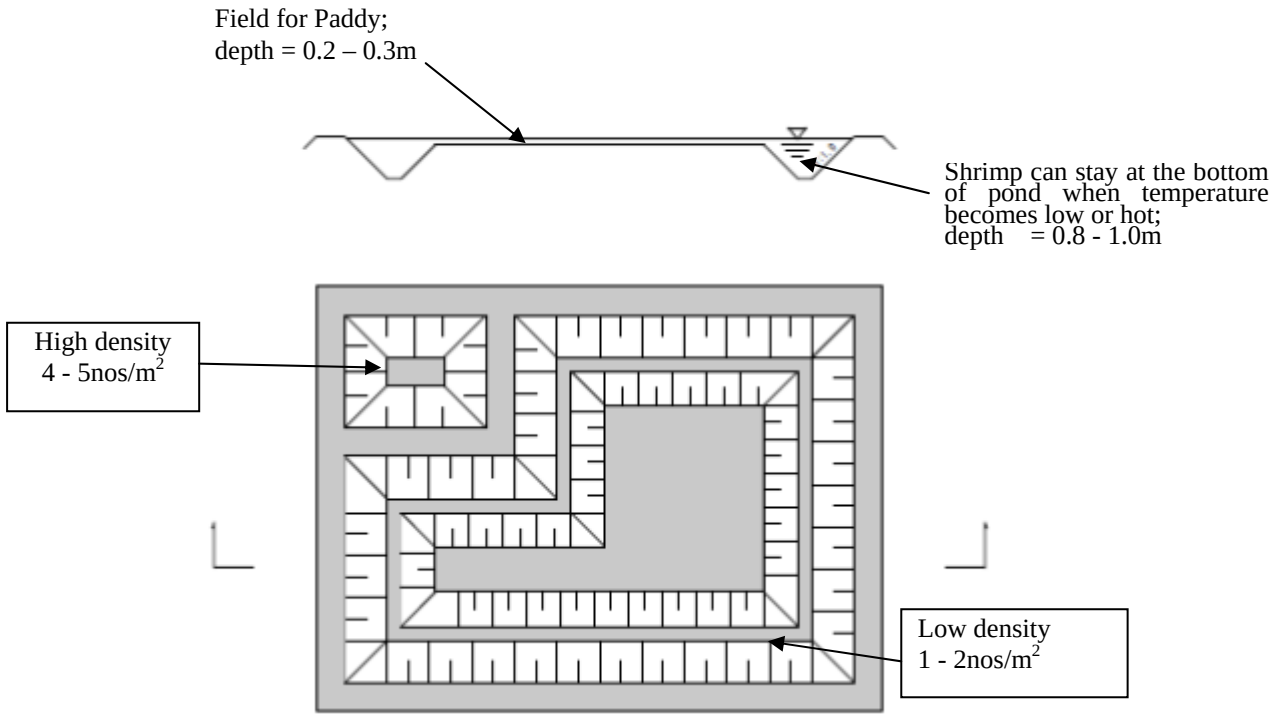


Figure 5.2.8 Typical Cross Section for Improved Shrimp Farming (up) and Plan (below)
Source: Research Institute for Aquaculture No.2

In dry season, it is known that sudden wind in night cools down not only air temperature but also water surface temperature. According to research results obtained from Research Institute for Aquaculture No.2, lower-down of air temperature becomes a trigger for decrease of saline water content and the temperature. Surface water temperature goes down together with the air temperature but water at medium and bottom depth does not change much. About 1 m of pond depth is enough for this purpose and shrimp can escape from the low temperature (see the trench parts shown in Figure 5.2.8).

There is advantage on this method; phytoplankton can grow well under high temperature at the shallow water depth of paddy field, which is located at the center of pond. Increase of phytoplankton results in well-grown and increase of zooplankton since phytoplankton is the feed of zooplankton. Shrimp grows by taking zooplankton. Keeping this food cycle is advantage for this improved pond and it gives good result for shrimp farming.

There is one more improved extensive shrimp culture; mangrove - shrimp culture (see photo right). It is

Mangrove and shrimp culture where shrimp can escape from sunshine and high temperature thanks to the mangrove.

supposed that rearing condition in the shrimp pond will be worse e.g. by increasing temperature. Therefore, it is recommended to modify the pond design to retain the good rearing condition. Modification of pond design i.e. making evacuation spaces (shadow area aside from deeper bottom, etc) from high temperature water should be considered for improving the rearing condition. For instance, mangroves in the rearing pond functions as sun shade. It also contributes to rehabilitation of coastal forest zone.

On the appropriate disease diagnosis, DARD laboratories should be strengthened. More appropriate disease diagnosis by DARD laboratories can reduce risk of mass mortality. DARD laboratories have already adapted polymerase chain reaction (PCR) test to screen seed for major pathogens prior to stocking of ponds. However, some hatcheries sell seed without disease investigation by DARD laboratories although the investigation is obliged by a regulation.

In addition, some laboratories have conducted disease investigation by observation only due to limitation of the capacity. There is also no investigation service for drag resistance although intensive / semi-intensive farmers use antibiotics against bacterial diseases. In consideration of these situations, diagnostic service should be strengthened and also drug resistance test for bacterial diseases should be conduced in order to secure the sustainable development for shrimp culture. Diagnostic equipment required are shown in Table 5.2.1 as an example:

Table 5.2.1 List of Required Equipment per Provincial Laboratory

Equipment	Estimated cost (US$)
PCR (including reagents)	130,000
Homogenizer	10,600
Incubator	7,500
Autoclave	10,000
Total	158,100

Source: JICA Project Team

In addition, seed quality will be improved through the introduction of group purchase of seed by the shrimp farmers' cooperative since DARD laboratories could provide diagnostic service to the cooperative more effectively. Cooperative activities such as group procurement and group shipping improve the efficiency of shrimp farmers works. It also contributes to sustainable development of shrimp farming.

3) Expected Benefit

It is expected that the procedure for converting paddy field to shrimp pond will be clarified with the introduction of suitable extensive culture methods which alleviate the negative impacts of climate change (i.e. paddy-shrimp culture, mangrove-shrimp culture, etc). In addition, effective disease monitoring to decrease the risk of diseases is also developed. Shrimp farmers who convert their job to shrimp culture due to impacts of climate change can benefit from this program by starting their new business smoothly and more effectively.

Shrimp farmers can also benefit from their cooperative works as well. As aforementioned, DARD laboratories can hardly deal with individual shrimp farmers for, e.g. checking the disease for shrimp seed. However if the farmers form cooperative and practice mass purchase, the DARD laboratories could provide their services for the shrimp farmers to procure disease free seed. Cooperative members can purchase certified seed through the cooperative purchase. In addition, stable farm gate price of shrimp would also be expected when cooperative make contract with processing factories.