

GHG appraisal of Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (MD-ICRSL)

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Background

This working document does provide the results of an EX-ACT GHG appraisal of Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (MD-ICRSL) done with MD-ICRSL team during the EX-ACT workshop organized by FAO and World Bank from 14 to 17 June 2016 in Hanoi.

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance

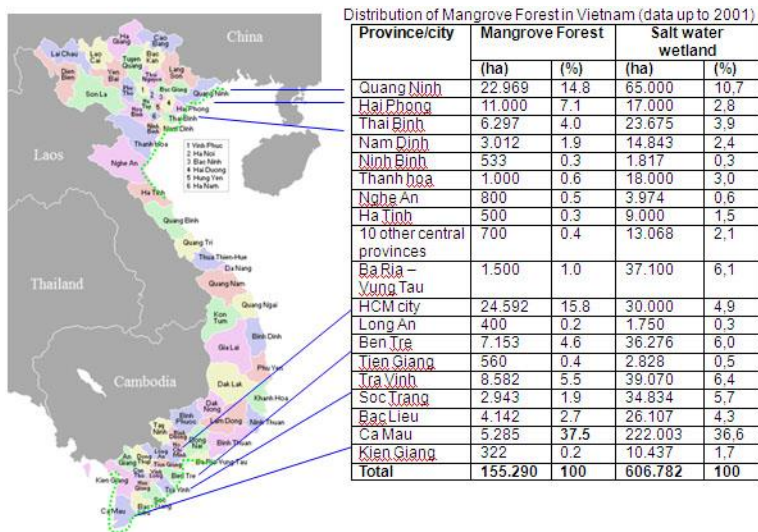
Mekong Delta situation and Mangrove restoration

Political and economic reforms (Doi Moi) launched in 1986 allowed Vietnam to decrease poverty from 60 % of the population down to 10% during the period 1990-2013. The Mekong delta, home of 22% of the population, was and still is one of the regions contributing significantly to the development of Vietnam, providing to 50% of the rice production and 70% of the aquaculture product.

Salinity intrusion into the delta estuary is reducing agricultural productivity and leading to dry season freshwater shortages. Tidal fluctuations drive saline intrusion more than 80km inland, affecting 40% of the Mekong Delta. Seven provinces are highly prone to saline intrusion, including: Kien Giang, Tra Vinh, Ben Tre, Soc Trang, Ca Mau, Bac Lieu and Long An, with more than 1 million hectares experiencing salinity concentrations above 4g/L. Each year the situation is different, depending on the magnitude of the previous years flooding, the ability to supply fresh water upstream in the dry season, the production level of Summer-Autumn paddy and the onset of the rainy season.

Expected sea level rise will further increase salinity levels in the delta's river branches and its water network. Water control infrastructure has been constructed in coastal provinces to control salinity intrusion into the estuaries. Saline water is prevented to enter the canals by the construction of sluices that can be closed when the seawater rises with the tide above river water levels. Balancing the needs of freshwater agriculture and brackish aquaculture is required to effectively adapt to salinity intrusion in the delta estuary. Investment in large water control infrastructure for salinity intrusion will have far-reaching and long-lasting

impacts on the delta system. Aquaculture area and aquaculture and shrimp production has increased in the delta estuary from 1995 to 2013 while fruit crops decreased. Furthermore, coping with dry season fresh water shortages and droughts and securing fresh water supply is a critical challenge for the delta estuary



Located within the tropical monsoon belt, Vietnam is extremely vulnerable to climate change, particularly to increases in storm intensity and sea level rise. Vietnam's built experience on adaptation approaches for protecting coastal infrastructure from sea level rise. It used mangroves as an adaptation approach. Large-scale

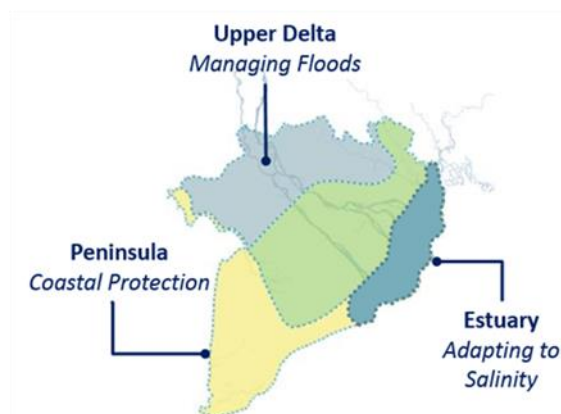
mangrove restoration and rehabilitation has been institutionalized as key adaptation interventions in Vietnam, with very different results in the north and south (Powell, Osbeck, & TanSinh, 2010).

In the North, mangroves have been planted primarily to protect the coast from sea level rise and storms, without giving local inhabitants user rights. This has magnified conflicts of interest over claims to coastal wetlands between the lucrative shrimp aquaculture industry and mangrove plantations. Marginalized members of society have been displaced, in particular women dependent on access to the coast to harvest non-cultivated seafoods, such as clams and crabs.

In the South, mangrove restoration and rehabilitation has been designed more as a multi-functional approach to alleviate poverty and diversify livelihoods. Rather than just being monocultures as in the case of the North, many plantations are both species-rich and exist under a number of different land-use arrangements. Under such conditions, mangroves can provide a host of ecological goods and services as well as livelihood benefits. One such project that reflects this character is the Coastal Wetlands Protection and Development Project, Mekong Delta (1997-2007). In this project, mangrove plantations have been established with the objective of providing protection and increasing ecosystem goods and services such as aquatic resources.

Project objectives and components

The complexity of issues in the Mekong Delta covers a range of sectors, temporal scales and divergent institutional and policy landscapes, which make difficult to plan for and build resilience in this region. The project development objectives (PDO) is to enhance tools for climate-smart planning and improve resilience of land and water management practices in selected vulnerable provinces of the Mekong Delta. The project will support information systems, institutional arrangements and the roadmap for building provincial and district-level planning capacity for sustainable development of the Mekong Delta (component #1, table 1). Overall, the project targets An Giang and Dong Thap in the upper Delta; Ben Tre Tra Vinh, Vinh Long and Soc Trame in the delta estuary; and Ca mau, Bac Lieu and Kien Giang in the coastal peninsula.



Project components	Project cost (US\$ million)	%IDA financing
#1 Enhancing monitoring, analytics and information systems	61.3	92.1
#2 Managing floods in the upper delta	101	78.2
#3 Adapting to salinity transitions in the Delta estuary	109.3	75.1
#4 Protecting coastal areas in the Delta Peninsula	101.3	81
#5 Project management and implementation support	14.5	75.1

The project will address challenges related to seawater intrusion, coastal erosion, sustainable aquaculture and improved livelihoods for communities living in these coastal areas. The related activities will be construction of **coastal defenses**, support farmers to **transition to mangrove-shrimp farming, rice polyculture** (shrimp, fish, cash crop), support modification of water and coastal infrastructures along the coastal zone in the **Delta estuary** and the **Coastal peninsula**. In the **Upper Delta** will prioritize **freshwater management** to reduce groundwater abstraction for agriculture and aquaculture, modernization and increased sustainability of aquaculture and rice cultivation by adopting polyculture based systems. Project activities are estimated to directly benefit over **1.2 million people** living in these provinces on an estimated around 110,000 ha.

The main activities of the project are therefore

1. **Mangrove restoration**/ coastal protection- These activities aim to restore coastal landscapes to enhance resilience of inland farming systems, reduce vulnerability to the impacts of sea-level rise and coastal erosion. These would include non-structural measures, such mangrove rehabilitation and restoration.
2. **Improving water resources management** on areas that would be more suitable as fresh water zones for rice or fruit/horticulture
3. **Supporting agricultural/aquaculture systems adaptive and resilient to saline intrusion.** These activities would aim to improve sustainability of shrimp farming and promote greater rotation/diversification farming systems



Project Data

The appraisal is done using tropical moist climate and LAC Soils. The GHG analysis is conducted on 20 years for a project area of around 110300 ha with 67000 ha or irrigated rice partly used for aquaculture, and 21000 ha of mangrove areas and others 21000 ha already used for shrimp aquaculture.

Some marginal deforestation is planned to build wood aquaculture and water channeling small infrastructure while afforestation is planned for future wood needs

EX-ACT screenshot 1: Deforestation and afforestation module

2.1. Deforestation						
?	AEZ map	Zone 1 = Tropical rain forest	Zone 2 = Tropical moist deciduous forest	Zone 3 = Tropical dry forest		
Type of vegetation that will be deforested	HWP# (tDM/ha)	Fire Use? (y/n)	Final use after deforestation	Forested area (ha)		
Forest Zone 2	60	NO	Other (nominal)	Start	Without	
Forest Zone 4	0	NO	Other (nominal)	400	400	
				100	100	

2.2. Afforestation and Reforestation						
?	AEZ map	Zone 1 = Tropical rain forest	Zone 2 = Tropical moist deciduous forest	Zone 3 = Tropical dry forest		
Type of vegetation that will be planted	Fire Use? (y/n)	Previous land use	Area that will be afforested/reforested			
Plantation Zone 2	NO	Set Aside	Without	*	With	*
			0	D	800	D

Forest management¹: Mangrove forest area, 20,000 ha, will progressively improve from moderate degradation² level (40%) to low degradation level (20%). Without project, the mangrove degradation process trend will carry on, down to 60% degradation level, screenshot 2.

¹ We used the Tier 2 approach, with on field value from Tai Tue et al 2014. Carbon storage of a tropical mangrove forest in Mui Ca Mau National Park, Vietnam. Catena 121, 119–126.

² The term degradation refers to a lowering of biomass density and soil carbon stock within a forest cover

EX-ACT screenshot 2: Forest management module for mangrove

5.1. Forest degradation and management										
 AEZ map	Zone 1 = Tropical rain forest			Zone 2 = Tropical moist deciduous forest			Zone 3 = Tropical dry forest			
Type of vegetation that will be degraded	Degradation level of the vegetation			Fire occurrence and severity						Area (ha)
	Initial State	At the end		Without (y/n)	Periodicity (year)	Impact (% burnt)	With (y/n)	Periodicity (year)	Impact (% burnt)	Start
		Without project	With project							
Mangrove	Moderate	Large	Low	NO	1	100%	NO	1	100%	20 000

In addition, 1,000 ha of mangrove will be replanted. We use the rewetting module, i.e. use in the case of restoration of hydrological conditions of the soils and additional replanting of mangrove. We assume that restoration activities will successfully lead to 100 % of restored biomass on the 1,000 ha, data not shown.

Flooded rice systems: Irrigated rice areas will switch from 3 to 2 crops with shrimp replacing the third crop on 7000 ha. The main area of conventional irrigated rice (60,000 ha) currently in rice double cropping will progressively be transformed in rice single cropping completed by aquaculture, screenshot 3.

3.3.2. Flooded rice systems remaining flooded rice systems (total area must remain constant)									
Fill with your description	Cultivation period (days)	Water regime		anic amendment type (straw or oil)	Area (ha)				
		During the cultivation period	Before the cultivation period		Area (ha)	Without	*	With	
Conventional rice 3 crops	270	Irrigated - Continuously flooded	Flooded pre-season (>30 days)	Straw exported	7000	7000	D	0	
Conventional rice 3 to 2 crops+Shrimp	180	Irrigated - Continuously flooded	Flooded pre-season (>30 days)	Straw exported	0	0	D	7000	
Conventional rice 2 crops	180	Irrigated - Continuously flooded	Flooded pre-season (>30 days)	Straw exported	60000	60000	D	0	
Conventional rice 2 to 1 crop+Shrimp	150	Irrigated - Continuously flooded	Flooded pre-season (>30 days)	Straw exported	0	0	D	60000	

EX-ACT screenshot 3: Flooded rice module with conversion from rice cultivation to rice cum shrimp farming

The high level of inputs will be slightly adapted with project

Description and unit to report	Amount applied per year				
	Start	Without	*	With	*
Lime application					
Limestone (tonnes per year)	0	0	D	0	D
Dolomite tonnes per year)	0	0	D	0	D
not-specified (tonnes per year)	0	0	D	0	D
Fertilizers					
Urea (tonnes of N per year - Urea has 46.7% of N)	0	0	D	0	D
Other N-fertilizers (tonnes of N per year)	0	0	D	0	D
N-fertilizer in irrigated rice (tonnes of N per year)	6,368	6,154	D	6,141	D
Sewage (tonnes of N per year)	0	0	D	0	D
Compost (tonnes of N per year)	0	0	D	0	D
Phosphorus (tonnes of P2O5 per year)	2,613	2,399	D	3,698	D
Potassium (tonnes of K2O per year)	3,886	5,119	D	6,700	D
Pesticides					
Herbicides (tonnes of active ingredient per year)	268	268	D	201	D
Insecticides (tonnes of active ingredient per year)	335	335	D	268	D
Fungicides (tonnes of active ingredient per year)	0	0	D	0	D

EX-ACT screenshot 4: Agricultural inputs module

Finally, total shrimp production will increase from 39,400 tonnes to 57,960 tonnes with the project. Production of shrimp is shared between mangrove-shrimp farming and rice-shrimp farming, screenshot 5.

EX-ACT screenshot 5: aquaculture module

Aquaculture (only emissions from N2O during fish production)					
		Annual production (tonnes per year)			
		Start	Without		With
Production system 1	Bio security mangrove shrimp	12600	12600	D	15750
Production system 2	Rice shrimp	26800	26800	D	42210
Production system 3	description 3	0	0	D	0
Production system 4	description 4	0	0	D	0
Production system 5	description 5	0	0	D	0
		this area should account only areas not accounted elsewhere			
Total (ha)		21000			
Emissions from feeds					
		Annual quantity of feeds (tonnes per year)			
		Start	Without		With
Feed n°1	For biosecurity mangrove shrimp	110250	110250	D	117600
Feed n°2	For Rice shrimp	4020	4020	D	3350
Feed n°3	description 3	0	0	D	0
Feed n°4	description 4	0	0	D	0
Feed n°5	description 5	0	0	D	0

Project GHG performance

The following tables (screenshot 6) summarize the GHGs sequestration and the share of the balance per GHG from the without and with-project situation. Results are given in tonne CO₂ equivalent (tCO₂-e). Positive numbers represent sources of CO₂-e emission while negative numbers represent sinks. The left table section summarizes estimated CO₂-e emissions and sinks from the scenario without-project (left column), from the scenario with-project (middle column) and the total balance (right column). The middle table details the Carbon Balance under project implementation, showing the CO₂ fluxes from biomass and soil carbon fluxes, GHG associated to agricultural and energy input, pond-farming activities, rice cultivation, mangrove restoration and planting. The right table details annual CO₂-e fluxes for the different activities without and with-project implementation:

With a total GHG emission decreasing from 20.2 million tCO₂ to 11.6 million tCO₂, the preliminary results of GHG appraisal is estimated around 8.6 million TCO₂ of mitigation impact on 20 years, or 429 000 tCO₂ / year

The biggest impact is due to changes in mangrove forestry systems allowing increased biomass of 4.4 million tCO₂ and to methane reduction (equivalent to -2.6 million tCO₂) in irrigated rice.

Project Name	Mekong Delta Integrated Cli.	Climate	Tropical (Moist)	Duration of the Project (Years)		20						
Continent	Asia (Continental)	Dominant Regional Soil Type	HAC Soils	Total area (ha)		110300						
Components of the project	Gross fluxes			Share per GHG of the Balance				Result per year				
	Without	With	Balance	All GHG in tCO2eq			N ₂ O	CH ₄	Without	With	Balance	
	All GHG in tCO2eq			CO ₂								
	Positive = source / negative = sink			Biomass	Soil	Other						
Land use changes												
Deforestation	0	133,667	133,667	133,667	0		0		0	6,683	6,683	
Afforestation	0	-306,460	-306,460	-277,288	-29,172		0	0	0	-15,323	-15,323	
Other LUC	0	0	0	0	0		0	0	0	0	0	
Agriculture												
Annual	0	0	0	0	0		0	0	0	0	0	
Perennial	0	0	0	0	0		0	0	0	0	0	
Rice	15,672,150	13,121,258	-2,550,893	0	0		0	-2,550,893	783,608	656,063	-127,545	
Grassland & Livestocks												
Grassland	0	0	0	0	0		0	0	0	0	0	
Livestocks	0		0				0	0	0	0	0	
Degradation & Management	2,559,737	-2,559,737	-5,119,473	-4,417,600	-701,873		0	0	127,987	-127,987	-255,974	
Coastal wetlands	0	-615,861	-615,861	-514,881	-100,980		0	0	0	-30,793	-30,793	
Inputs & Investments	1,102,584	1,273,326	170,742			-17,708	-320	0	55,129	63,666	8,537	
Fishery & Aquaculture	623,625	873,329	249,703			0	249,703	0	31,181	43,666	12,485	
Total	19,958,096	11,919,522	-8,038,575	-5,076,102	-832,025	-17,708	249,383	-2,550,893	997,905	595,976	-401,929	
Per hectare	181	108	-73	-46.2	-7.5	-0.2	2.3	-23.1				
Per hectare per year	9.0	5.4	-3.6	-2.3	-0.4	0.0	0.1	-1.2	9.0	5.4	-3.6	

EX-ACT screenshot 6: Project GHG fluxes and GHG balance

(1) The **without project** describes the business as usual scenario. GHG emissions stems from rice cultivation in the upper delta zone and the seawater intrusion zone, i.e. 15.7 million tCO₂-e, mangrove degradation with about 2.6 million tCO₂-e, use of fertilizer, herbicides and pesticides and the aquaculture sector. In the business as usual scenario, activities within the Mekong Delta are emitting about **20 million tCO₂-e**.

(2) The **with-project** scenario emissions still stems from the rice cultivation but in diminution as compared to the without project scenario due to the shift from 3 or 2 crop rice to rice aquaculture practices. Emissions from the rice cultivation is then about 13 million tCO₂-e. Mangrove restoration, additional mangrove replanting and reforestation sequester about -3.5 million tCO₂-e. Shift from rice paddies to aquaculture increase GHG production to about 870,000 tCO₂-e.

In order to overall evaluate the impact of The “Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project” for GHG mitigation, it is necessary to consider the difference between the gross fluxes of the with- and without-project scenario, which is given by the Carbon Balance (light green column): The

implementation of the project leads to an overall **Carbon Balance** of around **-8.1 million t CO₂-e** over the full analysis duration of 20 years. This is equivalent to **-73 t CO₂-e per hectare or -3.6 t CO₂-e per hectare and year**. With this impact the project can be characterized as having high benefits for climate change mitigation based on our assumptions. When translating the qualitative uncertainty assessments by the IPCC into a quantitative estimation as done by EX-ACT, the here indicated Carbon Balance is associated to an uncertainty level of 34 %.

The biggest impact is due to changes in mangrove forestry systems allowing increased biomass of 4.9 million tCO₂ and to methane reduction (equivalent to -2.5 million tCO₂) in irrigated rice, see middle table of screenshot 6.

GHG performance per improved practice and GHG intensity

The best practices registered in term of GHG per ha per year link with mangrove management. The top one is mangrove planting- rewetting which does allow a mitigation result of 30 tco2 per ha per year. The second one is the combination of mangrove protection and mangrove rehabilitation which does generate 14.16 tCO₂/ha per year of mitigation impact when compared to without project situation of mangrove degradation.

The switch from rice triple cropping to rice double cropping with shrimp production does allow to reduce the GHG emissions per ha of 4.72 tCO₂-eq. The switch from rice double cropping to rice mono cropping with shrimp production does allow a reduction of 1.57 tCO₂ eq /ha / year. With a yield of 1.1 t of fish per ha, aquaculture is emitting 0.96 tCO₂ eq without accounting feeds. Therefore associating both aquaculture and rice cropping systems drives to performances between -0.490 and -3.64 tCO₂/ha

	Tco2 per ha
Protection / rehabilitation of Mangroves	-14.16
Plantation - rewetting of mangroves	-30.79
Conventional rice 3 to 2 crops+Shrimp	-4.72
Conventional rice 2 to 1 crop+Shrimp	-1.57
Average rice performance	-4.23
Aquaculture	0.96
Double Rice aquaculture system	-3.64
Mono Rice aquaculture system	-0.49

Nevertheless most of this mitigation impact is linked to land use change (biomass increased) or improvement of cropping systems inducing reduction of emissions. Both rice and aquaculture are remaining GHG emitting activities. It appears through the positive GHG intensity per ton of production shown in the table beside with rice produced with a range of 1.19 to 1.91 tCO₂/ T of rice (average 1.49 tCO₂/T)

Carbon intensity	Tco2 per ton Carbon footprint
Conventional rice 3 to 2 crops+Shrimp	1.19
Conventional rice 2 to 1 crop+Shrimp	1.91
Average rice performance	1.49
Aquaculture	0.75

Discussion & Recommendations

Project objectives are to improve institutional and beneficiaries capacities to manage with increasing climate change impacts, among them seawater intrusion, sea level rise, increasing drought, changes rain patterns. Several pathways for transition considered such as conversion of multiple crop rice to rice-aquaculture, mangrove restoration. The project also provides with numerous additional infrastructures, such as additional mangrove, sluice gates and dikes. In mangrove, high rates of primary production and trapping of organic matter lead to the accumulation of carbon in the soil. The presence of a tidal to permanently water table subsequently limits the aerobic microbial degradation of the organic matter. Thus carbon can accumulate over millennia in the soil compartment of these ecosystems, and they continue to

accrete vertically with sea level rise as long as they are not disturbed³. Indeed mangrove restoration and replanting in 20% of the coastal and peninsula surface areas targeted by the project is about 64% of the mitigated emissions.

While the project leaves open which kind of alternative livelihoods can be adopted by farm households, “low regret” alternative such as additional replanting in shrimp ponds or in the coastal belt to prevent from extreme weather events and to cope sea level rise also significantly sway project mitigated emissions. Mangrove ecosystems are defined as **blue carbon ecosystem** because of their contribution in term of CC mitigation, but they also provide numerous ecosystems services such as fishery resources, nursery ground for coastal fish and crustaceans, improvement of water quality, protection from storm and stabilize the shoreline. They are indeed efficient at accumulating nitrogen and phosphorus, their complex root systems can colonize sediments and stabilize them to modify the foreshore, reduce suspended matter and thus protect nearshore habitats. Conservation and restoration of this coastal ecosystem is then significant to maintenance of coastal habitat, biodiversity, communities’ livelihood, protection against climate induced damages and participate in climate change mitigation.

³ McKee K.L. et al. 2007. Caribbean mangroves adjust to rising sea level through biotic controls on change in soil elevation. *Global Ecol Biogeogr* 16: 545–56.