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Socio-economic and Environmental Impact Assessment in Agricultural Cultivation, Case Studies in Rice Cultivation and Shrimp Farming in the Mekong River Delta, Vietnam

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Abstract

This paper provides two case studies of environmental impacts with socio-economic values. The first case is on flood protection levees conducted from 2003 to 2004 in Phu Tan district, An Giang province. The impacts were found by comparing full flood protection levees area (FFPL) to non-full flood protection levees area (NFFPL). Participatory Rural Appraisal (PRA) tools per each group of rich, middle, and poor people were used to list the impacts. Then, major impacts were selected by ranking and interviewing 60 households per site, and assessed by Cost Benefit Analysis (CBA) in rice production from 1996 to 2002 between two areas. The tested research indicated moving system of NFFPL to that of FFPL lost about 11 million VND/ha/year. The second case is on impacts of Penaeid shrimp farming conducted in Duyen Hai District, Tra Vinh Province in 2004-2005. Ninety households and 12 local officials were interviewed. Four PRAs were conducted and 36 water samples were taken inside and outside shrimp pond to measure values of DO, COD, Fe total, TSS, $N\text{-}NO_3^-$, $N\text{-}NH_4^+$, $P\text{-}PO_4^{3-}$, and Chlorophyll-a. Research results showed only 36.7% of the households got profit from shrimp farming. Highest financial efficiency was 0.72 for the semi-intensive system. Tested water indicators showed surface water quality did not match Vietnamese standard for surface water in coastal area (TCVN 5943-1995) and in rain. The water was very muddy and contaminated by organic aluminum. Summarily, the impacts were clarified more obviously via adding socio-economic values to assessment. Importantly, the values were transformed to household' s income which is an indicator for policy-makers to consider the impacts obviously. Besides, data of different group of people impacted are cases contributing to consideration of the impacts in an appropriate social level.

Keywords : Rice cultivation, shrimp farming, environmental impact assessment, socio-economic impacts, environmental economics

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I. Introduction

Environmental impact assessment is an important part for any project review. In the Mekong River Delta in Vietnam, the assessment usually lacks socio-economic impacts which leads to misunderstanding and being difficult to see invisible values of environmental impacts. This study provides two case studies on impacts of levee building for intensive rice cultivation and of shrimp farming.

II. Case study

1. Case study 1: Socio-economic and environmental impacts of full flood protection levees in Phu Tan District, An Giang Province, Vietnam

1) Overview

In past years, intensive rice cultivation planning was conducted in An Giang Province and the Delta to enhance rice production for exportation. In An Giang, most districts developed full flood protection levees (FFPL) for three-crop rice cultivation from non-full flood protection levees (NFFPL) for two-crop rice cultivation; yet some initial research showed that annual flood brought alluvial, nutrient for soil, and support development of fish in NFFPL (Nga, 1999). Major impacts from FFPL were not tested. This research was done in 2004 to figure out the impacts.

2) Hypothesis and Methods

(1) Hypothesis

The research emphasized on clarifying whether:

- FFPL impacted differently on groups of rich, middle, and poor people.
- Income per rice land unit in the FFPL was less than that in the NFFPL.

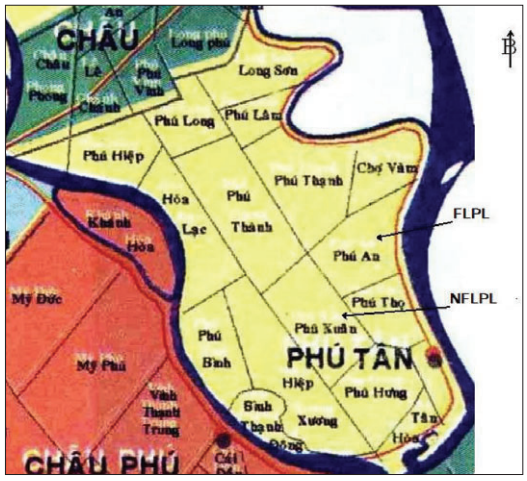


Figure 1. Research sites

(2) Methods

- **Research site selection:** Phu An commune (FFPL) and Phu Xuan commune (NFFPL) were selected for research (Figure 1). These areas have the same environmental and socio-economic conditions. In Phu An, people cultivated whole-year rice (three crops). In Phu Xuan, people had two-crop rice cultivation and three months for fish catching or hired work.
- **Secondary data investigation:** Collecting data from governmental offices or other institutions about history and circumstances of the levees building.
- **Environmental impact assessment:** Based on comments of Grootaert (2002) and on real situations in the research area, methods were selected as:
  * **Non-experimental (Quasi-Experimental designs)-Matching methods:** FFPL and NFFPL areas were selected for the matching comparison.
  * **Double difference design:** Combining questionnaire with PRA tools to test data before and after FFPL building in two

matching research sites.

- **Socio-economic research:** Household investigation was implemented, which followed to recommendation of World Bank (2001) for socio-economic research.
- **Procedures for EIA**
  * Seeking impacts: Related impacts were figured out by using PRA tools to investigate three groups of the rich, middle, and poor. The tools were: Analysis of related factors, seasonal calendar, SWOT (Strengths, weaknesses, opportunities, and threats), and ranking. Six PRA surveys (3 visits/commune with 1 visit/group) were done in total.
  * Selecting major impacts: The impacts were scored by ranking of community for how they affected people's lives importantly.
  * Impact prediction: The prediction was conducted by community under support of the trend analysis tool for each major impact.
  * Impact assessment: Information of major impacts was collected by using questionnaire for interviewing 60 people each commune and then the assessment was conducted by the method of Cost Benefit Analysis (CBA).

Formula 1: Formula for CBA (Munasinghe, 1993)

$$NPV = \sum \frac{B - C}{(1 + r)^t}$$

NPV : Net profit values
B: Benefit
C: Cost
r: Discount rate
t: time

Since the FFPL was built in 1996, investigation before 1996 and after 1996 (in 2002) was done. Then, the assessment way was followed by Table 1.

Table 1. Environmental impact assessment methods (Nhã, 2004)

Area	1996	2003	Change	Building impact
FFPL	X1	X2	X2-X1= A	C = A-B
NFFPL	Z1	Z2	Z2-Z1= B	

3) Results

(1) History of the building and impacts

PRA investigation showed high loses in NFFPL area (Table 2).

Table 2. Historical events

Year	FFPL	NFFPL
1978	House and rice were flooded and lost	House and rice were flooded and lost
1996	FFPL building and development of transportation	Non- building
2000	People and houses were safe	People were hungry because of rice and raised fish lost for small levees broken

(2) Income structure of local people

The structure in NFFPL was more stable by time than that in FFPL while that of rich and middle people in FFPL is similar to that in NFFPL. The poor in the NFFPL had their fish catching income but not in FFPL (Figure 2). Percentage of total income from hired work in NFFPL was lower than that in FFPL.

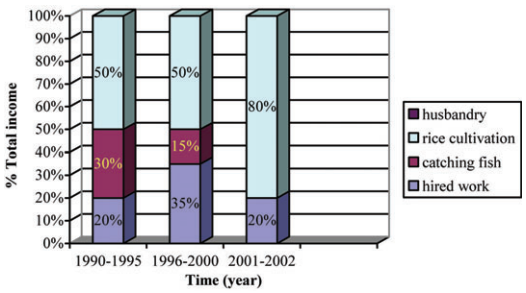


Figure 2. Income structure of poor people in NFFPL (Phu Xuan commune)

(3) Groups of people receiving major impacts of the building

Knowledge from community showed major

Table 3. People groups having benefits and losses from the building in FFPL

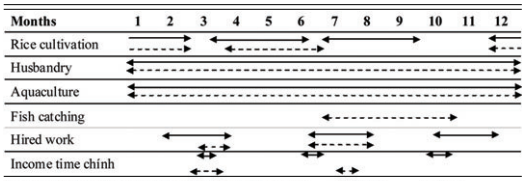
No.	Groups	
	Beneficial	Lost
1	Rice cultivation	Fish catching
2	Hired work	
3	Land exchange	

groups of people receiving the major impacts are those in rice cultivation, hired work, fish catching, land losses for the building. Table 3 described their benefits or losses.

(4) Activity calendar

The building importantly changed annual activities of rice cultivation, fish catching, hired work and income time in the FFPL area (Table 4).

Table 4. Yearly seasonal calendar of people's activities



Note: Month in the table follows solar calendar. And, ----- : NFLPL, ____: FLPL

(5) Impact prediction

Research result also showed that FFPL area and NFFPL area had the same soil nutrient decrease by time; however, the reduction was greater in the FFPL because of levees' prevention of alluvial input. Although the two areas had the same productivity of rice cultivation per area, amount of fertilizer used in the FFPL was 50 kg higher than that in NFFPL. In general, integration impacts of the building found were decrease of soil nutrient and natural fish, and increase of fertilizer use.

(6) Assessment

To undertake the values of environmental impacts via major factors of soil, natural fish, and fertilizer use, the research evaluated them by comparing two models of income of local people within 1996 and 2002 (Table 5).

Table 5. Models for environmental impact assessment

Model 1 in FFPL		Model 2 in NFFPL	
1996	2002	1996	2002
2-crop rice (6 months) + fish catching or hired work (3 months)	3-crop rice (9 months)	2-crop rice (6 months) + fish catching or hired work (3 months)	

In table 5, 1996 is the time when people built levees. Before 1996, people in FFPL and NFFPL had the same activities consisting 2-crop rice cultivation 6 months) and fish catching or hired work (3 months). Since from 1996 to 2002, the FFPL only had an activity of 3-crop rice cultivation while the NFFPL still kept the same activities as those in 1996. Comparision of activities between 1996 and 2002 is to figure impact values.

Applying the formula 1 of CBA to this case with costs and benefits added such as:

+ Costs of building and maintenance per 1,000m^2: 21,760 VND/year for FFPL and 19,200 VND/year for NFFPL
+ Benefit of hired work in flooding time (3 months) was about 1,350,000 VND equal to that of fish catching at the same time.
+ Costs of soil nutrient loss and fertilizer use increase were included in rice production value.

Values of costs and benefits in 1996 were converted into those in 2002. Between 1996 and 2002, market price bias was approximately equal to zero. Thus, (1+r) was approximately one. Result from using T-test method showed NPV in model NFFPL is 11 million/ha/year greater than that in model FFPL (at 95% confident level and values of sig. of 0.000 < 0.05) (Table 6).

Table 6. Values of NPV of two models (million VND/year/ha)

Factors	Areas	
	FFPL	NFFPL
Number of households	38	36
Average of NPV	-6,469	4,927
Standard Errors	0,322	0,522

4) Summary

The FFPL significantly changed income structures of local people and impacted different groups of rich, middle, and poor people. Amongst them, the poor received the most negative impacts because of loss of the fish catching income. In addition, it caused major impacts such decrease of soil nutrient and natural fish, and increase of fertilizer use. These negatively affected local people's income. Removing NFFPL system to develop NFFPL lost 11 million VND/ha/year for people in rice cultivation.

2. Case study 2: Assessing impacts of penaeid shrimp farming on environment, economy and society in Duyen Hai District, Tra Vinh Province

1) Overview

In past years, salty soil used for shrimp farming was increased in Tra Vinh province. Many shrimp farms were developed; however, success level of the farming systems was very limited. The farms negatively impacted ecological environment, polluted water source due to harming wildlife animal as well as the quality of human life. To contribute to strategies for sustainable development of shrimp farming, the research "Assessing impacts of Penaeid shrimp farming on environment, economy and society in Duyen Hai district, Tra Vinh province" was done in 2005.

2) Methods

Four PRA visits, 12 depth interviews for local leaders, and interviewing 90 households were implemented to know effectiveness of the farming models and to check socio-economic and environmental problems. 36 water samples were taken in outside and inside of ponds. Water samples were collected in 2 times: the first in dry season (February, 2004) and the second in early wet season (June, 2004) to measure concentrations of pH, salinity, DO, BOD_5, COD, P - PO_4^{3-}, N- NO_3^-, N- NH_4^+, SS, Chlorophyll-a, and total Fe. The research used methods such as data schedule, economic efficiency analysis, issues ranking tool, expert's judgment, and comparison to conduct the assessment.

3) Results

(1) Economic efficiency of penaeid shrimp farming models

Research results showed that amongst 90 shrimp farming households surveyed, about 41.1% lost their investment, 22.2% did not get any profit, and only 36.7% achieved from shrimp farming. Only households for the semi-intensive farming system got the highest profit with economic efficiency (profit/cost) rate of 0.72 because of their lower investment cost (Table 7).

Table 7. Investment efficiency and cost of the shrimp system (million VND)

Model	Total income	Total cost	Profit (RAVC)	Economic efficiency
Intensive farming system	62.41	40.50	21.91	0.54
Semi-intensive farming system	26.2	15.23	10.97	0.72
Improved extensive farming system	15.49	10.56	4.93	0.47

(2) Impacts of the farming on inequality of poor and wealthy family

Penaeid shrimp farming contributed actively to the poverty-alleviation work. Annually poor household number was reduced from 700-1000. Rate of poor household decreased from 40% (in 1999) to 28% (in 2000). In comparison with 1999 poor households in 2003 were reduced by 24.3%.

(3) Impacts of shrimp farming to the environment

- Changing chemical-physical soil characteristics

Due to lack of water and being burned by light, pyrite (FeS_2) (in potential capacity) was oxidized as:

$$FeS_2 + 7/2O_2 + H_2O = Fe + 2SO_4^{2-} + 2H^+$$

$$Fe_2^+ + SO_4^{2-} + 1/2O_2 + 3/2\ H_2O + 1/3K+ = 1/3\ KFe(SO_4)_2\ (OH)_6 + H^+ + 1/3SO_4^{2-}$$

Rain made land face perforated due to bringing acid soil down to shrimp pond while the pond water is hard to be exchanged when rapid pH diminishment. Concretely, concentration of total Fe in the improved extensive shrimp ponds was 1.84 mg/l, 18 times exceeding the standard.

- Reducing mangroves

In 2000, Duyen Hai District had 5,514.4 ha of mangrove forest. In 2004, the number was 4,839.12 ha. It also had typical flora species such as *Nypa fruticans* (812 ha), *Avicennia sp*. (403.85 ha), *Rhizophora sp*. (851ha), *Phoenixpaludosa* (109ha); *Acrostichum aureum, Derris trifolia, Plucheaindica* (2102ha). However, flora populations were significantly diminished from cutting down trees for farming.

- Water pollution

Results from Table 8 showed surface water in research site met problems of organic compounds. Compared to 1998, water quality in 2004 was less.

(4) Summary

Amongst the interviewed households, 36.7% of them got profit from shrimp farming. The semi-intensive farming system had the highest rate of financial efficiency (0.72). Households who had no land or exploited mangrove forest and natural fish for their income were affected much from the shrimp farming. Currently, their lives are difficult. Shrimp farming contributed to creating jobs and reducing the number of poor households; however, it negatively impacted on environment such as deforestation of mangroves, reduction of natural fish resources, and water pollution increase.

Table 8. Monitoring water sample in canals in Duyen Hai, Tra Vinh, 2004

Parameters	Survey in 2004	Comparison with 1998	Rating WQI (%) (*Water quality index*)	Standard (5943-1995)
Salty ‰	14.32	Proximity	----	18-25‰
DO (mg/l)	5.42	Proximity	Clean	>5mg/l
COD (mg/l)	23.58	<1.65 times	Pollution	<10mg/l
TSS(mg/l)	74.41	>1.43 times	Light pollution	50mg/l
pH	6.26	>7.25 times	Light pollution	6.0-8.5
Fe total (mg/l)	1.11	---	----	0.1mg/l
Chlorophyll-a (μg/l)	56.0	<20 times	----	50-200μg/l
N-NO_3^- (mg/l)	0.54	<1.8 times	---	0.4-0.8mg/l
N-NH_4^+ (mg/l)	0.736	< 46 times	Light Pollution	<0.5mg/l
P-PO_4^{3-} (mg/l)	0.18	< 3.75 times	-----	

III. Conclusion

Two case studies provided obvious examples of combining socio-economic and environmental impacts. The combination helps know what impacts are very meaningful for local community. Usually, if concentrating on environmental sides, livelihood of local people will easily be missed although they significantly received the direct and indirect influences daily. To achieve the combination, it is recommended that major integration impacts including socio-economic and environmental sides should be found for assessment.

* This is the revision of the paper from Vietnamese and Korean Experiences in Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) which was published in the Vietnam-Korea Workshop on August 21, 2009.

References

Dương Văn Nhã và cộng sự. Nghiên cứu tác động của đê bao đến đời sống kinh tế-xã hội và môi trường tại một số khu vực có đê bao ở tỉnh An Giang. Chương trình nghiên cứu Việt Nam-Hà Lan (VNRP). Trang 109-118.

Grootaert, Christian. 2002. Socioeconomic impact assessment of rural roads - methodology and questionnaires. World Bank, pp. 20 - 32.

Munashinge, Mohan. 1993. Environmental economics and sustainable development. World Bank. pp. 3 - 10.

Nguyễn Trần Nhẫn Tánh. 2004. Tác động của đê bao đến kinh tế xã hội và môi trường huyện Phú Tân, tỉnh An Giang. Luận văn Thạc sĩ. Đại học Cần Thơ.

Trần Thị Hồng Ngọc. 2005. Đánh giá tác động của các mô hình nuôi tôm biển đến kinh tế xã hội và môi trường huyện Duyên Hải, tỉnh Trà Vinh. Luận văn Thạc sĩ. Đại học Cần Thơ.

Trương Thị Nga. 1999. Ảnh hưởng của phù sa trên năng suất lúa và một số động vật thủy sinh chính tại An Giang (phần I và II). Sở Khoa học Công nghệ và Môi trường An Giang.

World Bank. 2001. Understanding impact evaluation. http://www.worldbank.org.

최종원고채택 09. 12. 20