

**Southeast Asian Regional Center
for Graduate Study and Research in Agriculture**

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Enhancing Adaptive Capacity to Climate Change of Vulnerable Communities in the Mekong Delta of Vietnam

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outline

1. Introduction
2. Methodology
3. Findings & Discussion
4. Policy Recommendation

introduction

1. Introduction

2. Methodology

3. Findings & Discussion

4. Policy Recommendation

introduction

- To measure vulnerability level and analyze adaptive capacity of agricultural households and community regarding the effect of salinity at the study sites.
- To propose solutions that help reduce damages and losses caused by salinity and increase adaptive capacity of communities.

introduction

- specific objectives include:
 - (i) to evaluate salinity situation,*
 - (ii) to evaluate vulnerability level caused by salinity,*
 - (iii) to analyze adaptive capacity dealing with salinity, and*
 - (iv) to propose appropriate adaptive solutions in order to deal with salinity in agricultural production.*
- The study is implemented at Cau Ngang, Tra Cu, and Duyen Hai districts at Tra Vinh province.
- The study targets are agricultural households.

methodology

1. Introduction
- 2. Methodology**
3. Findings & Discussion
4. Policy Recommendation

methodology

Social Vulnerability Index

Factor	Variable	Expected sign
Potential losses	- Economic vulnerability = annual values of agricultural production and aquaculture	+
Resilience capacity	- dependent ratio = dependent number/total persons in the household	+
	- Losses by high tide and salinity	+
	- Preparedness to coping	-
	- Disaster information access	-
Self-recovery capacity	- Investment on adaptive measures before disaster coming	-
	- credit access	-
	- Access to other helps by community	-
	- Total household income	-

methodology

Social Vulnerability Index

According to Smit et al (2006), a standardization method is used to calculate the SVI. For the positive variables, Equation (1) is applied. Conversely, for the negative variables, Equation (2) is used.

$$V_{ij} = (X_{ij} - \text{Min}X_i) / (\text{Max}X_i - \text{Min}X_i) \quad (1)$$

$$V_{ij} = (X_{ij} - \text{Max}X_i) / (\text{Min}X_i - \text{Max}X_i) \quad (2)$$

where

V_{ij} : standadized values of vulnerability of the component i for the household j

X_{ij} : observed values of vulnerability of the component i for the household j

$\text{Min}X_i$: minimum value of vulnerability of the component i for all households

$\text{Max}X_i$: maximum value of vulnerability of the component i for all households

methodology

Social Vulnerability Index

SVI value	Degree of vulnerability
≤ 0.20	Very low
0.20 - 0.40	Low
0.41 - 0.60	Average
0.61 - 0.80	High
0.81 - 1.00	Very high

Determinant	Rationale	Expected sign
Economic resources	- economic resources	+
	- Lack of financial resources	-
Technology	- Lack of technology	-
Information and skills	- Lack of informed, skilled and trained personnel	-
	- Access to information increases	+
Infrastructure	- Infrastructure	+
Institutions	- Well-developed social institutions	+
	- Policies and regulations	+

Source: Swanson et al. (2001).

Adaptive capacity

This study measures the Household Adaptive Capacity Index (HACI) using weighted mean index method.

$$HACI = \frac{\frac{\sum_{i=1}^n w_i S_i}{n} + \frac{\sum_{j=1}^o w_j E_j}{o} + \frac{\sum_{k=1}^p w_k P_k}{p} + \frac{\sum_{l=1}^q w_l N_l}{q} + \frac{\sum_{m=1}^r w_m I_m}{r}}{5}$$

where

n, o, p, q and r are the total numbers of social, economic, physical, natural and institutional indicators respectively.

w_i , w_j , w_k , w_l , and w_m are the weights of Social indicator i (S_i), Economic indicator j (E_j), Physical indicator k (P_k), Natural indicator l (N_l), and Institutional indicator m (I_m) respectively. These weights are equally assigned to each indicator.

Community –based Adaptive Capacity Index (HACI):

$$CACI = \frac{\frac{\sum_{i=1}^n HACIS_i}{n} + \frac{\sum_{i=1}^n HACIE_i}{n} + \frac{\sum_{i=1}^n HACIP_i}{n} + \frac{\sum_{i=1}^n HACIN_i}{n} + \frac{\sum_{i=1}^n HACII_i}{n}}{5}$$

where

n is the number surveyed households in the community.

HACI/CACI value	Degree of adaptive capacity
≤ 0.20	Very low
0.20 - 0.40	Low
0.41 - 0.60	Average
0.61 - 0.80	High
0.81 - 1.00	Very high

Analysis of Vulnerability

$$V_i = \alpha_0 + \alpha_1 \text{DUM-aquaculture} + \alpha_2 \text{DUM-vegetable} + \alpha_3 \text{DUM-area} + \alpha_4 \text{DUM-CauNgang} + \alpha_5 \text{DUM-TraCu} + \alpha_6 \text{Distance} + \alpha_7 \text{dependent} + \alpha_8 \text{Salinity} + \alpha_9 \text{Connection} + \alpha_{10} \text{Earning} + \varepsilon_i$$

where

V_i : degree of vulnerability

DUM-aquaculture: Dummy; aquaculture = 1; others = 0

DUM-vegetable: Dummy; vegetable = 1; others = 0

DUM-area: Dummy; $\geq 1\text{ha}$ = 1; others = 0

DUM-Cau Ngang: Dummy; Huyện Ngang = 1; others = 0

DUM-Tra Cu: Dummy; Tra Cu = 1; others = 0

Distance: Distance to coastal area (km)

Dependent: dependent ratio (%)

Salinity: state of salinity (5-scale Likert: (1: abnormal, 5: normal))

Connection: Community connection (5-scale Likert: 1: very easy, 5: not easy at all))

Earning: annual income (million VND)

α_i : estimated coefficients

ε_i : error term

Analysis of adaptive capacity

$$\text{HACI}_i = \beta_0 + \beta_1 \text{DUM-TraCu} + \beta_2 \text{DUM-area} + \beta_3 \text{DUM-aquaculture} \\ + \beta_4 \text{DUM-vegetable} + \beta_5 \text{Gender} + \beta_6 \text{Education} + \beta_7 \text{Age} + u_i$$

where

HACI_i: degree of adaptive of household i

DUM-TraCu: Dummy; Tra Cu = 1; others = 0

DUM-area: Dummy; ≥ 1ha = 1; others = 0

DUM-aquaculture: Dummy; aquaculture = 1; others = 0

DUM-vegetable: Dummy; vegetable = 1; others = 0

Gender: Dummy (male= 1, female= 0)

Education: head's education (schoolyear)

Age: head's age (year)

β_i: estimated coefficients

u_i: error term.

Data collection

- For household survey, a questionnaire is designed to collect data as the evaluations on state of salinity, vulnerability, adaptive capacity, and the household behavior to the salinity.
- Study selects three study sites at Cau Ngang, Tra Cu, và Duyen Hai district of Tra Vinh province.
- In each district, some communes are randomly selected for survey. At Cau Ngang district, among 15 communes there are 6 communes selected. At Duyen Hai district, among 10 communes there are 6 communes selected. At Tra Cu district, among 17 communes there are 5 communes selected. Targeted households in the survey are rice, vegetables, and aquaculture farmers.
- As a result, there are 1,814 households interviewed.

Findings & Discussion

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Findings & Discussion

1. Salinity situation
2. Description of the sample
3. Awareness and coping to salinity
4. Vulnerability assessment
5. Assessment of adaptive capacity
6. Determinants of vulnerability and adaptive capacity

Salinity situation

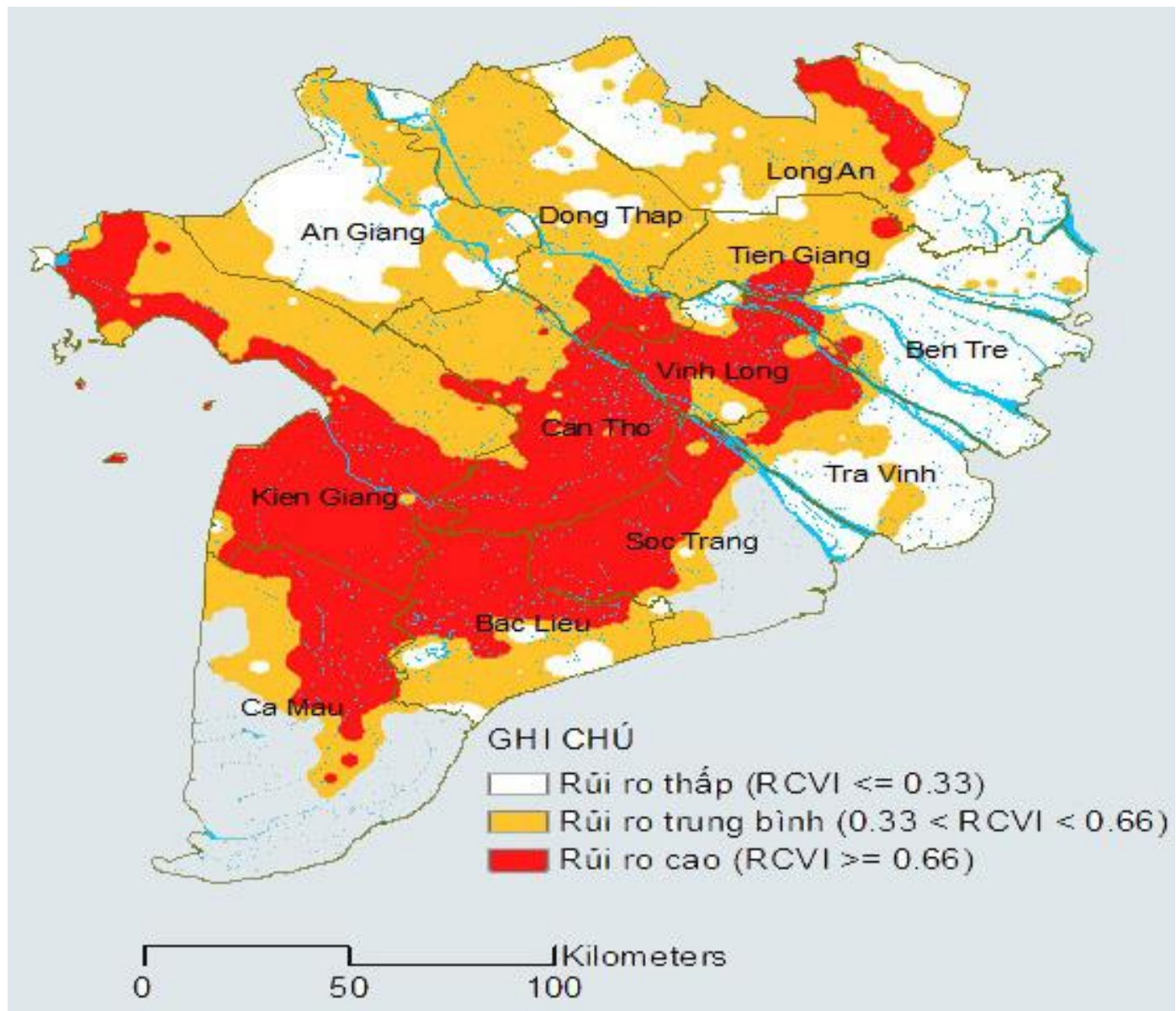
Description of the sample

Awareness and coping to salinity

Vulnerability assessment

Assessment of adaptive capacity

Determinants of vulnerability
& adaptive capacity



Map of vulnerability risk in rice production

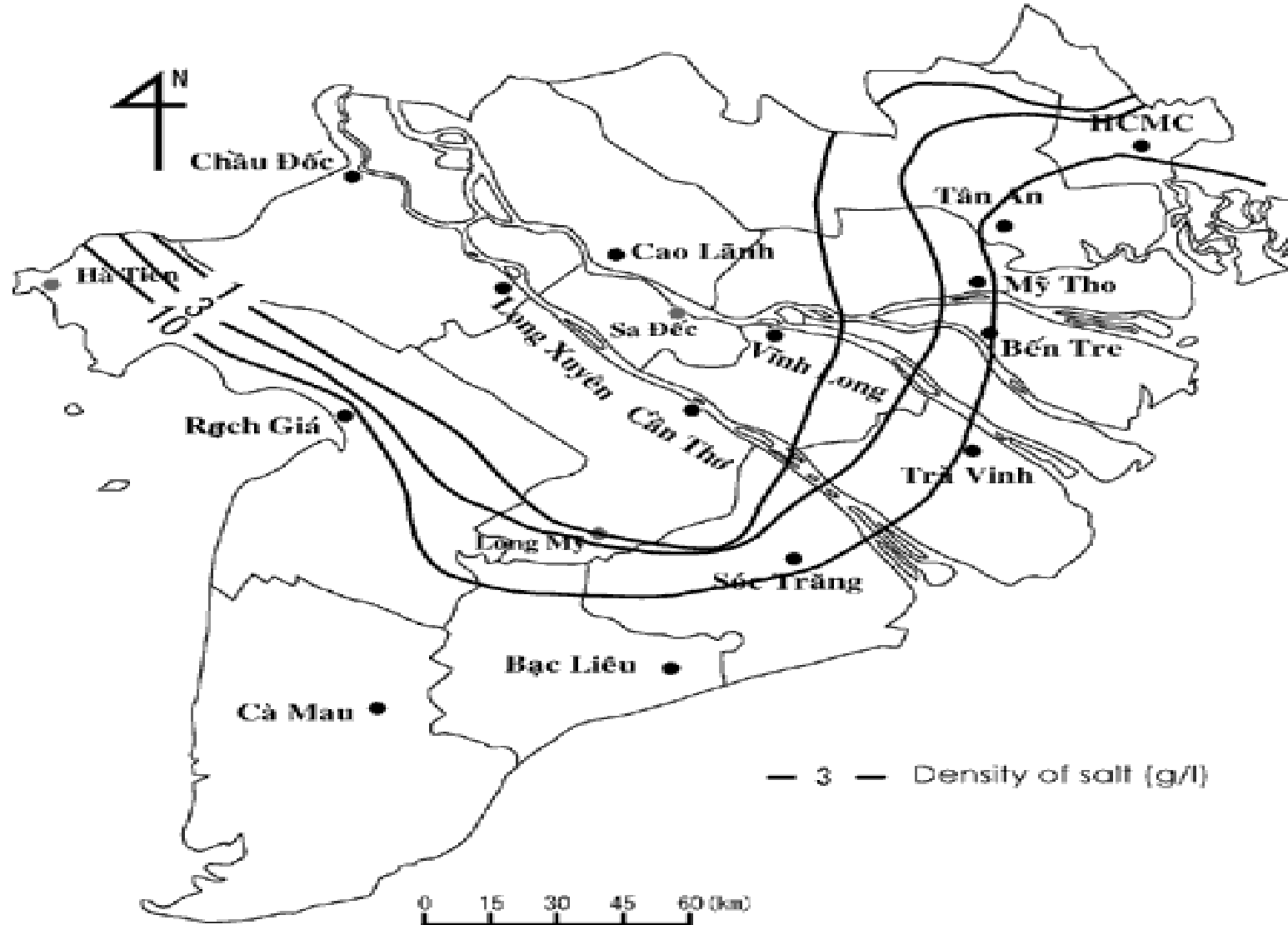


Fig. Density of salinity in surface water in Mekong Delta

Source: T.T.Be (2007)

Map of salinity intrusion in the Mekong Delta

Salinity situation

- Tra Vinh has more than 90 percent of natural land salinized.
- Salinity process begins from December at Co Chien and Tra Kha branches of Hau river.
- Salinity degree gets at highest in April at Cau Quan and Vung Liem rivers.
- Sea water intrusion will be ended in June.
- Tra Vinh has six salinity-affected regions with different levels: (i) a year-round saline region with 17.7 percent, (ii) a half year saline region with 25.8 percent, (iii) a four-month saline region with 13.9 percent, (iv) a three-month saline region with 16.6 percent, (v) two-month saline region with 1.8 percent, and (vi) abnormal two-month saline region with 15.1 percent of total agricultural land area respectively.

Salinity situation

Description of the sample

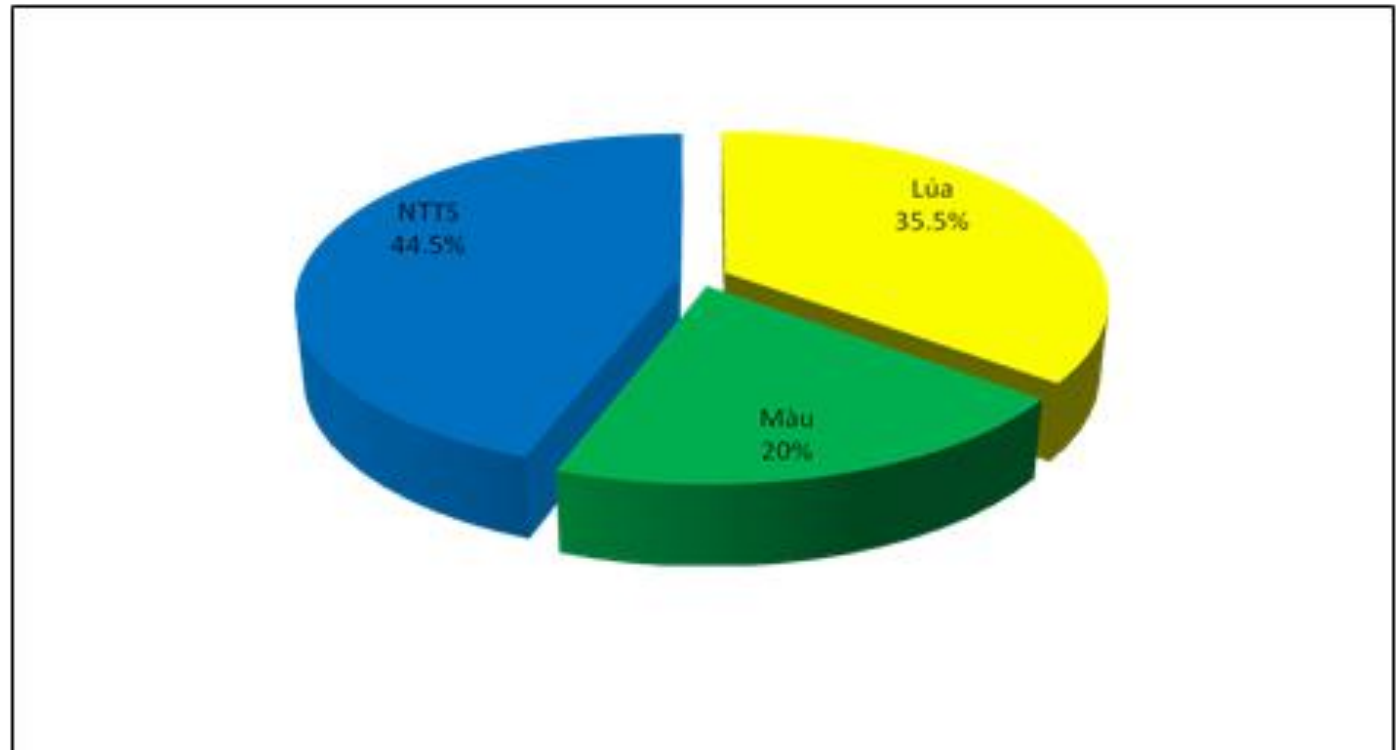
Awareness and coping to salinity

Vulnerability assessment

Assessment of adaptive capacity

Determinants of vulnerability
& adaptive capacity

Description of the sample



Survey 2012

Description of the sample

Variable	Unit	mean	minimum	Maximum	Standard Deviation
Head's age	Number of year	47	18	84	12
Head's gender	Male (1)	0.77	0	1	0.42
	Female (0)				
Rice area/household	1.000m ²	7.04	1.0	50.0	5.51
Vegetable area/household	1.000m ²	4.79	0.2	40.0	4.18
Aquaculture area/household	1.000m ²	11.90	0.1	100.0	13.62
Earnings from rice/household	Million VND	18.74	0	120	18.74
Earnings from vegetable/household	Million VND	38.83	0	180	35.69
Earnings from aquaculture/household	Million VND	201.18	0	3,600	374.78
Farm size	Person	4.48	1	12	1.43
Number of person/household	Person	1.23	0	5	1.02
Annual household income	Million VND	154.74	2	3,700	279.27

Survey 2012

Salinity situation

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Awareness and coping to salinity

Household evaluation on the trend of degree of salinity

Degree of salinity	frequency (person)	percent (%)
Not at all	142	7.8
Less	249	13.7
Normal	265	14.6
More	812	44.7
Abnormal	346	19.1
Total	1,814	100.0

Source: Survey (2012)

Awareness and coping to salinity

Household concern on high tide and salinity

Degree on concern	high tide		Salinity	
	frequency (person)	Percent (%)	frequency (person)	percent (%)
Not at all	4	0.9	36	1.9
A little	36	7.1	192	10.6
Normal	50	9.9	120	6.6
More	232	46.0	784	43.2
Very	182	36.1	682	37.6
Total	504	100.0	1,814	100.0

Source: Survey (2012)

Salinity situation

Description of the sample

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Vulnerability assessment

Household evaluation on changes of yields of rice, vegetable, and aquaculture

Degree of impact	Rice		Vegetable		aquaculture	
	frequency (person)	percent (%)	frequency (person)	percent (%)	frequency (person)	percent (%)
Unchanged	272	33.7	203	31.5	58	15.9
A little	279	34.6	267	41.4	144	39.7
Much	256	31.7	175	27.1	161	44.4
Total	807	100.0	644	100.0	363	100.0

Source: Survey (2012)

Vulnerability assessment

Determinants of changes in yields of rice, vegetables, and aquaculture

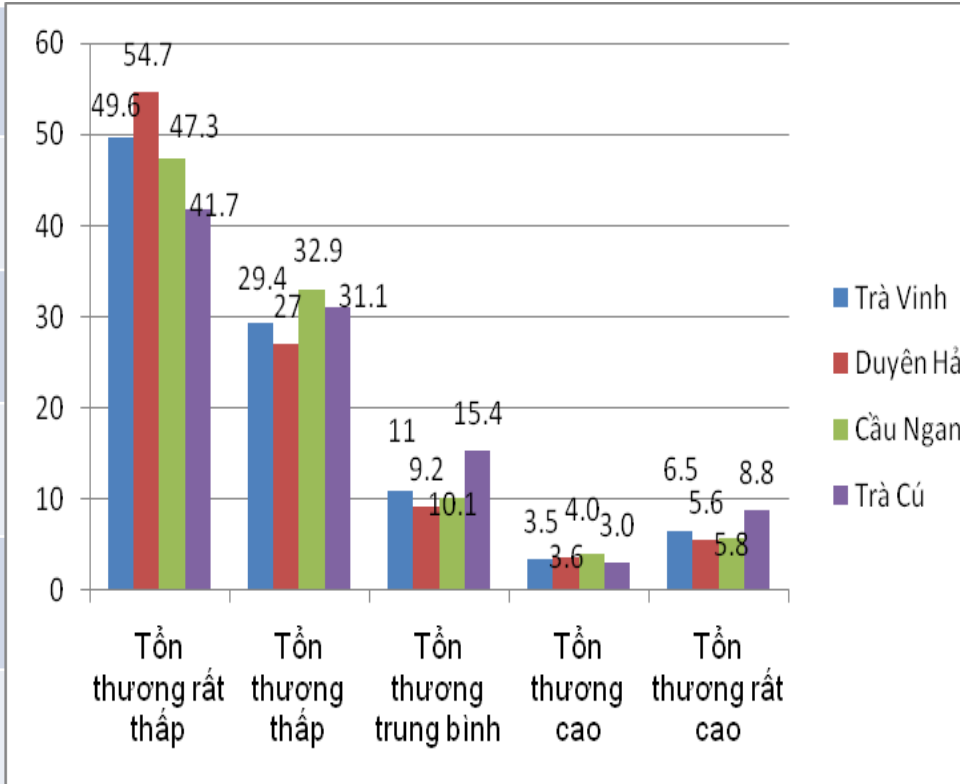
Determinant	Rice		vegetable		aquaculture	
	Crop 1	Crop 2	peanut	watermelon	shrimp	Fish
Salinity	47.0	31.4	53.4	30.3	39.3	37.9
storm	3.0	0.0	1.7	0.0	1.9	3.4
Flood	0.0	2.0	0.0	0.0	0.0	0.0
Others	50.0	66.7	44.9	39.4	58.8	58.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Survey (2012)

Vulnerability assessment

Proportion of salinity-related vulnerable household

Degree of vulnerability	Tra Vinh	Duyen Hai	Cau Ngang	Tra Cu
Very low	49.6	54.6	47.3	41.7
Low	29.4	27.0	32.8	31.1
Average	11.0	9.2	10.1	15.4
High	3.5	3.6	4.0	3.0
Very high	6.5	5.6	5.8	8.8
Total	100.0	100.0	100.0	100.0



Source: Survey (2012)

Vulnerability assessment

Summary of salinity-related household vulnerability

Location	VSI index	Degree of vulnerability
Tra Vinh province, in which	0.470	Average
Cau Ngang	0.466	Average
Tra Cu	0.485	Average
Duyen Hai	0.462	Average

Vulnerability assessment

Descriptions of the social vulnerability indices in Tra Vinh province

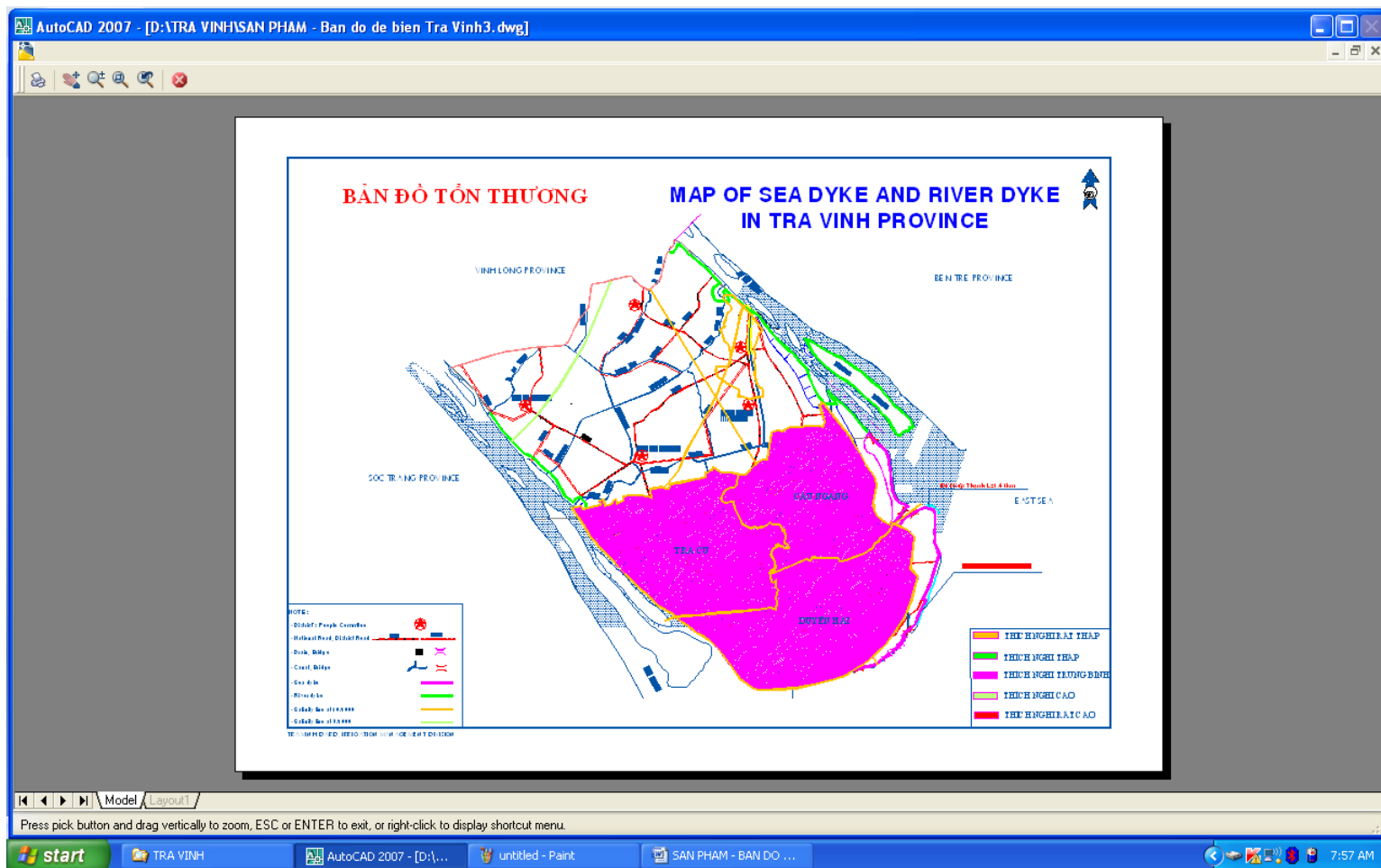
Component of vulnerability	minimum	maximum	Mean	Standard Deviation
Tra Vinh province				
Total vulnerability, in which:	0.109	1.000	0.470	0.090
Potential loss	0.000	1.000	0.273	0.347
Resilience capacity	0.133	0.702	0.453	0.117
self-recovery capacity	0.207	0.997	0.572	0.122
Duyen Hai				
Total vulnerability, in which:	0.109	0.901	0.462	0.083
Potential loss	0.000	1.000	0.316	0.345
Resilience capacity	0.177	0.637	0.426	0.123
self-recovery capacity	0.207	0.916	0.602	0.117
Cau Ngang				
Total vulnerability, in which:	0.217	1.000	0.466	0.082
Potential loss	0.000	1.000	0.256	0.386
Resilience capacity	0.133	0.702	0.461	0.111
self-recovery capacity	0.261	0.996	0.546	0.118
Tra Cu				
Total vulnerability, in which:	0.284	0.715	0.485	0.105
Potential loss	0.000	1.000	0.260	0.231
Resilience capacity	0.215	0.689	0.465	0.117
self-recovery capacity	0.327	0.997	0.594	0.125

Vulnerability assessment

Determinants of salinity-related household vulnerability

Location	Component of vulnerability		
	Potential loss	Resilience capacity	self-recovery capacity
Duyen Hai	A little	Many	Many
Cau Ngang	A little	Many	Many
Tra Cu	A little	Many	Many
Tra Vinh province	A little	Many	Many

Vulnerability assessment



Map of salinity vulnerability at Tra Vinh province

Salinity situation

Description of the sample

Awareness and coping to salinity

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Assessment of adaptive capacity

Household's coping measures to salinity

Measure	Compared to total number of sampled households		Compared to number of households using coping measures to salinity	
	frequency (person)	percent (%)	frequency (person)	percent (%)
Change in crop calendar	363	20.0	363	47.7
Maintaining the internal dyke, sluice systems	290	16.3	290	38.1
Change to another crop	108	6.1	108	14.2
Total	1,814	42.4	761	100.0

Source: Survey (2012)

Assessment of adaptive capacity

Involvement of institutional in helping farmers coping to the salinity

Institutional	Before salinity		During Salinity		After Salinity	
	frequency (person)	percent (%)	frequency (person)	percent (%)	frequency (person)	percent (%)
Women union	171	9.4	15	0.8	5	0.3
Farmer association	151	8.3	18	1.0	5	0.3
Youth union	111	6.1	18	1.0	7	0.4
Veteran union	51	2.8	0	0.0	0	0.0

Source: Survey (2012)

Assessment of adaptive capacity

Institutional' measures in helping farmers coping to the salinity

Measure	Before salinity		During Salinity	
	frequency (person)	percent (%)	frequency (person)	percent (%)
Informing the crop calendar	265	14.6	0	0.0
Repairing the dyke	76	4.2	40	2.2
Technical supporting (credit, seed, ...)	102	5.6	9	0.5

Source: Survey (2012)

Assessment of adaptive capacity

Household evaluation on community-based measures to coping with the salinity

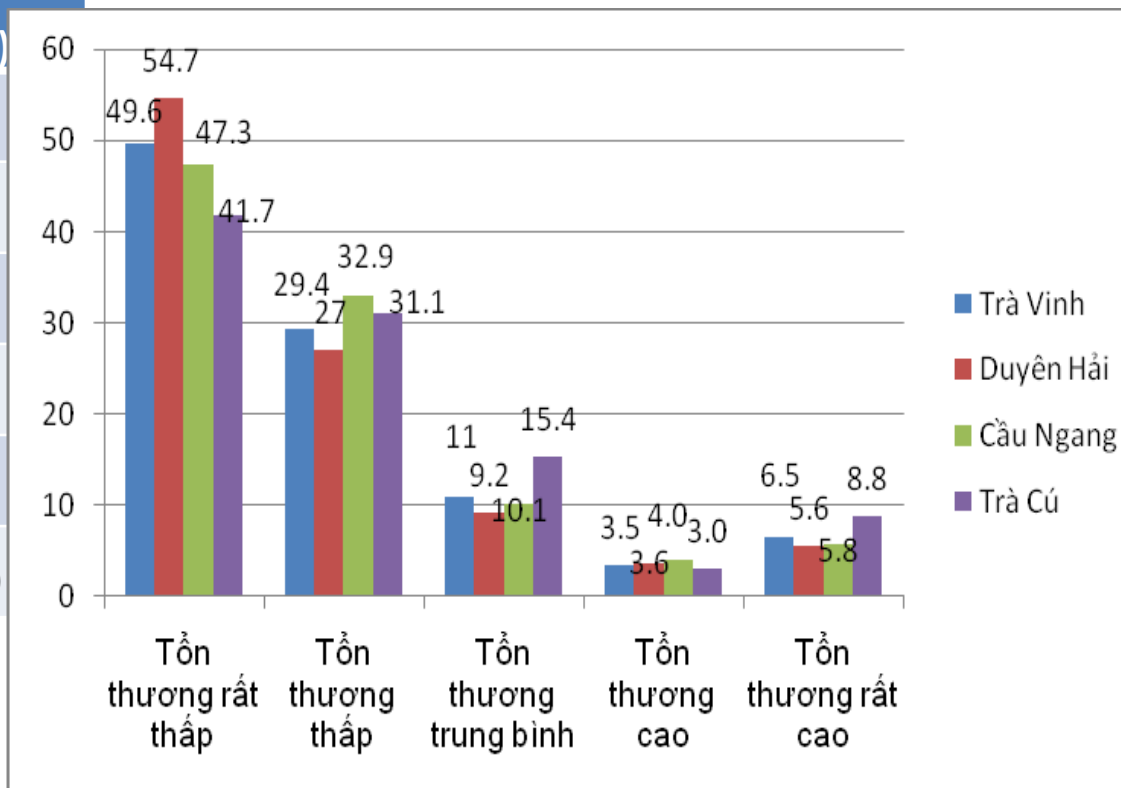
Degree of ease of finding the salinity-resistance measure	frequency (person)	percent (%)
Not easy at all	33	1.8
A little	370	20.4
Average	654	36.0
Easy	659	36.3
Very easy	98	5.4
Total	1,814	100.0

Source: Survey (2012)

Assessment of adaptive capacity

Household adaptive capacity (HACI)

Degree of adaptive	frequency (person)	percent (%)
Very low	27	1.5
Low	435	24.0
Average	1,152	63.4
High	200	11.0
Very high	0	0.0
Total	1,814	100.0



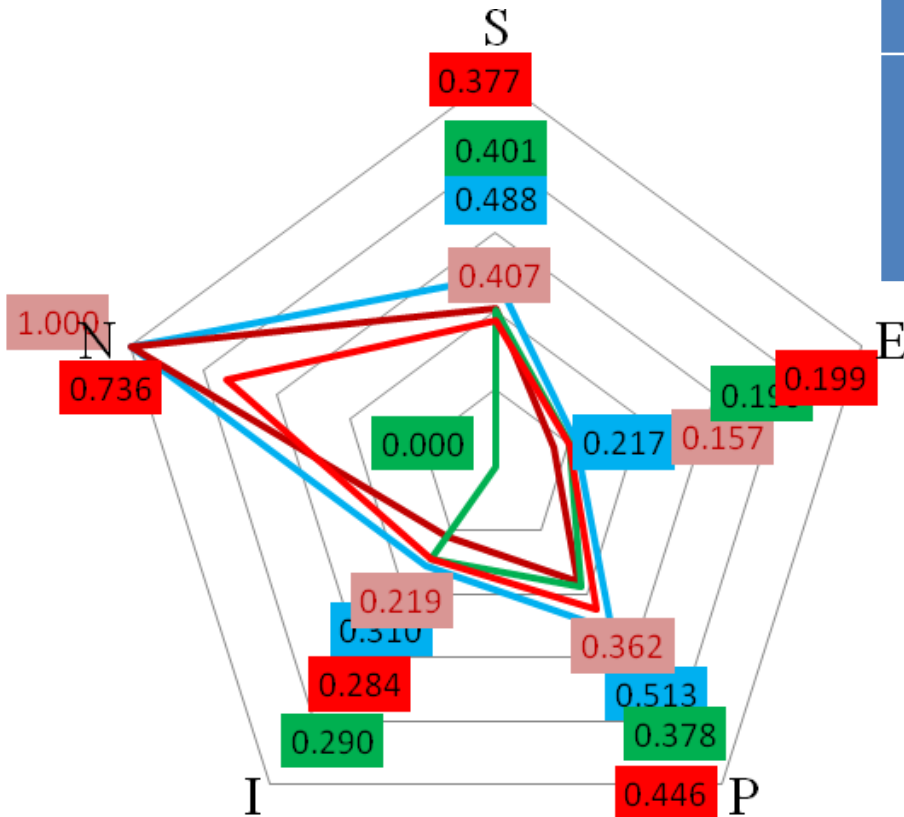
Assessment of adaptive capacity

Community-based adaptive capacity (CACI)

Location	Adaptive component					CACI
	Social (S)	Economic (E)	Physical (P)	Institutional (I)	Natural (N)	
Cau Ngang	0.488	0.217	0.513	0.310	0.939	0.542
Tra Cu	0.407	0.157	0.362	0.219	0.977	0.438
Duyen Hai	0.473	0.215	0.400	0.274	0.021	0.317
Tra Vinh province	0.377	0.199	0.446	0.284	0.736	0.468

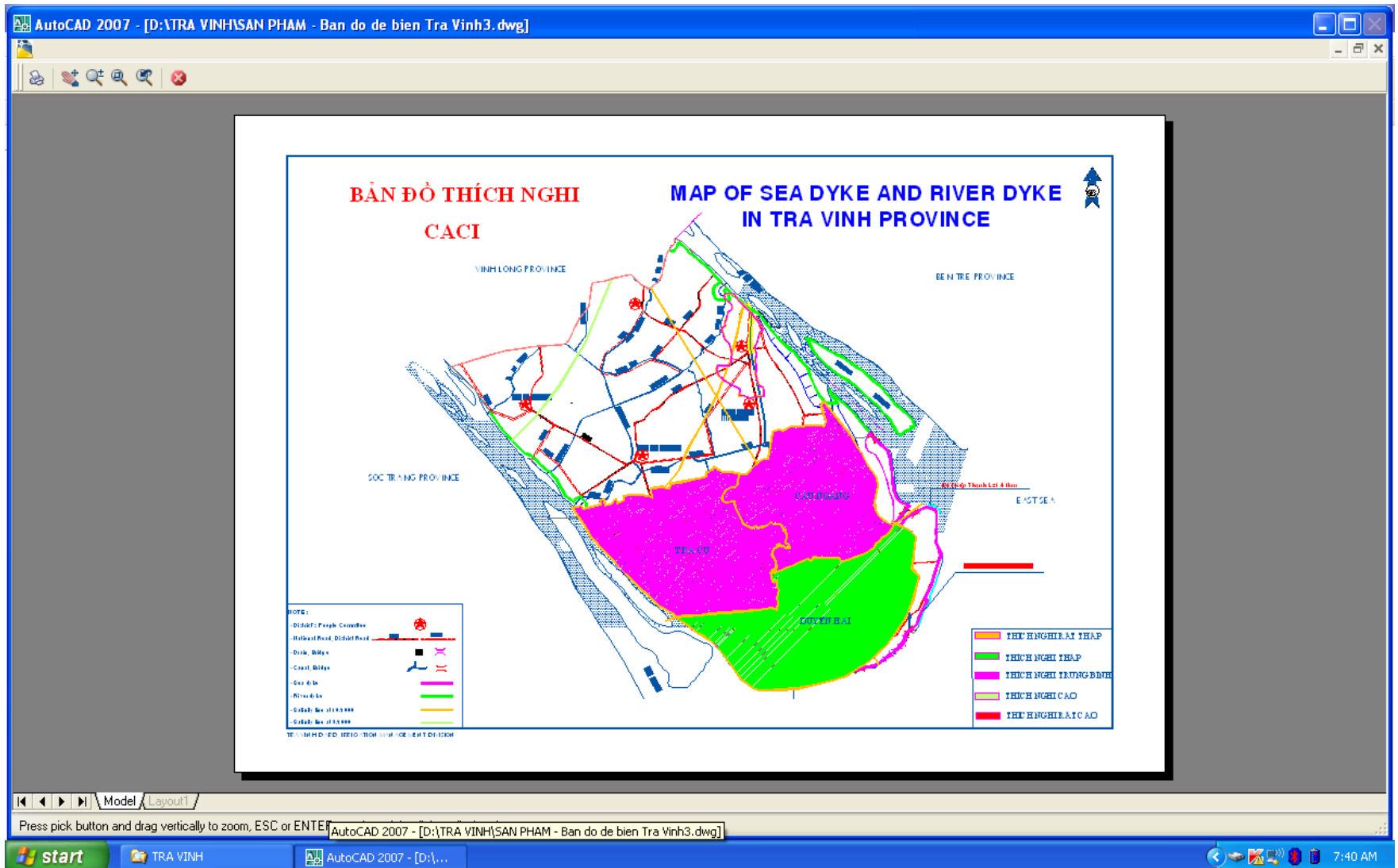
Assessment of adaptive capacity

Commune	Component				
	(S)	(E)	(P)	(I)	(N)
Duyen Hai	High	Low	High	Low	Low
Cau Ngang	High	Low	High	Low	High
Tra Cu	High	Low	Low	Low	High
Tra Vinh province	High	Low	High	Low	High



- CÀUNGAN
- TRÀ CÚ
- DUYÊN HẢI
- TỈNH

Map of community-based adaptive capacity



Salinity situation

Description of the sample

Awareness and coping to salinity

Vulnerability assessment

Assessment of adaptive capacity

**Determinants of vulnerability
& adaptive capacity**

Determinants of vulnerability

- aquaculture, farm size, community connection, and household income had **negative** impacts on the degree of vulnerability.
- location, dependent ratio, and status of salinity had **positive** impacts on the degree of vulnerability.
- no significant difference in the degree of vulnerability between Duyen Hai and Cau Ngang
- But, significant difference in the degree of vulnerability between Duyen Hai and Tra Cu.

Variable	Value of variable	Estimated coefficient
Constant coefficient		0.5240
DUM-aquaculture	aquaculture = 1; other = 0	-0.0160** (0.0150)
DUM-vegetable	vegetable = 1; other = 0	-0.00007 ^{ns} (0.9920)
DUM-Area	≥ = 1; other = 0	-0.0140** (0.0370)
DUM-Cau Ngang	Cau Ngang = 1; other = 0	0.0020 ^{ns} (0.8230)
DUM-Tra Cu	Tra Cu = 1; other = 0	0.0290* (0.0000)
Distance	Distance to coastal area(km)	0.0010 ^{ns} (0.3010)
Dependent	dependent ratio (%)	0.1320* (0.0000)
Salinity	Degree of salinity (1: abnormal, 5: normal)	0.0070* (0.0030)
Connection	Community connection(1: very easy, not easy at all)	-0.0220* (0.0000)
Earnings	Annual income (Million VND)	-0.00005* (0.0000)

Determinants of adaptive capacity

- farm size, location, type of farming system, household head's gender, and education had statistically significantly impacts on the household's adaptive capacity to the salinity

Variable	Value of variable	Estimated coefficient
Constant coefficient		0.0010
DUM-Tra Cu	Dummy; Tra Cu = 1; other = 0	0.0020* (0.0000)
DUM-Area	Dummy; ≥ 1ha = 1; other = 0	0.0010** (0.0170)
DUM-aquaculture	Dummy; aquaculture = 1; other = 0	0.0020* (0.0000)
DUM-vegetable	Dummy; vegetable = 1; other = 0	0.00002 ^{ns} (0.4700)
DUM-Gender	gender (Nam = 1, Nữ = 0)	0.0010** (0.0660)
Education	Head's education (number of year)	0.0010* (0.0000)
Age	Head's age (number of year)	0.00002 ^{ns} (0.01880)

policy recommendation

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policy recommendation

- Public awareness raising
- Community connection
- Structures and technologies
- Production adjustment
- Socio-economic measures

more.....

- Integration of Climate Change into Masterplan
- Vulnerability Assessment & Agriculture and Rural Development Plan
 - ✓ District vs. Commune vs. Province
- Different measures of vulnerability index
 - ✓ Standardization
 - ✓ Social index vs. technical index
 - ✓ Weight-related problems

Thank you.