Economic Analysis of Farm Household Perceptions and Preferences for Salinity Intrusion Risk Reduction in the Mekong River Delta

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Declaration

I certify that this work contains no material which has been accepted for the award of any degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and, where applicable, any partner institution responsible for the joint-award of this degree.

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Publications arising from this thesis

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Abstract

As a result of three prime compounding factors, sea water is intruding into the Mekong River Delta (MRD). Declining flows, as a result of increasing upstream water use, are a primary cause of sea water intrusion. Climate change-induced sea level rise is a secondary cause. Finally, increased water use due to an expansion in the number of farmers planting three, rather than two, rice crops per year have generally extended the total area of salinity intrusion in the MRD. Adverse impacts of this increased salinity on rice and other forms of agricultural production are now occurring, and are expected to get worse; with severe consequences for local farmers and rural incomes.

To address the issue of MRD salinity intrusion various mitigation and adaptation strategies have been proposed. Chief among these strategies is the construction of earthen and concrete sea-dikes along the MRD coast to protect farmland from flooding, and to prevent further salinity intrusion. It has been estimated that, based on the total MRD coastal region length involved, it would require an investment of between US$1.7 and US$4.1 billion to construct concrete sea-dike walls to a height of between two and four meters, respectively. Although the benefit of concrete sea-dikes is significantly higher than their cost, Vietnam like other developing countries is limited in its capacity to fund projects of this nature. Hence, there is a degree of uncertainty for policy-makers as to how best to proceed. It is possible that Vietnam could access international funding to support its strategic construction plans, especially as the need for much of the damage that would be prevented has been caused by others. But if this were achieved, there would be repayment issues for the loans, as well as the ongoing costs of sea-dike maintenance and operation.

In this context, it is possible that affected farmers as beneficiaries of a MRD sea-dike construction program, might provide part or all of the necessary funds. This thesis therefore seeks to explore MRD farmer perceptions of salinity intrusion impacts, and their willingness to contribute to the cost of building and maintaining the sea-dikes necessary to protect their livelihoods.

The project collected primary data from a sample of 441 farm households, stratified by salinity intrusion impact level. The results provide an in-depth economic analysis aimed at contributing to the research literature, and practical policy advice for consideration by the Vietnamese, other developing country governments, and the broader international community.

Two broad research questions were examined in this study: (1) whether or not community-based governance arrangements designed to mitigate salinity intrusion impacts may succeed in developing countries, and in terms of methodology, (2) can inferred valuation (IV) approaches to the estimation of willingness to pay be used to reduce payment-bias impacts commonly associated with conventional Contingent Valuation Methodology estimates of value.

The results of the farm households' perception analysis in Chapter 2 reveal that farm households are aware of the salinity intrusion risk, and have already implemented some adaptation strategies. The analysis offers an understanding of how MRD farm households respond to salinity risk, and farmer perceptions of the effectiveness of any private and public responses. Facing the dilemma of changing traditional paddy-rice farming to aquaculture, livestock and/or other off-farm activities, MRD farm households are seeking more detailed salinity impact risk information from local and central authorities. Notably, additional to impacts on physical health, this analysis found evidence of adverse impacts of salinity intrusion on farmers' mental health.

Chapter 2 also finds that farmers have a strong preference for the construction of infrastructure in order to mitigate salinity intrusion impacts, which allow them to maintain rice farming. These results indicate farm households' choices are consistent with other climate change perception studies in the literature. Building upon the data collected, this study goes on to recommend some specific local policy proposals to mitigate salinity intrusion risk mitigation, and improve planning arrangements. In summary, local authorities and policymakers are advised to recognize the benefits of making greater investments in awareness programs as they consider how best to construct sea-dikes and the associated hard infrastructure necessary to reduce the adverse effects of salinity intrusion. When making these recommendations, pragmatically it is assumed that the international community and upstream water users in the Mekong River will never be made to pay for the full cost of building the concrete sea-dikes needed to maintain rice production in the MRD; even though they have caused most, if not all, of the need for it.

Chapter 3 in this thesis employs a referendum Contingent Valuation Methodology (CVM) approach to estimate farm household willingness to pay for sea-dike salinity intrusion risk mitigation including ongoing operation and maintenance. Interviewee responses indicate that farm households are willing to contribute sufficient funds to reduce any deficit associated with international loans, as well as ongoing annual maintenance and operational costs. Interestingly, and consistent with other studies, our results show that farmers are willing to make a significant cash contribution – even in areas that are unlikely to be affected by salinity intrusion in the next 15 years.

Chapter 4 then explores the use of an inferred valuation (IV) method, which can be employed to potentially provide robust estimates of willingness to pay than a conventional CVM. In WTP estimation research, social desirability bias, hypothetical bias, and large private gains can result in over-estimates of willingness to pay. It is reasoned that before settling on a final program, policy-makers would be well-advised to check the robustness of farmer willingness to pay estimates. I therefore use several mechanisms to address hypothetical bias impacts, and explore whether any overestimation has occurred.

It is found that the determinants of WTP are broadly consistent across different valuation approaches. However, the IV estimates of willingness to pay were found to be as much as 17 percent lower than the conventional CVM estimations; although it must be noted that these values still account for a very small proportion of annual farm income. Moreover, in real dollar term any disparity may not significantly alter the actual contribution levels by MRD farmers. This may have important implications for the financial viability of salinity mitigation project funding, and any future loan repayment/operational maintenance cost-recovery requirements.

Overall, the findings from this thesis confirm that MRD farm households are aware of salinity intrusion threats, and that they are willing to pay for reduced salinity intrusion risks. Significantly, it is found that community financial contributions towards salinity intrusion mitigation projects could be used to overcome any public funding deficit. In passing, I observe that this result could be generally applicable to other developing countries.

Chapter 4 also finds that, to mitigate any bias arising from the estimation of stated values for non-market goods, the use of IV methods offers a valuable alternative estimation approach and, arguably, more reliable approach than conventional CVM. Further, involving *cheap talk* script and provision point mechanism (PPM) payment vehicles as *ex-ante* instruments also offer effective means to mitigate bias.

Future researchers may like to extend from this study in the following ways. Firstly, the survey could be expanded to include all adult members of a household, rather than focusing only on the farm households' head. More in-depth householder perception analysis would then be possible, as well as the capacity to focus on gender issues. Secondly, it might be useful to expand the survey to other areas of Vietnam where salinity intrusion impacts are also being experienced. Finally, if the policy recommendations for contributions to a mitigation fund are accepted, then it would be important to determine the extent of the gap between stated intentions and the actual contribution households are willing to pay as the program is implemented.

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List of Abbreviations

CVM	Contingent Valuation Methodology
DARD	Department of Agriculture and Rural Development
Ha	Hectare
HH	Household
IV	Inferred Valuation
Km	Kilometres
MNL	Multinominal Logistic Regression
MRD	Mekong River Delta
PPM	Provision Point Mechanism
SI	Salinity Intrusion
SLR	Sea Level Rise
US$	United States Dollar
VND	Vietnam Dong
VHLSS	Vietnam Household Living Standards Survey
WTP	Willingness-to-pay

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Chapter 1: Introduction

1.1 Research background and motivation

Totaling about 4 million hectares and producing around 45 per cent of Vietnam's rice, the Mekong River Delta (MRD) plays an important role in the Vietnamese economy. Around 22 per cent of the population live there and, in the past, flooding has been one of this region's most serious problems. In recent years, however, rising sea levels, increasing agricultural water use, and a significant decline in river flows from upstream areas of the MRD have introduced a more serious problem – salinity intrusion. This thesis focuses on this problem.

Salinity intrusion, typically, occurs when saline water migrates inland or upstream to places where freshwater previously dominated (Grabemann et al., 2001; Rice et al., 2012). From a hydrological perspective, Werner (2017) cited in Bear (2012) defined salinity intrusion as "the landward movement of seawater in coastal aquifers arising from disequilibrium between the boundary conditions and the position of the fresh-seawater mixing zone". The problem is not unique to the MRD, it can also be found in other deltas such as the Ganges River Delta in Bangladesh and West Bengal, India.

In practice and based on the movement of seawater and the groundwater flow, salinity intrusion can be classified as active SI, passive SI or passive-active SI (Werner, 2017). Sea level rise is one of the most common causes of salinity intrusion (Werner, 2017, Cosslett, T. L, & Cosslett, P. D., 2014).) and is typically caused by climate change and/or groundwater depletion[1] (Konikow, 2011). In the

[1] Global groundwater depletion attributes 12.6mm of sea level rise during 1900-2008 which is higher than 6 percent of the total (Konikow, 2011)

MRD, however, these processes are further aggravated by the construction of upstream dams and the construction of irrigation works that have enabled the development of three-rice-crop per year rotations (The Vietnam Academy for Water Resources, 2016).

The extent of the current problem and expected increases in it are shown in Figure 1.1. MRD salinity intrusion is expected to worsen as a result of further sea level rise and upstream dam construction (Khang et al., 2008). A recent study commissioned by the World Bank has shown that, under a very plausible one-meter sea level rise, Vietnam will be the most adversely affected country in the developing world (Buys et al., 2006). This study concludes that, if the sea level continues to rise and, as predicted, further dam construction reduces summer flows, 45 per cent of the MRD will be affected by salinity intrusion by 2030.

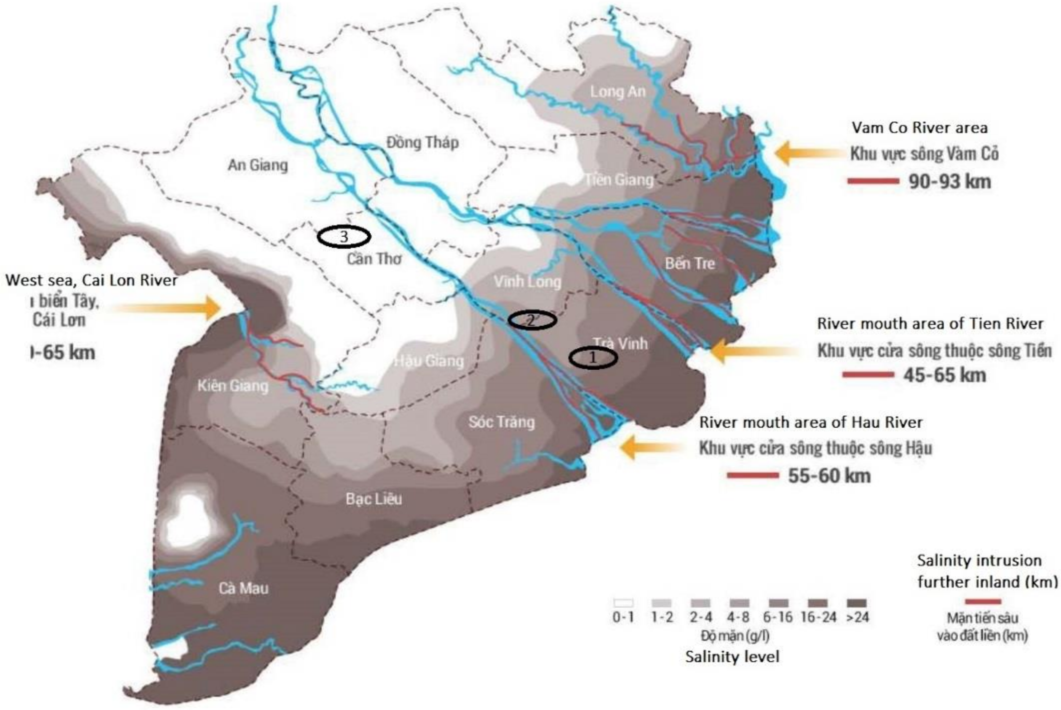

Figure 1.1 Mekong River Delta salinity intrusion levels in 2015

Source: Adapted from the Vietnam Academy for Water Resources (2015)

The likely impact of further dam construction is of particular concern from a MRD perspective as, since 1990, China has been building 19 dams Moreover, a further 12 dam projects are under consideration in Lower Mekong countries (Grumbine et al., 2012; Molle et al., 2012). Whilst dam projects are expected to generate energy and wealth for upstream users, they have clear negative outcomes for people living in the MRD where flows are expected to reduce. Flow reduction is caused primarily by the construction of dams which in turn enables the manipulation of seasonal flows so that hydropower generation opportunities can be maximized and total utilization increased. As indicated in Figure 1.2, the MRD is located at the end of the Mekong River Basin; any water flow changes from upstream countries will result in the significant reduction of fresh water supply in this area.

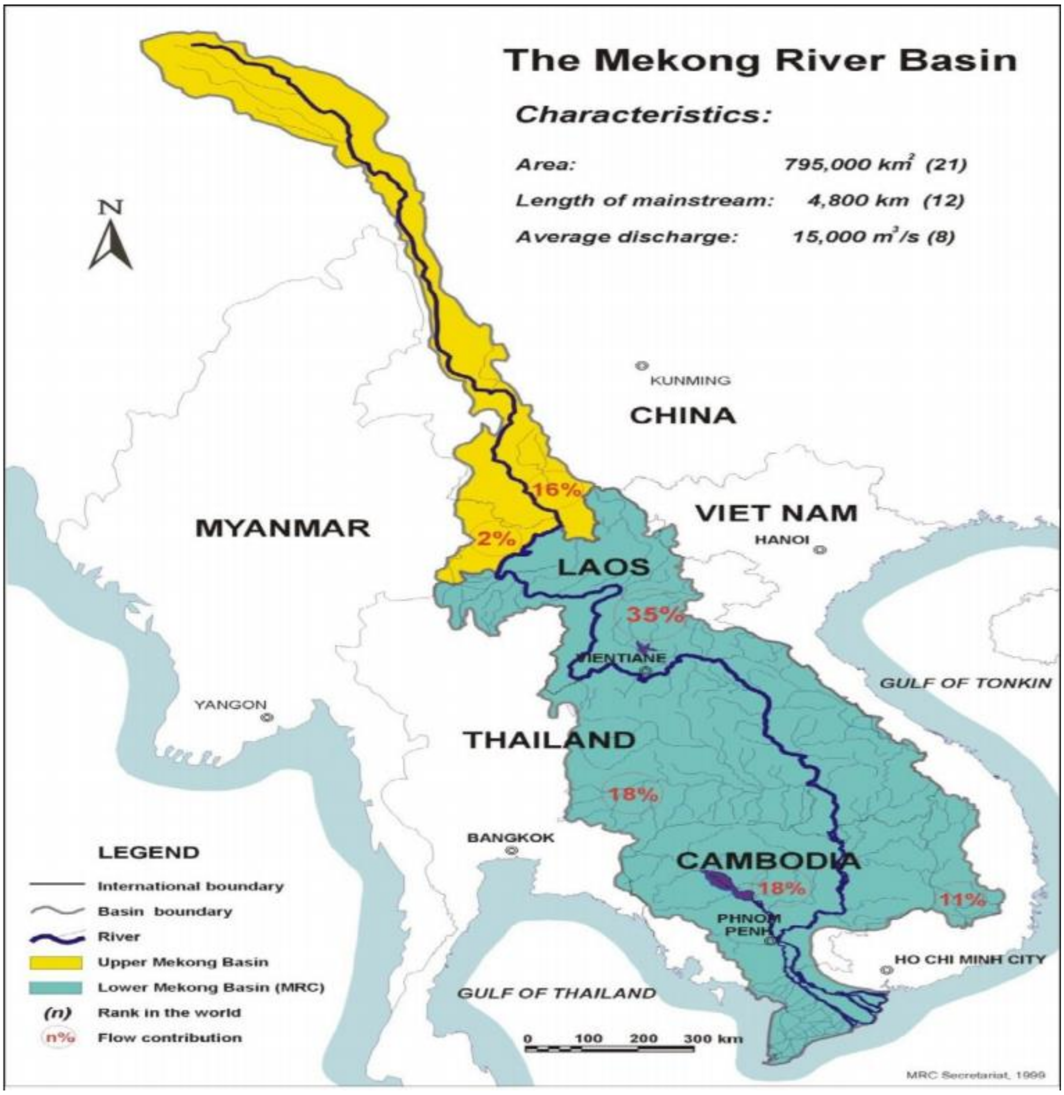

Figure 1.2 The Mekong River Basin and water flow contribution by country

Source: Mekong River Commission, Data and Information Services

Finally, it is possible that, as a result of climate change there could be an increase in drought frequency in a manner that further reduces river flow and, as a result, further increases salinity intrusion in the same manner that this occurred during the 2016 El Nino event (National Hydro-Meteorological Service of Vietnam, 2017).

From a MRD viewpoint, the consequences of salinity intrusion are many. One of the direct and major influences of increased salinity is decreasing agricultural output, especially rice yields (Bhuiyan and Dutta, 2012). The worst impacts are predicted to occur in coastal provinces such as Tien Giang, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau, and Ben Tre (Center of Environmental Engineering, 2012). Currently, the total affected area is already about 620,000 hectares, which accounts for nearly 20 per cent of the MRD area. Since 2015, salinity intrusion impacts have also been exacerbated by drought in the upper Mekong. Evidence that the problem is getting worse is supported by the fact that, for the first time, saline water was detected in 2015 in the inland provinces of Kien Giang and Hau Giang (TuoitreNews, 2015). More detailed estimates of the extent of productivity loss are shown further in Figure 4.1. When measured by the dollar value of exports, Vietnam was ranked as the world's third largest rice exporter. In recent years, however, rice exports have declined by 47% (The World Factbook, 2018).

In response, local authorities have begun to search for new management strategies. Options under consideration include changing irrigation schedules, increasing local water storage and altering planting times. These options, however, are viewed broadly as short-term solutions (1-5 years). In search of a long-term solution (>30 years), two alternative options have emerged. The first option is regarded as a 'soft' policy approach and is supported by those involved in the National Program on Responding to Climate Change (Smajgl et al., 2015). This soft policy approach involves deciding to live with the problem, change cropping patterns and starting to farm fish in the increasingly saline water (Smajgl et al., 2015). Changed agricultural insurance arrangements have also been proposed as this would allow farmers to shield themselves from the adverse effects of salinity intrusion. It has been found, however, that the nature of most farm household'[2] income in the MRD makes it difficult if not impossible to design and implement an effective agricultural insurance program (Khoi, 2014; Thong, 2014). As these authors observe, the financial wisdom of insuring farmers against an inevitable outcome is questionable.

The second option is to invest in 'hard' infrastructure construction such as the construction and enhancement of existing sea dikes. Exploring this option, Danh (2012) and Danh and Khai (2014) have considered the possibility of expanding the current network of earthen sea dikes and converting them to concrete structures. Under a range of construction scenarios, the authors find a significant positive benefit-cost ratio and therefore recommend that the investment is made. This approach is supported by the Dutch-Vietnamese cooperation on the Mekong Delta Plan; the Japan International Cooperation Agency (JICA)-funded Climate Change Master Plan; and the Mekong Delta Water Resource Plan.

Supporting this second option, in May 2009, the Vietnamese government issued Decree No. 667/QD-TTg that puts in place a suite of programs designed to maintain and upgrade sea dike systems in the central to the southern areas of Vietnam. This Decree, however, has yet to be funded and requires an investment of billions of USD to be effective (Danh and Khai, 2014; Jonkman et al., 2013).

Questioning the wisdom of this second option, local and national commentators in Vietnam argue that budgets are limited and that the country as a whole cannot afford to build the dikes needed to prevent salinity intrusion that the replacement of

[2] The term 'Farm household' refers to all family members who (1) have lived together for at least 6 months in the last 12 months in the house and (2) are taking food from the same kitchen and (3) are contributing to the household's income and/or drawing from it.

earthen dikes would be too expensive and that local government bodies cannot afford to maintain them (Danh, 2012). Recognising that these arguments may be valid, this thesis explores the question of whether or not farm households as the principal beneficiaries of these construction works should be required to contribute to the cost of their construction and maintenance.

The research in this project is undertaken in an attempt to assist policy makers and local authorities to decide on whether to invest in 'hard' infrastructure approaches or 'soft' policy approaches, and as such this thesis aims to gather objective information on MRD farm households perceptions, classified by region of:

1. salinity intrusion risk
2. preferences for the management of this risk
3. willingness to contribute their own funds towards the cost of constructing and managing dikes.

Using this information, the thesis closes with recommendations to national policy-makers and local MRD authorities as to whether or not household willingness to contribute is sufficient to justify the collection of all or some of the estimated cost of the proposed sea dike program. Having done this, final observations are drawn to the attention of those responsible for considering the costs of managing sea water intrusion in other developing country river deltas.

1.2 Research objectives and questions

1.2.1 Research objectives

The overall aim of this project is, therefore, to gather objective information from farm households in order to derive policies and principles for the management of salinity intrusion risk in the MRD. Data is collected and stratified by objective estimates of salinity risk so as to provide local authorities with detailed information to assess policy responses associated with considerations of deciding to adapt to and live with increasing salinity intrusion versus investment in the development of a sea dike system. To achieve these aims, the following specific objectives are set for this thesis:

(1) To identify farm households' perceptions of and current/future adaptation strategies in response to salinity intrusion in the MRD[3].

(2) To estimate farm households' willingness to pay (WTP) for salinity intrusion risk reduction, and the factors that affect their WTP decisions.

(3) To estimate consistent and conservative WTP values without bias by comparing two different valuation response techniques: conventional contingent (CV) and inferred valuation (IV) methodologies.

(4) To identify policy implications for the management of salinity intrusion risk in the MRD, and inform changes to the typical methodology employed for eliciting WTP values for public goods in the broader literature related to climate change risk reduction.

1.2.2 Research questions

As set out in Figure 1.3 and in order to achieve the research objectives, this thesis will address the following research questions:

[3] That is, the study seeks to examine the perceived impacts of salinity intrusion at farm household and regional levels, provide descriptions of those adaptation measures which have already been applied, and, also, to discover farm households' intentions/preferences for adaptation in future.

(1) Are farm households aware of the causes and impacts of salinity intrusion on their livelihood and farming activities? (The null hypothesis is that they are not aware).

(2) How do farm households in the MRD deal with salinity intrusion risks at individual and community levels via autonomous and public adaptation strategies? (The null hypothesis is they are not responding to changes in salinity intrusion risks.)

(3) What factors determine farm households' adaptation actions to salinity intrusion and what drivers affect their agreement level regarding expected public adaptation strategies?

The first two questions seek to discover how farm households perceive and have adapted to salinity intrusion recently, and their intentions to adopt other/similar strategies in the next three years. The third question seeks to provide information about the determinants of farm households' private adaptation actions and their preferences for future public intervention actions. The data is organized so as to test whether or not differences in farm households' perceptions between current and intended adaptation measures exist (Q1). The null hypothesis is that no differences exist.

Building upon this information and in order to determine farm households' WTP for salinity risk reduction, this thesis goes on to attempt to answer the four further research questions:

(4) Are farm households in the MRD willing to pay for collective action to manage salinity intrusion risk reduction?

(5) If so, how much they would be willing to contribute?

(6) Regarding the drivers and WTP values, are there any differences among farm households living in different areas stratified by salinity intrusion, including salinity intrusion areas, high risk of salinity intrusions and a control group?

(7) What are the determinants of farm households' positive WTP, based on farm households' socio-demographic characteristics and their location?

If farm households are willing to pay, then it may be possible to develop a program based on a PPM payment vehicle that would mandate household contributions to the cost of dike maintenance, their heightening and, even the costs of constructing the necessary mouth sluices, etc. It may also be possible to develop incentive programs that encourage farm households to pursue their own adaptation options.

One way of examining this issue is to find out whether or not the stated WTP value is dependent on the salinity intrusion level and, as indicated in the literature, socio-demographic characteristics of farm households are key determinants in positive farm households' WTP for salinity intrusion risk reduction projects and do not differ in respect of farmers' location. Therefore, another null hypothesis this research aims to test is that stated WTP values are not affected by farm location (indicating the differences of salinity intrusion level) and other socio-demographic characteristics of farm households.

Finally, since the data collected through the research is obtained by proposing a hypothetical rather than a real program, the thesis also seeks to test the robustness of conventional Contingent Valuation Modelling (CVM) by asking:

(1) Is there any over/underestimation of willingness to pay for salinity risk reduction among MRD farm households?

(2) Are there any differences between conventional CVM WTP value determinants, and Inferred Valuation (IV) WTP value determinants?

By answering these specific research questions, this thesis seeks to determine whether or not IV estimation approaches be used to mitigate hypothetical biases that are commonly present in conventional CVM? If the determinants of the two different WTP value estimations are statistically different and these values derived from two approaches are also different, then the usefulness of IV approaches for identifying bounds of WTP that may inform investment choices will have been provided with additional evidence.

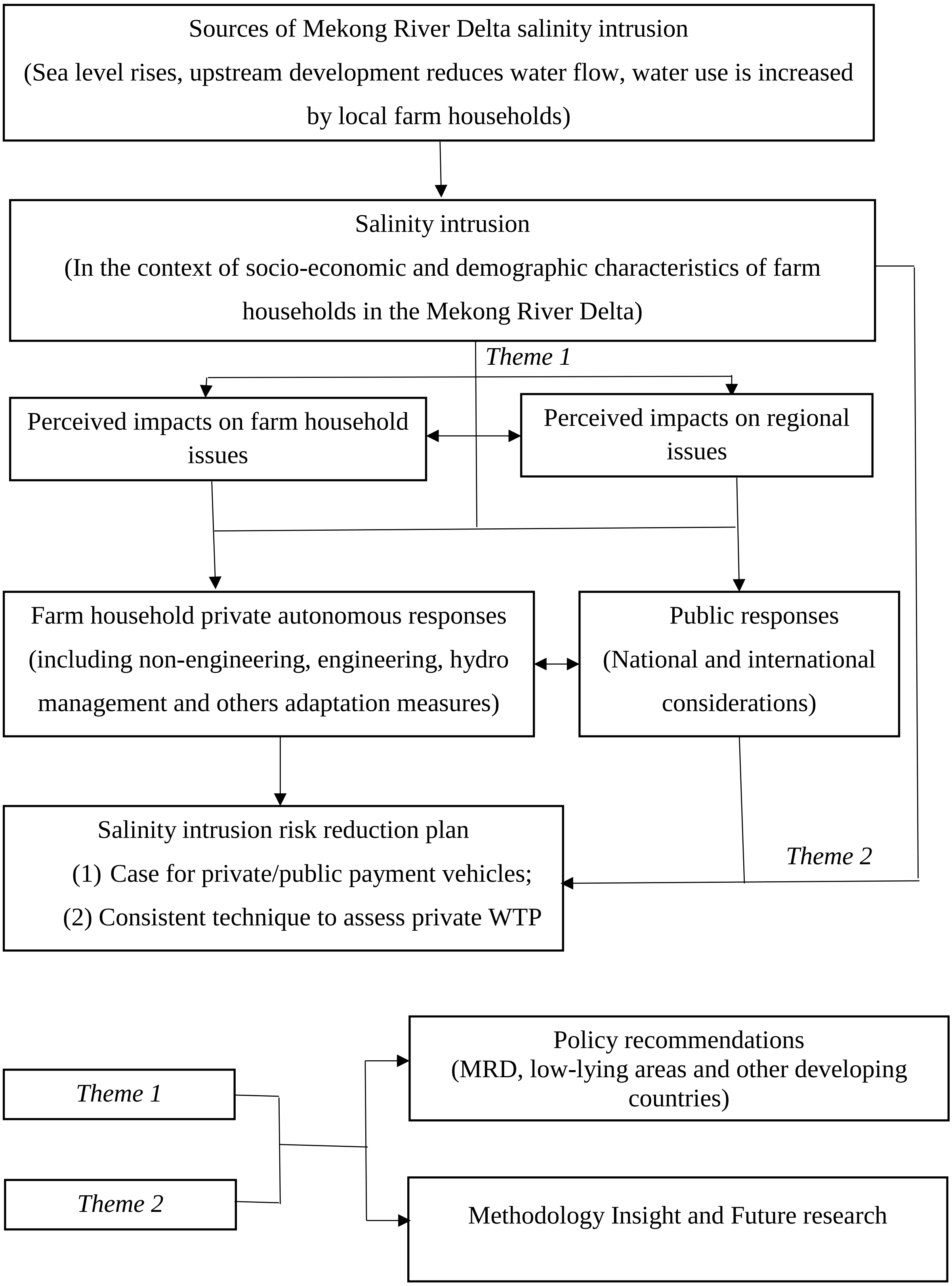

Figure 1.3: Conceptual framework for the research

1.3 Contribution to the Literature

The research described in this thesis also presents a unique opportunity to contribute to the development of literature.

First, most research on adaptation to climate change in developing countries is general in nature. That is, very little is regionally and context-specific (Gbetibouo, 2009; Le Dang et al., 2014; Nguyen, 2011). This thesis seeks to examine a particular adverse consequence of one climate change impact - salinity intrusion caused in part by sea level rise as a largely as a result of the melting of previously frozen landscapes and the flow of this water into the sea. So far, little information and evidence related to salinity intrusion risk reduction preferences and perceptions have been collected in the context of developing countries.

Second, many previous studies have tended to treat salinity intrusion ex-ante as a disaster. In this thesis, however, information about farm households' perceptions is was collected without any ex-ante context that presented salinity intrusion as a disaster. Rather the tone was one that presented the forthcoming challenge as a problem that could be managed, albeit at a cost. This is important, as some farm households may have adequate means to adapt to salinity intrusion impacts, and may even see salinity intrusion as a way to increase income through a transition to aquaculture. That is, the thesis aims to collect information about current behaviour and intentions in a non-negative manner. The study is unique in the sense that in the areas where salinity intrusion has already occurred, we can collect information on adaptions that have been made.

Third, in addition to employing a standard IV question approach to test the robustness of conventional CVM value estimates, this research tests a novel IV question. In this thesis, each survey respondent was asked to predict how much they think their neighbours would state that they (i.e. the respondents) would be willing to contribute to a salinity management program is then compared with estimates derived from both CVM and the standard IV question. This is presented as a test of the robustness of the WTP estimates derived but, in response to comments received when the relevant paper was submitted for publication, was deleted from Chapter 4 and as a consequence is presented in Appendix 1, 2 and 3.

1.4 Data collection and methods description

The primary data used in this thesis was obtained through a stratified field survey with three replicates.[4] The survey was led and conducted by Tien Dung Khong (thesis author) in the Mekong River Delta in late 2016. The survey involved three different districts in three different provinces –Tra Vinh Province, Vinh Long Province and Can Tho Province. Within these districts, the face-to-face survey focused on three groups of farm households: the first group was drawn from areas where salinity intrusion was already occurring (Cau Ke district), the second group involved farm households in areas with a high probability that salinity intrusion was about to occur (part of Cau Ke district and Tra On district), and the third comprised a control group where there is no risk of salinity intrusion in the near future (Vinh Thanh district). Households to be included in the survey were chosen randomly from lists provided by local government agencies. After data cleaning, a final sample of 441 (out of 450) farm households were stratified by salinity intrusion

[4] This research was approved by the University of Adelaide Human Research Ethics Committee with Ethics Approval No. H-2016-123 (Appendix 6). A Participation Information Sheet and Consent Form was also provided to/obtained from all participations before the survey started (Appendices 7-10)

level to be included in the analysis. Survey reports have a response rate of higher than 95% and, based on the comparison with another national survey results, demonstrate that the survey sample is broadly representative of the MRD farmer population. The protocol of the survey is explained in detail in the subsequent analytical chapters[5]. The survey instruments, including the questionnaire, consent form, and participant information sheet are also presented in the Appendices (4-10).

After a discussion about the relevance and consistency of information presented on the questionnaire with experts and local officials from Department of Agriculture and Rural Development (DARD), the questionnaire was pre-tested with 30 randomly-chosen farm household heads within each study area. The purpose of the pretest survey was to: (1) to test the contents of the questionnaire to make sure respondents could understand the survey and options presented, (2) refine the range of willing to pay measures proposed, and (3) where appropriate improve the local language translations. Pre-test households were not included in the final survey sample.

Due to the importance of collecting reliable information, enumerators were chosen carefully from the staff and senior students at the Department of Agriculture of College of Economics in Can Tho University. These enumerators were all local people with experience of this form of data collection and all received additional training before the official survey took place.

The farm household questionnaire contained three main sections:

(1) socio-economic characteristics of farm households in the study area,

[5] These chapters are aimed at being 'stand-alone' articles.

(2) farm households' perceptions about salinity intrusion risks including autonomous and public adaptation strategies in salinity-affected areas and

(3) farm households' willingness to pay via a PPM payment vehicle for risk reduction projects in the MRD elicited by conventional CVM and IV methods through direct and indirect questioning approaches.

The second part of the questionnaire collected information related to farm households' perceptions about how salinity intrusion has affected them over the past few years, and how it has affected them at the regional level. Household heads were also asked to rank the causes of salinity intrusion in order of importance. They were then asked questions relating to any adaptation measures that they have applied in the past and/or intend to adopt in the future. In this section, the questionnaire also collected information about any adaptation measures local authorities have employed in local areas and perceptions about their effectiveness.

The final section of the questionnaire collected information on farmer willingness to contribute to the construction and maintenance of sea dikes. The farm households were first provided information about the proposed risk reduction plan, while conventional direct and indirect CVM and IV approaches were used to ask farm households about their willingness to pay for the plan. In all three approaches, a *cheap talk* script was utilized to reduce the prospect for hypothetical bias, and the payment vehicle followed a PPM design.

Noticeably, when compared with data collected under a national survey conducted by the General Statistic of Vietnam (GSO) every two years—namely the Vietnam Household Living Standards Survey (VHLSS)—the socio-economic and demographic characteristics of farm households presented in this thesis including the age, gender, education level, farming experience of the farm household head, household size and household income were all very similar. Therefore, it can be concluded that the analyses drawn from the observations in this thesis may be broadly representative of the MRD farmer population. More details of this discussion can be found in a published article in Chapter 3.

1.5 Structure of the thesis

This thesis contains five chapters: this introduction, three analytical chapters written in a form that is ready for publication, and a conclusion chapter. It is important to note that the three analysis chapters were designed as 'stand-alone' journal articles. Hence, the literature review, data collection and methodology contained repeats some of the information provided in this chapter.

Chapter 2 examines farm households' salinity intrusion perceptions, as well as current and intended adaptation strategies at local and regional levels of the MRD. This chapter establishes the core data, as a prerequisite to identifying and evaluating farm households' current/future adaptation strategies and determinants.

Chapter 3 examines farm households' WTP for a salinity intrusion risk reduction plan and compares these WTP values and determinants across three groups of farm households. By employing strategic behaviour techniques, a PPM payment vehicle, a *cheap talk* script to control for hypothetical bias the estimated WTP values are expected to provide the base contribution evidence from which to propose local, national and international implications for salinity intrusion risk reduction programs in the MRD.

Chapter 4 checks of the robustness of *cheap talk* scripts to manage hypothetical bias impacts, by comparing two different response techniques: conventional CVM and inferred valuation (IV). By providing another form of IV question (Appendices 1-3), this chapter also proposes a novel addition to the standard IV question that offers an opportunity for further development and testing.

The concluding chapter, Chapter 5 details possible policy implications for the management of salinity intrusion in the MRD, suggests hypothetical bias management improvements based on expanded IV value estimation approaches for studies that rely on conventional CVM, and outlines further study that could be conducted following the work undertaken in this research project.

Eighteen appendices complete the thesis.

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Chapter 2 - Statement of Authorship

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Name of Principal Author (Candidate)	Tien Dung Khong
Contribution to the Paper	Led and conducted data collection, performed analysis and interpreted data, wrote manuscript and acted as the corresponding author.
Overall percentage (%)	65%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.

Signature		Date	25/06/2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate to include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100%, less the candidate's stated contribution.

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Signature		Date	25/06/2018

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Contribution to the Paper	Supervised development of work, helped to evaluate and edit the manuscript.		
Signature		Date	25/06/2018

Chapter 2 : Farm household perceptions and responses to rising salinity intrusion in the Mekong River Delta

Abstract

Farmers in the Mekong River Delta (MRD) are adapting to rising salinity intrusion. Saline water is migrating further and further inland due to upstream damming and increased local water extraction to meet agricultural needs. Efforts to develop an MRD salinity intrusion risk reduction plan can benefit from understanding farmer awareness, along with current and intended adaptation strategies. This research samples 441 farm households and finds that some households have adopted individual strategies to deal with salinity intrusion impacts; although these actions are short-term, and their effectiveness varies. Farm households expressed concerns about salinity intrusion impacts and their capacity to cope in the future. Consistent with other research findings, MRD farmers will struggle to adapt to salinity intrusion by themselves using short- and medium-term approaches. Our results indicate MRD farmer preferences for the construction of salinity intrusion mitigation infrastructure as a means of long-term risk reduction. Further, by providing more information and training local authorities can expect to enhance farmer's willingness to contribute financially towards, and participate in, public salinity intrusion risk reduction projects.

Keywords salinity, adaptation measures, smallholder farmers, Vietnam

JEL classification Q54, Q59

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Highlights

- Salinity intrusion is decreasing agricultural productivity in the MRD
- In response, farmers are adapting to salinity intrusion autonomously
- Data suggests household understanding is variable and adaptation strategies likely flawed
- Understanding current perceptions and adaptation preferences could provide a basis for improved risk-reduction programs

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2.1 Introduction

Tropical river deltas around the world are experiencing decreased flooding and increased negative water quality impacts. Vietnam's Mekong River Delta (MRD) in particular has experienced rising levels of salinity intrusion, with significantly associated reductions in agricultural production and farm income. Sea level rise is changing MRD hydrological conditions to create increased pressure along coastal areas. The development of dams and reservoirs in countries upstream of the MRD has further altered the hydrologic properties of the Delta, reducing freshwater flows. Finally, increased water extraction to support annual three-rice crop agricultural systems has also reduced total freshwater flows to the sea.

The MRD covers an area of 4 million ha, 78% of which is used annually for rice production. It contributes more than 55% of Vietnam's rice production and more than 85% of national rice exports (General Statistics Office of Vietnam, 2016). Under salinity intrusion impacts, rice yield loss estimates vary from 2.5 tons to 4 tons per hectare (or 18 to 30 per cent of total yield loss) depending on the area and level of impact (Khai et al., 2018). Salinity intrusion impacts have increased since the 2014-2016 period, especially during the dry season, enabling salt water to intrude further inland causing significant negative impacts on rice yields. In total, nine out of 13 provinces are now affected. In 2016 specifically, more than 620,000 ha of agricultural land was affected by salinity intrusion, resulting in significant rice yield and farm household livelihood reductions. Data gathered by the Vietnam Southern Institute of Water Resource Research indicates that observed salinity levels at selected MRD stations in March 2016 were higher than previous observations for the same month in 2014 and 2015. The largest difference was observed at My Hoa station (+6.7 mg/l), and the lowest at Xuan Hoa station (+0.1 mg/l). Only three stations observed a decrease in salinity levels, but these were relatively minimal (Figure 2.1).

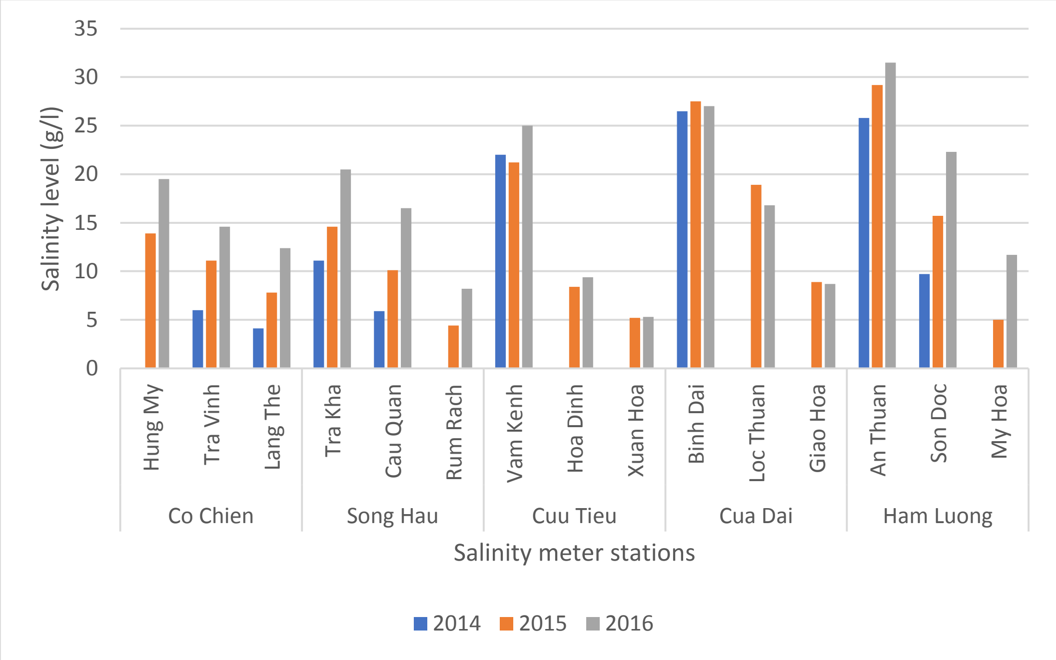

Figure 2.1 Comparison of the highest observed salinity levels in the MRD mouth area stations between March 2016, and for the same period in 2015 and 2014[6]

Source: Based on data from the Vietnam Southern Institute of Water Resources Research (2016)

In response to salinity intrusion, MRD farmers have adopted various strategies. These include changes to planting times, adjustments to fertilizer and chemical use, and accessing alternative sources of freshwater (e.g. groundwater). However, while these strategies may provide some short-term mitigation, their long-term adaptation benefits remain uncertain. Alternatively, infrastructure such as coastal sea dikes and

[6] Data obtained from a range of salinity meter stations in 2014 are not available including Hoa Dinh, Xuan Hoa, Loc Thuan, Giao Hoa, My Hoa, Hung My and Rum Rach stations

sluice gates have been identified as a long-term strategy for salinity intrusion risk reduction. Recent studies by Danh (2012) and Danh and Khai (2014) performed benefit-cost analysis to calculate the net present value of concrete sea dikes in the MRD. The analyses concluded that salinity intrusion mitigation benefits from concrete sea dikes would exceed the total costs, including construction and on-going operation and maintenance costs, with farmers as the principle beneficiaries. However, sea dike infrastructure construction, operation and maintenance would require significant public investment; which Vietnam would struggle to achieve.

As the primary beneficiaries of sea dike construction, MRD farmers could be called upon to contribute to fully fund its upfront and ongoing costs. To assess the potential for MRD farmer contributions toward mitigation projects, it will be useful to better understand current salinity impact perceptions. Further, an understanding of current and intended adaptation strategies may inform program implementation and policy decision-making. Adaptation strategies are typically not effective without information about farmers' awareness and perceptions (Alam et al., 2017), and very few smallholder farms are able to adapt to climate variability impacts alone (Nyamadzawo et al., 2013). Successful policy implementation depends on local characteristics and the specific context in which mitigation is to occur (Dost, 2010; Hoornweg, 2011). For Vietnam therefore, any lack of information about farm household perceptions of salinity intrusion risk may lead to ineffective adaptation measures (Alam et al., 2017). This study aims to provide descriptions and explanations about the divergence of adaptation measures and strategies that have been applied by farm households in the MRD to offer insights, information and policy suggestions to government officers, policymakers and other researchers in this field. Knowledge about these issues is also expected to enhance farm household-level of policy participation and acceptance.

I broadly hypothesizes that farm households are aware of the causes and impacts of salinity intrusion their livelihood and farming activities (H1). The null hypothesis is that they are not. Further, demographic characteristics (e.g. age, gender, education, family members and salinity intrusion impacts) are expected to significantly predict farmer adaptation behaviour and preferences for public adaptation strategies and differ in respect of farmers' location (H2). The null hypothesis is that no differences exist. This would suggest that some farmers will be better able to adapt autonomously, while others may require public planned interventions. This study will test our proposed research questions by identifying current farm household perceptions and adaptation strategies in response to MRD salinity intrusion. We are ultimately interested in: (1) whether farm households are aware of the causes and impacts of salinity intrusion on their livelihood and farming activities; (2) what independent strategies and measures farm households are currently adopting in response to salinity intrusion; (3) what salinity intrusion adaptation strategies (if any) farmers are intending to adopt in future; (4) what future planned public salinity intrusion mitigation strategies farm households would prefer; and (5) what drives those decisions/preferences? It is expected that this information will help to understand how local farmers have tried to adapt to salinity intrusion, and provide insights about what adaptation strategies the Vietnamese national and local governments might explore for long-term salinity mitigation solutions.

2.2 Previous research and related theory on farm households' perceptions and drivers of adaptation

Adaptation strategies are usually classified into planned and autonomous groupings (World Bank Group, 2010). Whilst planned adaptation is based on public policy decisions, autonomous adaptation is based on private actions without government intervention (Margulis et al., 2010). In the agriculture sector, private adaptations vary (World Bank Group, 2010), and can focus on changes to cropping systems, adoption of new crop varieties, input combination changes, or seeking non-agricultural-sector employment. Publicly-funded adaptation strategies include institutional and/or structural adjustment, technological options, investments in human and social capital, risk spreading, and information management (WHO - Regional Office for Europe, 2002). Margulis et al. (2010) therefore make the distinction between hard adaptation resources (e.g. infrastructure construction or technological innovations) and soft adaptation resources (e.g. cropping type or input changes at farm level).

How farmers choose to adapt is based on their perceptions of the relevant risk. Farm households that perceive greater potential climate variability impacts have a higher level of policy acceptance and participation (Niles et al., 2013), and tend to support more adaptation or mitigation actions (Arbuckle et al., 2013). Research into farmers' perceptions, adaptation behaviour and strategies have been conducted in developing countries where poorer rural populations are more vulnerable. Commonly studied factors include socio-economic demographic characteristics such as age, farming experience, household size, income and the level of perceived risk (Bosello and De Cian, 2014; Filatova et al., 2011; Gbetibouo, 2009; Hinkel et al., 2013; Ibáñez et al., 2014; Le Dang et al., 2014; Mycoo, 2014; Storbjörk and Hedrén, 2011; WHO - Regional Office for Europe, 2002; World Bank Group, 2010). Other factors expected to have an impact on farm household adaptation behaviour include financial, farm physical characteristics, social characteristics, human capital and regional factors. These variables are consistent with the estimation variables in previous studies, such as Botzen and van den Bergh, 2012; Le Dang et al., 2014; Wheeler et al., 2013, which suggest that farmers are aware of impacts or adaptation drivers, and that their perceptions align with available data (Ayanlade et al., 2017; Banerjee, 2015; Elum et al., 2017; Limantol et al., 2016).

However, private adaptation strategies are typically short-term in nature (Dubey et al., 2017), may be insufficient for reliable mitigation into the future (Ayanlade et al., 2017), and dependent upon the specific country context (Margulis et al., 2010). Therefore, it has been suggested that more data about farmer perceptions and adaptation strategies are needed in Southeast Asia (Schad et al., 2012), together with accurate information for each farming season (Mamba et al., 2015). There is some previous research into MRD farmers that explores how they have adopted strategies to cope with rising salinity. For example, farmers in the MRD have shifted to hybrid salinity-tolerant varieties of rice in some coastal provinces, introduced rice-aquaculture rotations, and constructed small local earthen sea dikes, sluice gates and irrigation systems (World Bank Group, 2010). However, studies looking at farm household awareness and adaptation strategies in response to salinity intrusion are quite rare, especially for Vietnam, and provide only limited evidence of actual strategies adopted (Ayanlade et al., 2017). It is therefore also recognised that data improvements are required with respect to smallholder farmers, particularly the information and resources that they will need to adapt and cope with future conditions (Ayanlade et al., 2017). This can offer important insights for future public salinity intrusion mitigation program design and implementation.

2.3 Materials and methods

2.3.1 Data collection

The research described here was part of a wider farm household survey conducted in late 2016. An objective for that survey was to collect data on farm household perceptions of salinity intrusion risk, and any relevant existing/planned adaptation strategies in response. A further objective for the survey was to explore farm household preferences for alternative salinity intrusion risk reduction projects.

To select the districts that were included in the survey, we used available data from the Vietnam Academy for Water Resources and maps of rice crop vulnerability to sea level rise (Khang et al., 2008) to identify two areas with different levels of salinity impact (*currently affected* and *at high risk*), and one area unaffected by salinity intrusion (*control group*). The area currently affected by salinity intrusion is the Cau Ke district located close to the coast of the MRD. The at high risk of future salinity intrusion impact area includes part of Cau Ke district and the Tra On district which is located further inland from the coast. Finally, the control-group area where there is very limited risk of salinity intrusion at present—or in the immediate future—is the Vinh Thanh district (Figure 2.2). These districts were also recommended by local officials from the Department of Agriculture and Rural Development, who are knowledgeable about, and familiar with, the local characteristics of MRD farm households.

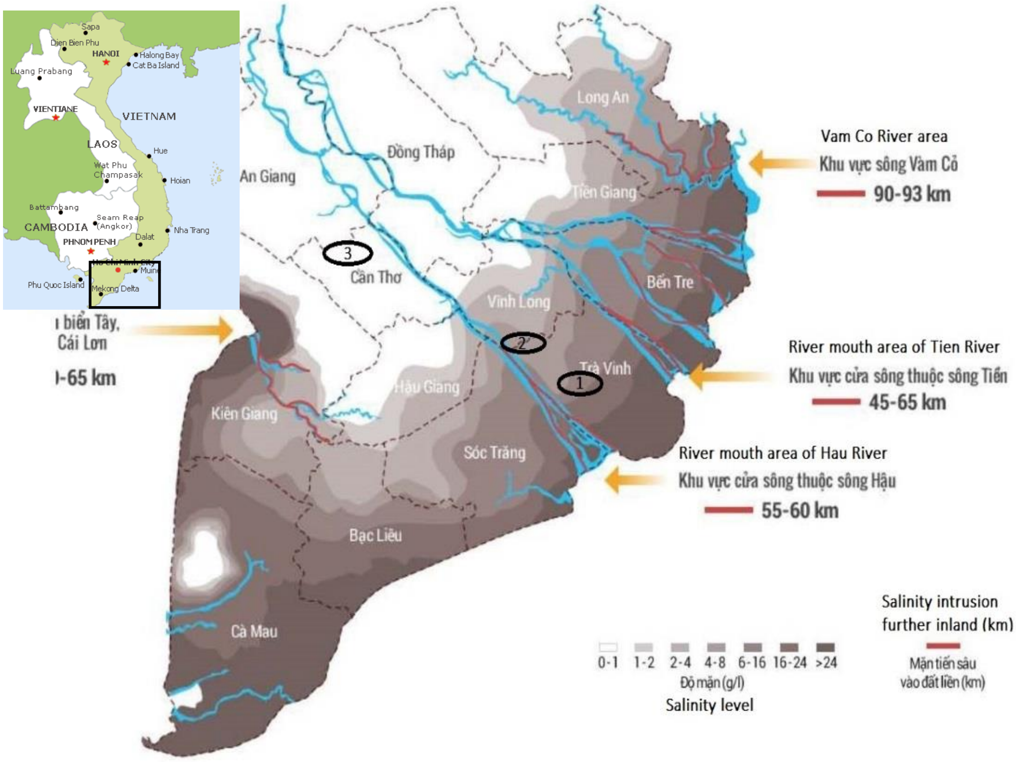

Figure 2.2 Mekong River Delta salinity intrusion levels in 2015 and the study area locations (1-Cau Ke district, 2-Cau Ke and Tra On districts, and 3-Vinh Thanh district)

Source: The Vietnam Academy for Water Resources (2015)

Note: As indicated in Table 2.1 Page 42, three survey sites have similar socio-demographic characteristics. In addition, the MRD has a flat terrain – most of that lies more than one meters above the sea. This quite hydro-homogenous formation predisposes this area to high risk of salinity intrusion. Hence, while three sites of farm households are stratified by salinity intrusion, hydrological conditions are broadly the same.

Using a random sampling procedure, this study surveyed 441[7] farm households from the study districts listed above. A list of farm households was provided by government officers from the Department of Agriculture and Rural Development.

[7] A total sample size of 441 farm households, which included three farm households with less than three years' farming experience was surveyed. However, the mean values of the observations' socio-demographic characteristics do not vary after these three farm households were truncated. Hence, they were still included in this analysis.

Survey respondents were chosen randomly from these lists. The sample size (n) was achieved by using the following equation:

$$n = \frac{Z^2 p(1-p)}{d^2} \qquad (2.1)$$

where Z equals 1.96 for a 95% confidence level, p is the probability of being selected into the sample (in this case 0.5 used for the sample size needed), and d is the confidence interval. The number of farm households required for analysis based on this equation was 384. Thus, the study aimed to survey at least 150 farm households in each of the three different districts, with the objective of completing 450 observations in total. Before the official survey was implemented, the questionnaire was pilot tested with 30 farm household-heads to ascertain whether or not farmers could understand the questions and information provided. Moreover, technical language was noted for the enumerators to translate and/or explain to the farmers' in local/everyday language. Enumerators for the study were carefully chosen from staff and final year Agricultural Economics students at the Department of Agricultural Economics, Can Tho University, with prior experience with farm household surveys.

Ultimately, 441 usable surveys were collected as a representative sample of the farm household population in the MRD. The total number of observations were then divided into three farmer groups consistent with those listed above: i) current salinity intrusion impacts (146 farm households), ii) high risk of future salinity intrusion/impacts (145 farm households), and iii) unaffected by salinity intrusion (150 farm households)[8].

2.3.2 Survey design

Based on range of adaptation drivers specified in the previous section, open-end categories were first used to identify perceptions of salinity intrusion drivers, and to classify any private adaptation strategies adopted by farm households. The survey instrument was focused on four data collection objectives including (1) farmers' awareness of salinity intrusion causes and impacts, (2) current individual adaptation measures, (3) farmers' intention to adapt to salinity intrusion, and (4) proposed public intervention strategies/measures.

However, farmers were not expected to be knowledgeable about future adaptation options, especially at the public provision level. Therefore, to identify possible future adaptation strategies and mitigation options Participatory Rural Appraisal (PRA) methods (FAO, 2018) were employed in advance of pilot-testing the survey instrument. This involved consultations with local experts (one in each district) from the Department of Rural Development in each survey area, and farmers (three in each district) who had lengthy experience with rice farming. During this meeting, the participators were provided a list of open-end questions regarding the causes of salinity intrusion, current and intended adaptations strategies and public adaptation measures. They were asked to list the answers and then had group discussions in order to clarify and achieve the relevance among each other. The outputs from the PRA were then used to formulate a series of close-ended questions of adaptation options in the farm household survey. The categories

[8] A detailed survey map and descriptions can be found in Chapter 3.

of adaptation strategies were identified by PRA involving experts and local farmers aim to reduce any biased in the results.

The PRA approach resulted in a total of four adaptation strategy groups identified for use in the survey: i) non-engineering adaptations (e.g. crop changes); ii) engineering adaptations (e.g. earthen dikes); iii) hydro-management adaptations (e.g. new water sources); and iv) other adaptation measures (e.g. off-farm employment). Although differences related to salinity intrusion causes and location characteristics exist, the classification in this study is consistent with definitions from World Bank Group (2010), WHO - Regional Office for Europe (2002) and a recent study in America (Barlow and Reichard, 2010).

Ultimately, a series of seven-point Likert scales were employed to collect responses for perceptions about to salinity intrusion impacts (i.e. 1=No effect to 7=Extreme effect), drivers of salinity intrusion in the MRD (i.e. 1=Strongly disagree to 7=Strongly agree), the effectiveness of adopted strategies (i.e. 1=Very ineffective to 7=Very effective), and proposed future salinity mitigation programs (i.e. 1=Strongly disagree to 7=Strongly agree).

2.3.3 Data analysis

Likert scales are widely employed by marketing researchers for examining consumer behaviour, commercial market indicator evaluations, and public attitudes (Cabooter et al., 2016; Dawes, 2008; Green and Rao, 1970; Weijters et al., 2010). To date, a number of risk perception and attitudinal studies have adopted/modified Likert-scale measurement in their field research (e.g. Le Dang et al., 2014). Different formats are often employed by different researchers, depending on the respondents and the research categories (Cabooter et al., 2016; Harpe, 2015). Researchers often find similar results using five- and seven-point scales (Dawes, 2008), and it has been suggested that the appropriate scale depends on the population survey and analysis target (Harpe, 2015; Weijters et al., 2010). However, in terms of a standard methodological recommendation, the seven-point scale appears to be widely preferred because it contains a neutral position that enhances measurement quality (Nowlis et al., 2002) and avoids poor information recovery without overburdening respondents (Cabooter et al., 2016). Hence, the dimensions in this analysis were measured based on a seven point Likert-type scale suggested by Vagias (2006). An *ex-post* calibration was also employed to improve the certainty of farm household answers, and the reliability of the findings. To do this, the perception and awareness questions were followed by a question asking farm household-heads to rank how certain they were about this choice on a scale of 1 to 3 (where 1=Not confident, 2=Confident, and 3=Very confident). Any farm household-head who reported a certainty level of one was asked to review their perception/awareness answer.

To estimate coefficients for drivers of adaptation strategy adoption, a Poisson regression model (PRM) for count data[9] was employed to examine the determinants of farm household adaptation strategies at the individual level, and the drivers of farm household preferences for public adaptation strategic investment. Based on the collected data, farm household adaptation choices offer multiple options and/or evaluation opportunities. Hence, the dependent variable takes numeric form,

[9] Since this research focuses on providing empirical results from the model, definition and detailed technical discussions about PRM model can be found in Scott Long (1997) and Winkelmann (2008)

denoting how many private adaptation actions have been adopted by farm households[10]. In such cases, PRM offers an appropriate multiple regression model (Scott Long, 1997; Winkelmann, 2008). Finally, an ordered logit regression model was used to estimate drivers of farm households' preference for implementation and heightening of sea dike systems in this area. This adaptation strategy is proposed as a potential long-term public adaptation strategy investments and revealed as one of the strong preferences for particular public adaptation strategy investments (see Figure 2.9).[11] The results of these models are discussed in the following section.

2.4 Results and Discussion

2.4.1 Farm household perceptions of salinity intrusion impact

Table 2.1 presents the main characteristics of farm households included in the survey. The majority (73%) of MRD farm household-heads are male with an average age of 47 years. Most farm households reported a relatively low level of education (up to secondary school), and high levels of experience working on farms (more than 23 years). These findings confirm our initial expectations of some limitations for survey engagement, requiring specific enumerator training and attention to language during the responses. The high level of farm experience also

[10] As farm households' heads were able to identify/choose more than one autonomous adaptation action, we were only able to test hypotheses about determinants of the quantity of adaptation strategies taken by farm households. Testing for the determinants adaptation actions is suggested for future research, which might investigate specific strategy effectiveness at either autonomous or public levels.

[11] Some of the instruments proposed as early-warning systems for saltwater intrusion include water-quality monitoring networks (Barlow and Reichard, 2010), and local monitoring networks (Le Anh Tuan et al., 2007) based on previous technical research and local characteristics.

increases our confidence in the sampled farmers' ability to respond meaningfully to questions about salinity intrusion perceptions and awareness. Importantly for survey finding generalizability and policy guidance purposes the farm/er characteristics present in our survey sample, together with the survey household size and household income results, are broadly consistent with data metrics from the national Vietnam Household Living Standard Survey (VHLSS)[12].

Table 2.1 Farm household's demographic and socio-economic characteristics

Information	Description	Total observation (n=441)	Current-SI* group (n=146)	High-risk SI group (n=145)	Control group (n=150)
Age	Household head's age (year)	47.41	46.89	46.46	48.83
Gender	Household head's gender (0: male, 1:female)	0.17	0.20	0.23	0.10
Education	Household head's education (0 to 5)	2.19	2.05	2.03	2.48
Farming experience	Years working on the farm	23.39	23.38	22.41	24.37
Household size	Number of members of the household	4.28	4.31	4.41	4.15
Income	Vietnamese dong (1,000 VND)	107,591	106,564	103,978	112,094

* SI = salinity intrusion

2.4.1.1 Perceptions of salinity impacts

We first asked farm household-heads how salinity intrusion has affected their family and region by asking *"For your worst affected plot, to what extent do you*

[12] The VHLSS is a national survey of the Vietnamese population conducted every two years by the Vietnam General Statistics Office (GSO)

think salinity intrusion has affected your household to date?" The results reveal that over 60% of respondents rated salinity intrusion results as having negative influences on their agricultural output/productivity and farm income. Since freshwater provides essential functions for rice paddy farming, nearly 50% of respondents also perceived that salinity intrusion had negative effects on their water supplies for agricultural activities—although far fewer were concerned about impacts on daily water supplies (Figure 2.3).

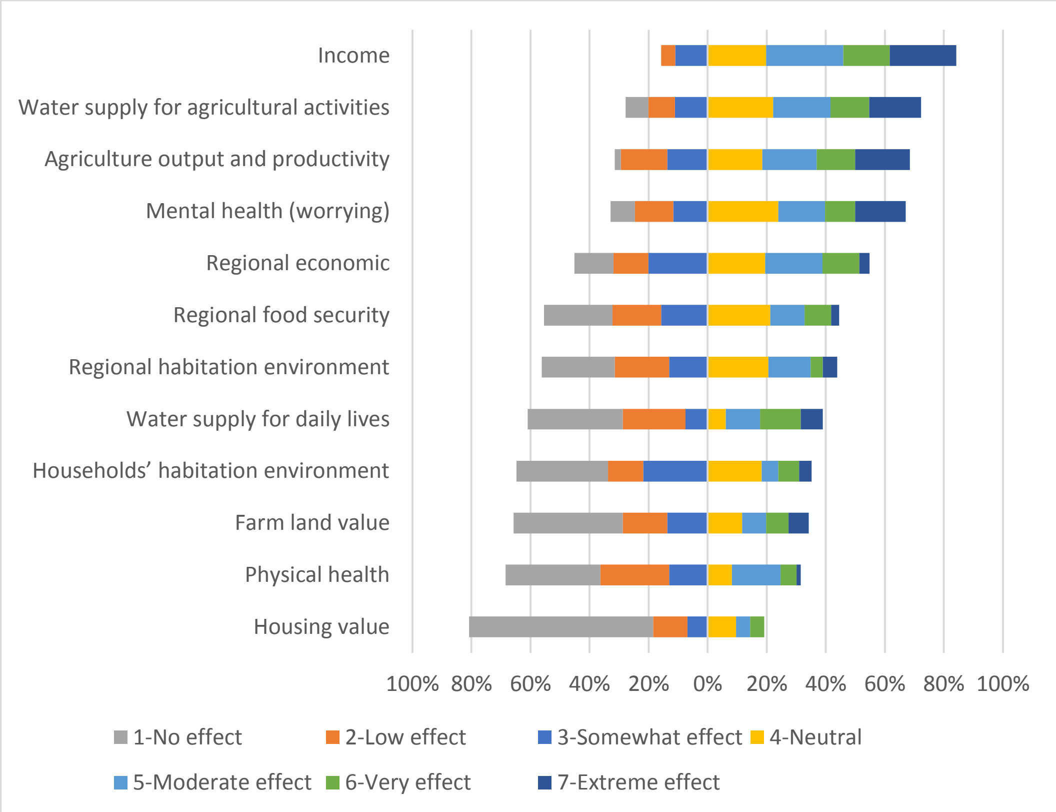

Figure 2.3 Distribution of perceived salinity intrusion impacts on farm household and regional issues (n=146[13])

Noticeably, the fourth highest observed perceived impact of salinity intrusion in our survey results was mental health. Our findings are consistent with other studies

[13] Only included Group 1 where salinity intrusion has been occurred

of broader issues suggesting that climate change-related issues affect both physical and mental health (Berry et al., 2011). One explanation may be that physical impacts of flood or drought events are more immediate, manifesting as sickness or famine over shorter periods (i.e. months), while the impacts of salinity intrusion take longer to manifest (i.e. years) with an eventual attendant mental toll. However, since the data related to mental problems in this study stem from one Likert scale answer it is necessary to conduct more research to any draw wider policy implications. Temporal aspects to salinity intrusion may also explain the roughly equal split between farmer perceptions of regional economic impacts. While some are experiencing problems at present, other districts would have less familiarity with regional changes. This highlights a need for more data collection with regard to health impacts, as well as improved information from local authorities to farmers in currently/future affected districts about salinity intrusion.

2.4.1.2 Future perceived salinity impacts

Next, household-heads were asked to indicate their perceived salinity intrusion impacts if nothing were done over the next three years to mitigate its effects. Again, more than half of the respondents indicated that salinity intrusion would be expected to have an extreme effect on their agricultural output, productivity and income as well as negative impacts for water supply and farmland values in the long-term. Interestingly, the expected future impacts of salinity intrusion on income were less than those for agricultural output, possibly suggesting an intention by farm households to explore income diversification within that period (Figure 2.4).

A Kruskal-Wallis H test was employed to determine if farm households' perceptions about salinity intrusion impacts were different across the three groups.

Unsurprisingly, the test showed that there was a statistically significant difference in each dimension between the three groups, with significance levels below 0.05. The result suggested that farm household perceptions were shaped by their location and exposure to salinity intrusion risk, which is consistent with other adaptation research (Alam et al., 2017).

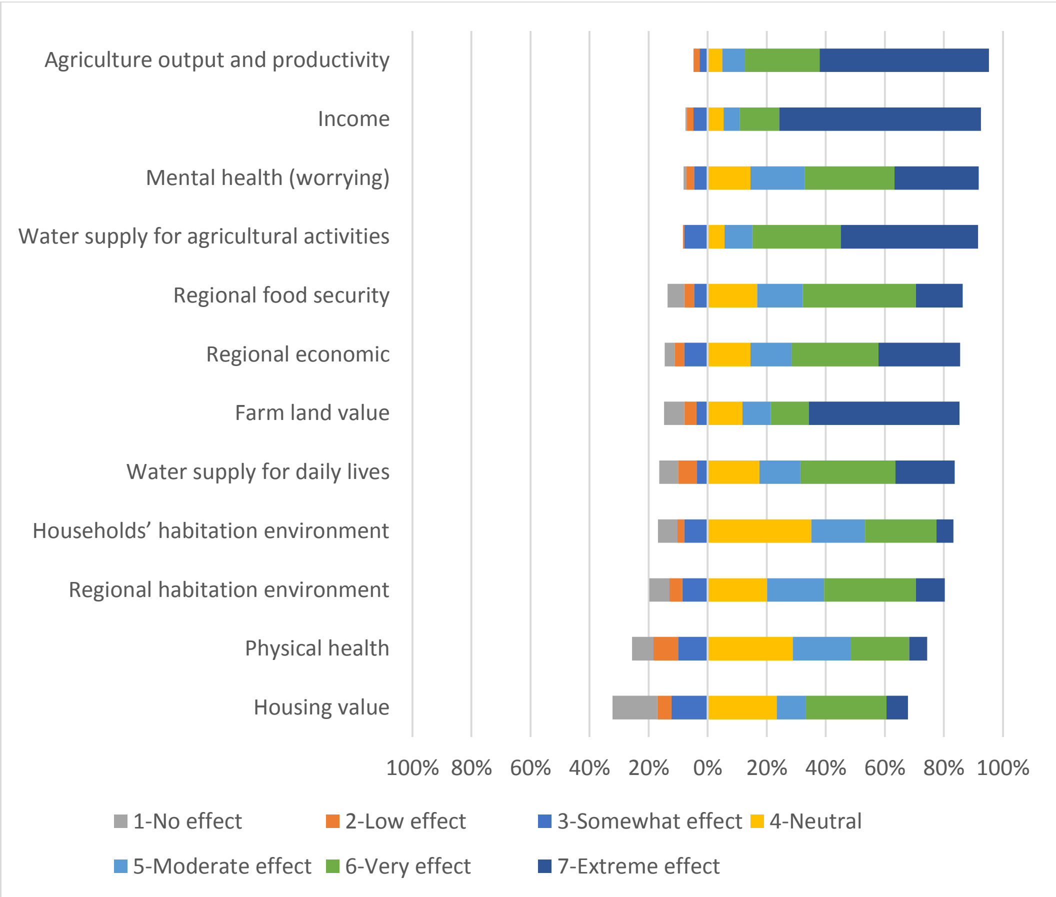

Figure 2.4 Distribution of expected salinity intrusion impacts on farm households' and regions over the next 3 years (n=441)

2.4.1.3 Perceived causes of salinity impacts

Each farm household head was then asked to identify their perceived causes of salinity intrusion in the MRD, ranging from 1=Less important to 4=Most important. In general, most farm households are very aware of the major causes of MRD salinity intrusion, with ≥50% of respondents identifying that sea level rise, upstream development impacts on river flows, and drought are the main causes. However, more than 70% of farm household-heads in the MRD viewed increasing water demand as a less important reason for salinity intrusion (Figure 2.5).

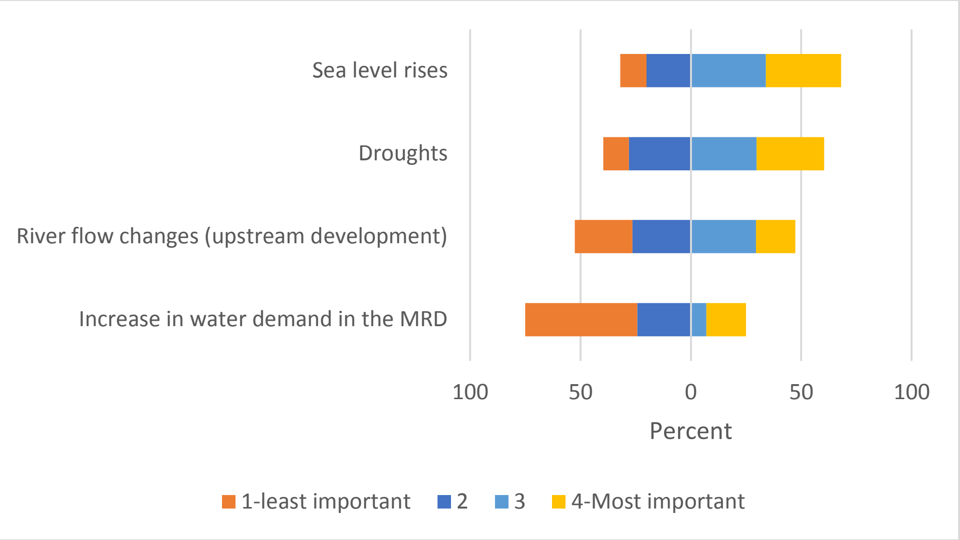

Figure 2.5 Distribution of causes of salinity intrusion, as perceived by farm households (n=441)

This suggests that, although changes to three-crop rice production systems in recent years has required increased water usage in the MRD, few farm households appear to have made the connection between that and increasing salinity levels. This may drive both a continued reliance on private short-term autonomous adaptation strategies, as well as a requirement for public planned adaptation interventions, if the effectiveness of these strategies reduces over time. Interestingly, recent evidence suggests that third-rice cropping strategies are already becoming less effective, with lower productive returns and higher chemical costs (Dan, 2015). The following section therefore explores current and intended autonomous adaptation responses at the farm and regional levels.

2.4.2 Private and public responses to salinity intrusion

2.4.2.1 Farm household autonomous responses

Those farm households located in the current salinity intrusion affected area were asked to indicate any adaptation strategies they had adopted, and their effectiveness. Only a small number of farm households had failed to adapt in any way. The majority of farm households had adopted at least one autonomous strategy over the last three years, consistent with other studies that find farmers generally apply more than one adaptive strategy to cope with adverse impacts (Alam, 2015; Trinh et al., 2018).

The most popular non-engineering adaptation measures were changes to farming systems through altered planting times, shifting to other crop varieties, changed irrigation schedules and altered uses of farm inputs (e.g. fertilizer). Again, this supports other studies which find that changing planting times is a popular adaptation strategy in the MRD (Van et al., 2015). Farm households also indicated the successful adoption of engineering strategies such as independent dike structures, dredging of local canals, increased water storage in farm dams or ponds, and water-saving techniques; with reasonable perceptions of effectiveness. However, effectiveness results for farm households that explored shifting from rice to aquaculture or livestock, and/or sought off-farm employment activities were relatively lower, suggesting limited success. This may be due to the fact that changes of this nature require new skill sets and training, which may be challenging for farmers with low levels of education and experience away from the farming environment (Figure 2.6).

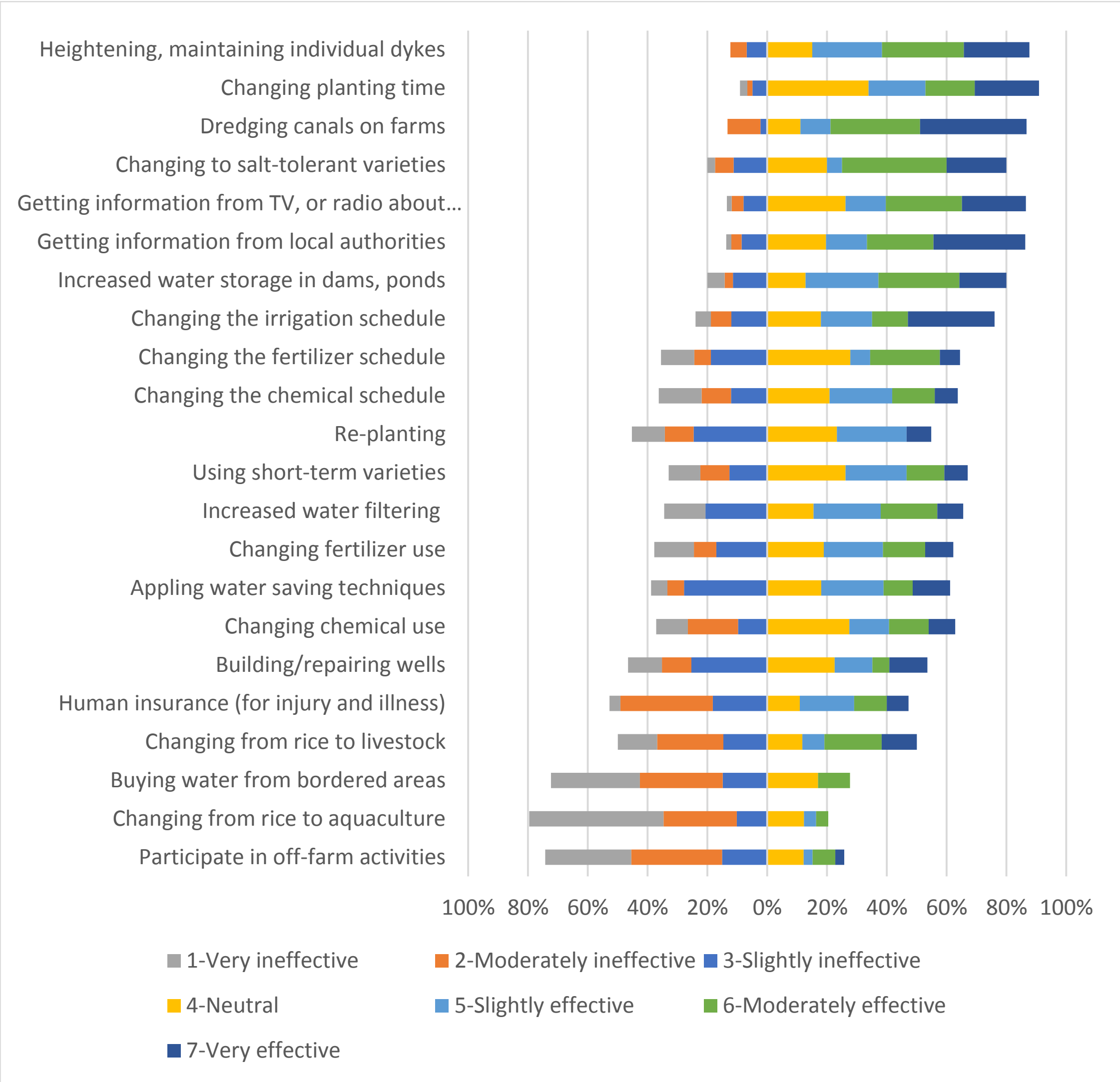

Figure 2.6 Distribution of the effectiveness of salinity adaptation strategies adopted by farm households (n=146)[14]

[14] The aggregate percentage in some is less than 100 per cent since several households did not apply any adaptation measures/strategies, and observations are only included farm households where salinity intrusion is already present.

Notably, many of the autonomous strategies listed in Figure 2.6 appear to score mixed effectiveness results, which may be an indication of their short-term nature depending on the location of the farm and relevant exposure to salinity impacts.

2.4.2.2 Intended adaptation responses

Following our exploration of current adaptation strategies, we asked MRD farmers to identify any adaptive strategies that they intended to adopt in future. Most reported an intention to continue with autonomous adaptation strategies such as changes to planting times, irrigation schedules, and input usage. However, as indicated by the dark-blue areas, the strongest future adaptation strategy adoption preferences were for salt-tolerant crop varieties and engineering measures such as canal dredging and dike maintenance/heightening. Increased access to information from local and national authorities also rated quite strongly. By way of example, salt-tolerant varieties are only suitable in areas where salinity is moderate, but many farmers remain unaware of this limitation.

Many farm households also agreed that agricultural insurance could be an effective future strategy (25% strongly agree). This is of interest, as many studies suggest that agricultural insurance, particularly in developing countries such as Vietnam, is not very effective (Khoi, 2014; Thong, 2014). Most farmers tend not to participate in agricultural insurance schemes due to low affordability and availability from insurance providers. Finally, the very low intended migration of farm households away from the MRD should be carefully noted, along with its implications for the importance of future policy/programs to mitigate salinity intrusion impacts. Farmers do not seem willing to leave the area, and therefore careful attention may be needed to ensure effective public interventions in support of those intentions (Figure 2.7).

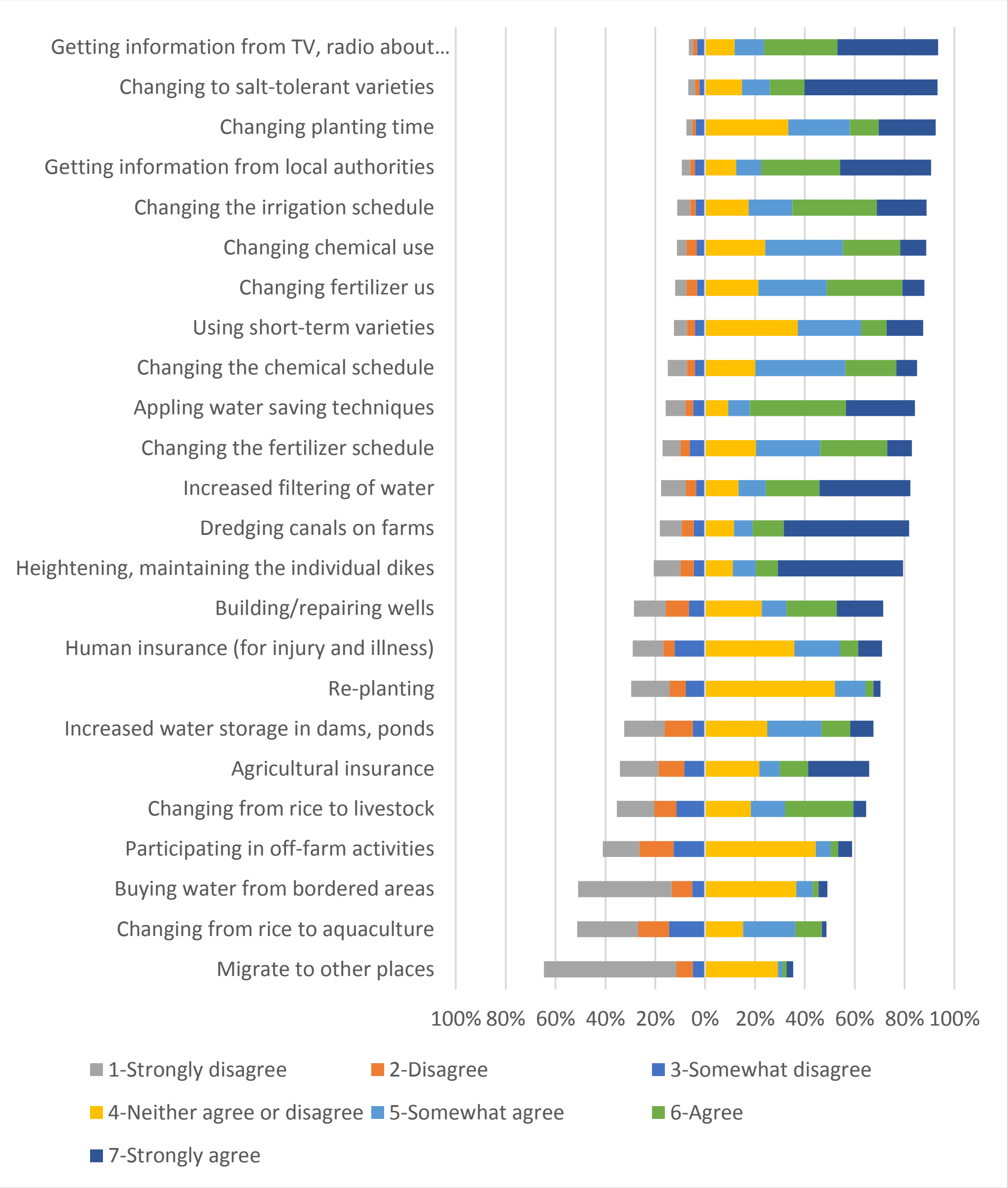

Figure 2.7 Distribution of intended future salinity adaptation strategies (n=441)

2.4.2.3 Public responses to salinity intrusion risks

With regard to current public responses to salinity intrusion, farm households were asked to identify those programs/strategies and evaluate the perceived effectiveness of those options. Only four strategies were reported, all with reasonable levels of effectiveness as far as farmers were concerned. Of those, training programs enjoyed relatively low levels of effectiveness perception, which may be concerning as training for risk mitigation is suggested as an important driver of farmers' adaptation decisions (Trinh et al., 2018). Overall however, the support by farmers for current MRD mitigation strategies appears solid (Figure 2.8).

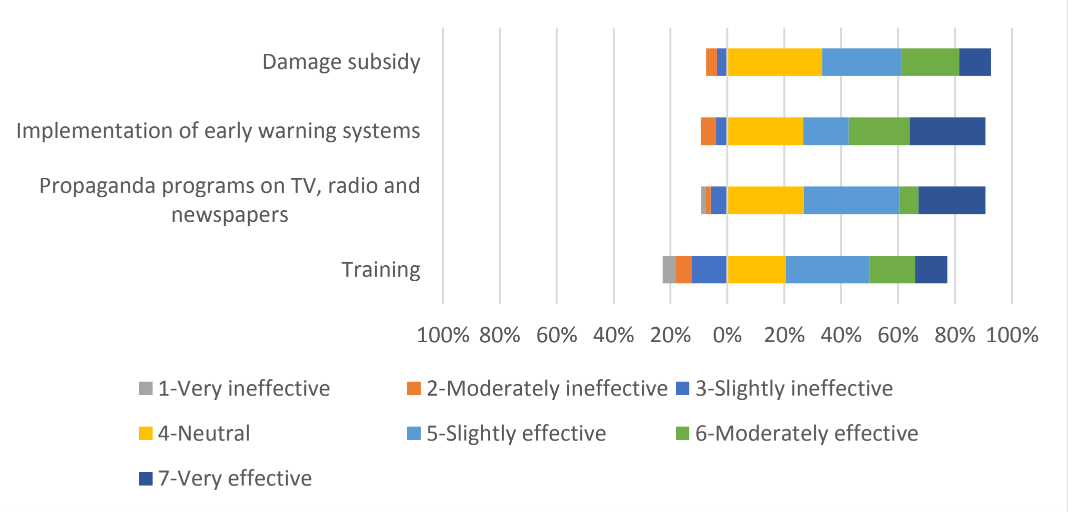

Figure 2.8 Distribution of the effectiveness of adaptation measures implemented by local authorities to deal with salinity intrusion (n=146 – Group 1)

Note: *"Implementation early warning system" is one of the possible mitigation options to salinity intrusion suggested by local experts from the Department of Agriculture and Rural development and local farmers during PRA and pilot survey. According to them, this system includes a connection among local government, local experts from the Department of Agriculture and Rural development and farm households. Based on the observations and analysis from those experts, local government, through an official instrument (e.g. mobile phone, local information office) will inform farm households about salinity intrusion levels. Moreover, every farmer group will also be provided with a salinity measurement tool to observe the current level of salinity in order to prepare and then respond appropriately.*

Finally, farm households were asked to indicate alternative salinity intrusion mitigation options for future public planned adaptation strategies. In addition to the current strategies identified above, farmers stated their short-term preference for additional salt-tolerant crop varieties, and increased information communication programs (~50% Strongly agree). In terms of longer-term adaptation, implementation of early-warning systems, updating freshwater supply systems, river-mouth sluice gate construction, and sea dike heightening/changes to concrete construction were the most popular strategies (>60% strongly agree—with sea dike heightening recording the highest overall Strongly agree response). This offers useful insight for policy-makers and local authorities in their consideration of future long-term adaptation solutions to salinity intrusion in the MRD (Figure 2.9).

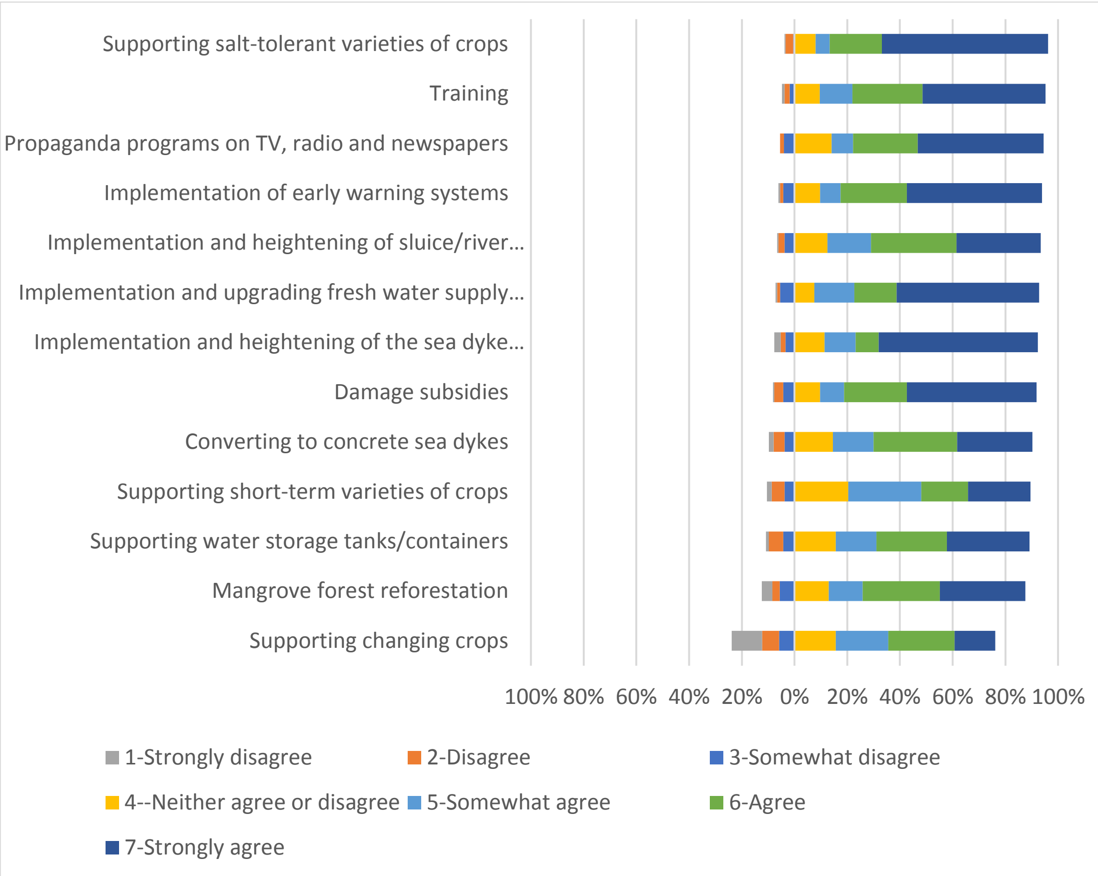

Figure 2.9 Distribution of farmers' responses to future public strategies (n=441)

2.4.3 Determinants of farm household adaptation preferences

We have seen that farm households in the MRD are aware of salinity intrusion impacts, that they are taking steps both now and in the future to adapt to those impacts, and that they have preferences for what public authorities might do to support their adaptation. It only remains then to investigate what drives farmer different adaptation strategy choices as a source of further information for those policy-makers interested in requirements for planned interventions. Recall that our research question suggests that we need to attempt to identify the nature of the factors that determine adaptation strategy choices and household capacity to adapt to salinity intrusion impacts. These factors are directly related to farm households' socio-demographic characteristics (i.e. the gender of the household head, number of household members, education level, the age of the household head, experience working on farms and household income), and farm household perceptions about salinity intrusion impacts at individual and regional levels.

We combined these variables in the Poisson regression model of adopted strategies over the last three years to identify influential factors in those choices. Initial tests for multicollinearity were undertaken using the Variance Inflation Factor (VIF) checks, with the resultant values indicating no significant multicollinearity issues (i.e. all VIF less than 5.0)[15]. Table 2.2 shows the estimated parameters of the PRM in terms of autonomous adaptation actions. The results suggest that the model is well explained by the independent variables (Pseudo R^2 =

[15] While some authors suggest the VIF cut-off threshold is 10 indicating a high degree of multicollinearity (Hair et al., 1998), others recommend this value is greater than 5.

0.2161, Prob>chi2=0.0000), while identifying some critical variables influencing farmer adaptation decisions.

Five factors positively influence increasing numbers of adaptation strategies, including age, salinity intrusion impacts on farmland values, physical health and impacts on the regional economy and habitation environment. On the other hand, five indicators were found to be negatively associated with greater adaptation strategy adoption, including increased farming experience, larger household sizes, larger impacts on mental health, higher changes to local habitation or the environment, and concerns about regional food security.

These drivers are all broadly consistent with other studies into climate change adaptation in Vietnam (Nguyen et al., 2017); although other drivers such as off-farm experience and income were found to be relevant for different study areas (Ayanlade et al., 2017). Experienced farmers have a greater understanding of salinity intrusion impacts, and exercise caution when adopting new strategies in response. Further, farm households with more membership have more opportunities (and incentives) to seek alternative income sources, which leads to fewer adaptation strategies being undertaken. Although this outcome is only applicable for Group 1 since this question asked for adaptation strategies already applied in the affected area, however, this point is supported in order to recommend policy implications for both high risk and control group by the fact that there are only slight differences in annual income among the currently affected, high future risk, and control group districts (Table 2.2).

Overall, these factors would seem to suggest that if autonomous adaptation strategies reduce over time, or begin to fail with individual (physical/mental health), private asset (house/land value), community (habitat/environment), and/or regional (food security/economy) impacts, increased planned interventions may be sought as an alternative approach.

Table 2.2 Estimation results of the Poisson regression model (PRM) estimates of adaptation strategy choices (n=146 Group 1 - already affected areas)

Indicators	Description	Mean	Min	Max
Dependent variable				
Strategies adopted[16]	Numeric variable	13.445 (8.22)[17]	0[18]	24[19]
Independent variables	Description	Coefficients	P-value	VIF
Household head's age	Numeric variable	0.027***	0.000	4.87
Household head's gender	1: Female, 0: male	0.0439	0.505	1.46
Household head's education	From 0 to 5[20]	0.035	0.104	1.31
Household head's farming experience	Numeric variable	-0.020***	0.000	4.50
Farm household size	Numeric variable	-0.047**	0.030	1.17
Farm household income	Numeric variable	-5.10e-08	0.820	1.28
Impact on income	7 point scale	0.012	0.603	1.97

[16] One of the limitations of this research is that some measures/strategies listed here could also be applied to other adaptation issues. However, during the PRA approach, it was emphasized that measures/strategies aimed at salinity intrusion mitigation was the focus for the study.
[17] Standard deviation.
[18] The zero value of the dependent variable here indicates that, although some farm households are currently affected by salinity intrusion, they have not taken any adaptation strategies or measures.
[19] As indicated in Appendix 18, there is a skewed right distribution of the dependent variable histogram, the right tail (more adaptation strategies taken) is much longer than the left tail (less adaptation measures taken). Most farm households have tried to perform some adaptation strategies (around 7-9), with a few exemptions that are distributed along a larger range of high number of adaptation strategies. There is one probable outlier to the far right (around 23), indicates only some of farmers have tried to adapt with this issue in many different ways. In other words, this distribution has a positive skew (Skewness = 0.5392>0 where normal distribution required). Therefore, a Poission regression model provides a better fit with the survey data.
[20] 0=Never attended school, 1=Primary school, 2=Secondary school, 3=High school, 4=Bachelor's degree, and 5=Postgraduate degree.

Impact on housing value	7 point scale	0.034	0.127	2.58
Impact on farm land value	7 point scale	0.075***	0.000	2.46
Impact on agricultural output and productivity	7 point scale	0.007	0.736	2.48
Impact on water supply for agricultural activities	7 point scale	0.009	0.563	1.50
Impact on water supply for daily lives	7 point scale	0.019	0.198	1.85
Impact on physical health	7 point scale	0.109***	0.000	3.01
Impact on mental health	7 point scale	-0.150***	0.000	2.02
Impact on households' habitation environment	7 point scale	-0.107***	0.000	3.24
Impact on regional food security	7 point scale	-0.093**	0.000	2.59
Impact on regional economics	7 point scale	0.122***	0.000	3.64
Impact on regional habitation environment	7 point scale	0.085**	0.003	4.74
Cons		1.594***	0.000	
Log-likelihood	-558.32046			
LR chi2	307.86			
Prob>chi2	0.0000			
Pseudo R2	0.2161			
N (sample size)	146			

Notes: ***, **, and * are statistically significant at 1%, 5% and 10% levels, respectively.

2.4.4 Determinants of farm household preferences for planned adaptation

We estimated a second model to gain additional insight into the drivers of farm household preferences for a long-term public adaptation strategy. The dependent variable comprised strategies not currently included in the planned approach to salinity intrusion mitigation (e.g. long-term strategies), selected based on the number of Strongly Agree responses provided by farm household survey respondents. Using this approach, implementing and heightening sea dike systems was included. We also expanded the vector of predicted salinity intrusion impacts across all observations in the three groups rather than focusing on farm household perceptions during the last three years.

Ordered logit regression models were estimated based on a discussion by Clogg and Shihadeh (1994). This regression is suitable for modeling Likert scale dependent variables, and can also be run using censored dependent variables. Other detailed discussions related to applications of this model can be found in Guagnano et al. (2016) and Hill and Fomby (2010). Once again, the VIF scores for each independent variables were less than five, indicating no serious multicollinearity. The coefficients and marginal effects (average marginal effects) of the determinants of farmers' preferences of long-term public adaptation measure are presented. It should be noted in the ordered logit model that instead of coefficients, marginal effects are used to interpret the influences of the variance of the independent variables per unit on the dependent variable. The likelihood ratio Chi-square of -235.59 with a P-value of 0.0000 indicates that this model as a whole is statistically significant. Table 2.3 presents the results for the sea dike construction mitigation options.

Table 2.3 Ordered logit regression estimates of the determinants of farm household preferences for sea dikes as a long-term public adaptation measure

Dependent variable: Public strategies preference (3-point scale agreement level)			
Independent variables	Coefficients	Marginal effects (dy/dx)	P-value
Location (1: Salinity intrusion area, 0: others)	0.852	-0.035**	0.218
Household head's age	-0.016	0.001	0.483
Household head's gender	-0.374	0.019	0.334
Household head's education	0.099	-0.004	0.451
Household head's farming experience	0.015	-0.001	0.474
Farm household size	-0.028	0.001	0.794
Farm household income	1.12e-07	-5.17e-09	0.937
Impact on income	0.240	-0.011*	0.062
Impact on housing value	0.108	-0.005	0.287
Impact on farm land value	0.083	-0.004	0.511
Impact on agricultural output and productivity	-0.012	0.001	0.937
Impact on water supply for agricultural activities	-0.297	0.014**	0.039
Impact on water supply for daily lives	0.034	-0.002	0.732
Impact on physical health	0.285	-0.013**	0.032
Impact on mental health	-0.147	0.006	0.206
Impact on households' habitation environment	-0.477	0.022***	0.003
Impact on regional food security	-0.200	0.009	0.271
Impact on regional economics	0.800	-0.037***	0.000
Impact on regional habitation environment	-0.062	0.003	0.671
Log-likelihood	-235.58735		
LR Chi2	71.66		
Prob>Chi2	0.0000		
Pseudo R2	0.1320		
N (sample size)	441		

Notes: ***, **, and * are statistically significant at 1%, 5% and 10% levels, respectively.

The results indicate that five determinants are significant determinants of farmers' preferences: , impact on income and physical health, impacts on water supply for agricultural activities, households' habitation environment and regional economics. It is interesting and important to note that the explanatory 'Location' factor does not affect farmers' preferences. Recall that this is the spatially differentiated group to which farmers were classified based on salinity intrusion impact levels (1: salinity intrusion area, 0: others). It suggests that almost all farmers in this area realized the negative impacts of salt water intrusion on their agricultural activities and daily lives, leading to preferences that are not significantly different across the groups.

Other drivers of preferences for public investment include impacts on water supply and habitation environments which increase the level of proposed strategy agreement. However, impact on income, physical health and regional economics decrease this agreement level. These results may be explained by noting that farm household preferences for long-term measure are also controlled by factors directly related to their farming activities. Thus, these drivers of preferences need more careful testing before any final recommendations for adaptation strategies can be made. The insight analysis discussed in this paper provides a useful starting point for that further study, which will be the objective of our future research. In addition, when identifying determinants of farm households' preferences of adaptation measures, their contributions and ability to cope with the problem should also be included. However, the contribution in the form of willingness-to-pay may effect their capacity to cope, and their capacity to cope also effects their willing-to-pay.

Hence, in order to address this endogeneity as a limitation in this analysis, future research needs to investigate this issue with appropriate instruments.

2.5 Conclusion

This paper examines farm household perceptions of salinity intrusion impacts, as well as current/intended adaptation strategies in the MRD. A better understanding of farm household salinity intrusion awareness could assist policymakers to develop and implement effective future planned adaptation strategies alongside autonomous private adaptation activity. The empirical findings presented here show that farm households in the MRD have a clear perception of the existing salinity intrusion risk, as well as the future risks associated with the unchecked spread of saline water. One of the important findings from this study is that most farmers in this study area realize the causes and impacts of salinity intrusion. The finding also indicates farmers' perceptions and attitude to salinity intrusion do not depend on the level of salinity intrusion impacts. To date, predominantly short-term adaptation measures have been applied, with varying levels of effectiveness. Findings from this study also indicate that farm households believe it is hard for them to adapt to the issue by themselves. Moreover, if the effectiveness of these strategies reduces over time, long-term planned salinity intrusion mitigation programs may be required under public funding arrangements. This study has therefore examined a possible long-term future public salinity intrusion adaptation or intervention options in an effort to inform this investment choice.

If Vietnam is required to invest in public interventions, then the findings from this study should provide valuable evidence in support of appropriate policy choices and implementation guidelines. Our results suggest that increased local farmer participation could be generated through enhanced local awareness and information programs in the first instance. This could be achieved using media such as television, newspaper and radio to address salinity knowledge, training and information gaps—some of which were identified by local officials during the pilot testing for this research survey. The findings from this study also indicate that engineering adaptation strategies such as sea dike construction are preferred by farm households as long-term planned interventions.

Farmers cannot achieve large-scale mitigation interventions autonomously; they will require public assistance to generate private gains. However, our investigation into factors driving adaptation strategy adoption indicates that farmers may be willing to positively engage with government to achieve these outcomes through collaborative efforts in order to avoid individual, private, local and regional negative impacts as the problem of salinity intrusion grows. Further research into the scope for farmer participation and financial contribution is therefore warranted.

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Contribution to the Paper	Led and conducted data collection, performed analysis and interpreted data, wrote the manuscript and acted as the corresponding author.		
Overall percentage (%)	65%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate to include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100%, less the candidate's stated contribution.

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Chapter 3 : Mekong River Delta farm-household willingness to pay for salinity intrusion risk reduction[21,22]

Abstract

Sea level rise and upstream development are causing salinity intrusion in Vietnam's Mekong River Delta (MRD) and, as a consequence, agricultural productivity is declining. The Vietnamese government and local communities search for a solution, it has become apparent that there are insufficient public resources to build the dikes necessary to control this problem. So, we employ a referendum contingent valuation methodology (CVM) to determine whether or not farm households might be willing to pay for part of the cost of a salinity intrusion risk reduction programs. We find that farm households would be willing to contribute funds to such a program. In areas where salinity intrusion is already reducing productivity, farm households are willing to contribute US$2.58 per month. In areas where salinity intrusion is expected to be reducing productivity by 2030, willingness to contribute is US$1.99 per month. Surprisingly, in MRD areas where salinity intrusion is not expected within the next 15 years, willingness to contribute remains positive at US$1.32 per month. The findings have local, national and international implications that require careful consideration. In passing, we make a methodological

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observation that a treatment model including ‘do not know’ responses provides consistent results with conventional referendum elicitation procedures.

Keywords Climate Change; Willingness to Pay; Referendum

JEL classification Q51, Q54, Q58

Highlights

- More than half of households are willing to pay for reduced salinity intrusion risk
- Willingness to pay increases with proximity to, and severity of, the problem
- Farm household income and bid value had a positive influence on WTP
- Community participation could overcome any public funding deficit

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3.1 Introduction

The Mekong River Delta (MRD), located in southern Vietnam, plays an important role in the country's agricultural development. The total agricultural area is four million hectares, producing approximately 45 percent of Vietnam's rice. While salinity intrusion impacts are beginning to affect other river deltas around the world, if mean sea level increases by one meter above current levels, Vietnam would be the most adversely-affected region in the developing world (Buys et al., 2006).

In the past, flooding was the most typical cause of disruption to agricultural production in this region (Le Anh Tuan et al., 2007). In recent years, however, salinity intrusion has become the most significant challenge faced by farm households. Salinity intrusion is caused by two processes: a) rising sea levels as a result of adverse climate change and b) a significant decline in river flows as a result of upstream dam construction and increased extractions of water. Reduced upstream flow rates combined with increased sea level under climate change drive lower hydrologic pressure in the MRD, which allows salt water to intrude further inland (Danh and Khai, 2014; Le Anh Tuan et al., 2007; Smajgl et al., 2015). According to the Vietnam Academy for Water Resources, salinity intrusion is on the increase and has recently been detected in the Kien Giang and Hau Giang provinces (see Figure 3.1) (The Vietnam Academy for Water Resources, 2015). Currently, around 620,000 hectares are affected by salinity intrusion—roughly 16 per cent of the total MRD agricultural production area. By 2030 under current sea level increase predictions, it is estimated that up to 45 per cent of the MRD agricultural area could be impacted, with coastal provinces such as Tien Giang, Tra

Vinh, Soc Trang, Bac Lieu, Ca Mau, and Ben Tre experiencing the highest levels of impact (Center of Environmental Engineering, 2012).

Adverse impacts of sea level rise are being worsened by increasing upstream development along the Mekong River. The National Hydro–Meteorological Service of Vietnam is warning that the impact of future droughts, similar to those experienced during the 2015 and 2016 El Niño events, will also be worse in future, creating further negative salinity intrusion outcomes.

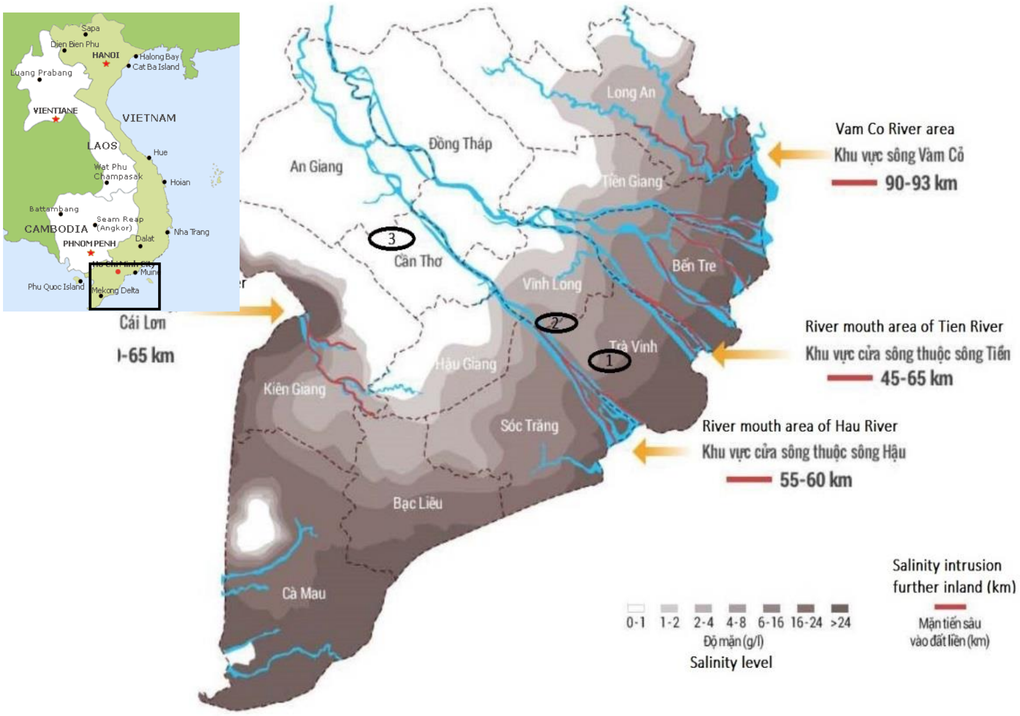

Table 3.1 MRD salinity intrusion, 2015. Study area locations are also indicated: 1) Cau Ke district, 2) Cau Ke and Tra On districts, and 3) Vinh Thanh district

Source: Adapted from Vietnam Academy for Water Resources (2015)

As one of the largest rice exporters in Asia, disruptions to MRD agricultural production can result in wider serious regional food security issues, as well as reduced national trade income. In the past, MRD farm households largely treated salinity intrusion as a normal phenomenon (Le Anh Tuan et al., 2007). More recently, under increasing salinity impacts, farm households and local authorities have recognized the abnormal properties of local salinity intrusion, and begun searching for management solutions including changed irrigation schedules, increased water storage in dams, and altered rice-planting times. These solutions are largely viewed as short-term (1 to 5-year duration) fixes. However, under a recent recognition that increasing salinity intrusion cannot be managed by private on-farm actions alone, in 2016 the General Program of the Mekong Delta Economic Cooperation Forum in Hau Giang (MDEC Forum – Hau Giang) argued that it would be necessary to explore and develop longer-term (5 to 30 years) solutions based on public intervention.

One possible long-term approach is the use of concrete sea-dikes or embankment-structures that prevent water inundation onto low-lying floodplain areas. The MRD is a vast floodplain only 0-4 meters above mean sea level. Over the last 300 years, more than 11,000 kilometres of canals have been constructed in the MRD to mitigate flooding in low-lying areas. In addition, approximately 2,000 kilometres of dike walls have been constructed to minimize MRD flooding during periods of high upstream flows and very high tides that can occur during storm events (Le Anh Tuan et al., 2007). In May 2009 the Vietnamese government issued Decree No. 667/QD-TTg with a view to upgrading dike walls and increasing maintenance in the central and southern MRD. This program will include the construction of additional earthen sea-dikes and concrete sluicegates along the coastline (Danh and Khai, 2014; Smajgl et al., 2015). As there is a shortage of soils suitable for upgrading these dikes, and the incidence of erosion is high (Sorensen et al., 1984), consideration is being given to the construction of concrete sea-dike-walls.

According to a UNDP Disaster Management Unit Project (VIE/97/002) managed by the General Department of Land Administration, the total length of required sea-dike walls in MRD would be 1469 kilometres. Danh (2012) and Danh and Khai (2014) argued that Vietnam cannot afford to build the total required lengths of sea-dike walls due to public budget constraints. These authors go on to point out that, if these sea-dike walls were constructed, local authorities would also struggle to maintain them (Danh, 2012). This means that if any proposed intervention program based on infrastructure is to proceed and be sustained over time, local households may have to fill a construction and maintenance funding gap. However, it is unclear whether local households are willing to contribute to these types of public investments and, if so, how much they would be willing to contribute. The purpose of this paper is to explore MRD farm household willingness to contribute (pay) to local authority programs aimed at mitigating salinity intrusion risk.

The willingness to pay literature is generally classified into revealed and stated preference methodologies; with stated preference methods typically employed to estimate WTP in contexts where actual markets for the good in question do not exist (Bateman et al., 2002; Competition Commission, 2010). In climate change related research, a subset of stated preference estimations known as Contingent Valuation Methods (CVM) has been widely employed to estimate willingness to pay for climate risk reduction projects. Many of these previous climate risk reduction studies have focused on issues such as willingness to pay for insurance (Botzen et al., 2009; Botzen and Van Den Bergh, 2008, 2012; Brouwer et al., 2014; Charpentier, 2008; McClelland et al., 1993), flooding risk mitigation through improved management (Baan and Klijn, 2004; Brilly and Polic, 2005; Brouwer et al., 2009), and willingness to pay to reduce environmental health or mortality risks (Alberini and Chiabai, 2007; Alberini et al., 2006; Corso et al., 2001). However, while Southeast Asian countries also face emerging climate risks especially salinity intrusion recently, previous studies (e.g. Brouwer, 2013) of WTP have mainly been conducted in developed countries.

Moreover, studies looking at people's willingness to contribute to coastal defence in climate risk areas are quite rare. So far, research on this topic has only been conducted by Jones et al. (2015) in England and Landry et al. (2011) in the US; with little that can be directly related to developing nation contexts. As a result, this paper contributes to significant gaps in the literature by applying a referendum contingent valuation methodology to evaluate developing country community contributions toward climate change risk reduction programs in the form of concrete sea-dike walls in the MRD.

This paper also attempts to identify the determinants of farm household characteristics on WTP. Previous studies have found a number of factors affecting people's WTP for climate change risk reduction in Japan, the Netherlands and Italy (Alberini and Chiabai, 2007; Botzen and van den Bergh, 2012; Zhai, 2006). For example, willingness to pay was positively associated with the size of the risk reduction (Alberini and Chiabai, 2007; Botzen and van den Bergh, 2012; Zhai, 2006), respondent age and health (Alberini and Chiabai, 2007), income (Zhai, 2006) and proximity to the risk (Concu, 2007). However, WTP can decrease with acceptability of (flood) risk and environmental information provision (Zhai, 2006). Moreover, risk awareness and geographical characteristics are also noted as important factors influencing respondents' willingness to pay (Botzen and Van Den Bergh, 2008). In those studies, referendum and payment cards were employed broadly as the instrument of CVM elicitation, and so we follow that approach in this paper.

3.2 Methods

Consistent with many of the studies of climate change risk reduction cited above, we employ the CVM approach to estimate farm household willingness to pay for MRD salinity intrusion management programs. CVM was first proposed by Ciriacy-Wantrup (1947), and since the 1970s the methodology has been routinely applied to measure the benefits of a variety of goods such as recreation, hunting, water quality and decreased mortality risk from accidents (Khai and Yabe, 2014). In essence, CVM requires each participant in a study to respond by employing four types of question including open-ended, dichotomous choice, iterative bidding or payment card. The most common question format is an open-ended and dichotomous choice. Although debate over the best form of CVM questionnaire continues, dichotomous choice rather than open-ended elicitation approaches are recommended due to minimization of opportunities for strategic behaviour, and an argument that such questions are cognitively easier on respondents (Mitchell and Carson, 1989). The valuation question in this study thus required each participant to respond to a dichotomous choice based on WTP guidelines by Bateman et al.

(2002) and the Competition Commission (2010). The robustness of the decision to adopt a dichotomous choice format was enhanced in this instance by a large sample of farm households.

3.2.1 Survey method

The primary data for the study was obtained through a field survey conducted among farm households in the MRD. The questionnaire was pre-tested with 30 randomly-selected farm household heads spread across three MRD study areas ranging from heavily salinity-affected areas, down to non-salinity-affected areas. The purpose of the pre-test was to check likely farmer comprehension of the questionnaire, refine the range of willingness to pay bid measures proposed, and test the viability of the proposed payment vehicle; that is, the feasibility of getting farmers to make a monthly contribution to a fund managed by their local authority. Based on the pre-test results, five different bid values were chosen for the monthly payment vehicle: VND 50,000, 100,000, 150,000, 200,000 and 250,000 (equivalent to US$[23] 2.20, $4.41, $6.61, $8.81 and $11.02).

Following the survey pretests and content finalization, the formal in-field face-to-face survey data collection commenced. The survey sample areas were based on an MRD salinity intrusion map provided by the local department of Agriculture and Rural Development. The opinion of local departmental staff as to which areas might present useful sample sites was also sought. As a result of this exercise, the survey was directed at three farmer groups: i) those where salinity intrusion impacts are already prevalent (the Cau Ke district); ii) those living in areas with a high probability and risk of future salinity intrusion (the Tra On district and part of the

[23] US$1 dollar was equal to 22,695 Vietnamese dong at May 01, 2017

Cau Ke district); and iii) a control group-area where salinity intrusion is not yet of concern (the Vinh Thanh district in the Can Tho province). Using simple random sampling techniques, farm households were randomly selected from a list provided by district local authorities. Once selected, a survey enumerator[24] visited the household to ascertain eligibility for survey participation. To be selected, the head of the farm household or their partner had to live in the area, work on an MRD rice field, and have at least three years' farming experience. Eligible respondents were then asked some demographic and social characteristic questions. This was followed by questions related to their perceptions of local climate change and then salinity impacts.[25]

Due to the importance of collecting reliable willingness to pay information, causes of salinity intrusion in the Mekong River Delta were first explained carefully to respondents. This included a range of hypothetical salinity reduction program options. Possible program options suggested in this survey included converting current earth sea-dike-walls to concrete structures, upgrading existing or building new river-mouth sluicegate systems, and the planting of new or reforestation of degraded existing mangrove systems next to sea-dike-walls. Each respondent was then asked whether or not they (their household) would be willing to contribute monthly to fund such programs. They were told that the program funds would be administered by a committee including their local government, local and international consultants, and representatives from non-government organizations.

[24] Enumerators were carefully chosen from staff and final-year students from Department of Agricultural Economics, College of Economics at the Can Tho University. Those with previous experience of survey data collection and CVM approaches were specifically targeted. Each enumerator also received additional training before the official survey took place.

[25] Sample copies of the questionnaire are available from the corresponding author in Vietnamese and English.

This committee would then decide how to invest in concrete sea-dike-walls, sluice-gate construction and mangrove forest in their local area. It was made clear that these measures would seek to reduce current and expected future salinity intrusion risk in their relevant village area.

Following the guidelines from Arrow et al. (1993) and Competition Commission (2010), willingness to pay bids were collected using a referendum style format, where respondents could select one of three options: 'Yes', 'No', or 'Do not know' ('DK') response. During the survey, respondents were given an opportunity to reconsider their vote before asking them to nominate their specific monthly payment bid[26]. Each possible willingness to pay bid value was provided to at least 30 of the randomly selected farm households, for a total of 150 observations from each area. After data cleaning, there were 441[27] useable observations from three different salinity-impact areas. Despite some disadvantages with referendum approaches, such as a limited range for the bid-values offered, this option simplifies the respondent's cognitive task (Pearce et al., 2002) which is an important factor in survey areas where farm household education levels can be quite low. Further, previous studies have identified the fact that CVM approaches can result in over-estimations of willingness to pay. The likelihood of this occurring can be reduced by: using survey pretesting ahead of official data collection, adopting face-to-face surveying approaches, and framing the willingness to pay question in the form of a referendum that includes a 'No vote' or 'Do not know' response option (Arrow et

[26] Although all enumerators were aware of this and always reminded respondents about this. It is considered as unofficial information since thesis author did not indicate it clearly in the final questionnaire version.

[27] Sample size was identified by function $n = z_{1-\alpha/2}^2 P(1-P)/d^2$

al., 1993; Carson et al., 1998; Competition Commission, 2010; Wang, 1997). In support of our adoption of these approaches, the referendum vote has been endorsed by the National Oceanic and Atmospheric Administration (U.S. NOAA) panel, which suggested that valuation questions should be formed as a vote, and include 'Do not know' answer options as distinct from 'Yes' and 'No' responses (Arrow et al., 1993; Carson et al., 1998; Champ et al., 2005; Pearce et al., 2002; Wang, 1997).

In this study, we also employed *ex-ante* bias correction by using a *cheap talk* instrument, which is designed to mitigate hypothetical bias by explaining the risk of this outcome to respondents before asking the valuation questions (Competition Commission, 2010; Mahieu et al., 2012). The version of the *cheap talk* approach we used was based on the 'short and neutral' approaches developed by Aadland and Caplan (2006), Do and Bennett (2007), Bennett, J. and Do, T.N. (2009) and Khai and Yabe (2014). The *cheap talk* scrip was also tested to ensure good understanding by participants in the pilot survey. Our approach included a reminder to respondents to consider budget constraints when making their responses, and treating their decision as if the payment were real. This information is then cross-checked with information about the respondent's socio-economic characteristics and their ability to pay. Finally, an *ex-post* robustness approach was also adopted using a follow-up question asking respondents to specify the certainty of their answers (Champ et al., 1997; Competition Commission, 2010; Whitehead and Cherry, 2007). In these approaches, the farm household participants had more time to reconsider their responses before a firm decision was made and noted in the questionnaire.

3.2.2 Analytical method

The basic theory of the CVM approach was proposed by Hanemann (1984), with concepts derived from consumer theory. We begin with the random utility function of a respondent, which is:

$$u_k = u_k(w, z, e_k) = v_k(w, z) + e_k \quad (3.1)$$

where k=0 is the status quo, and k=1 is the condition where salinity intrusion mitigation public good is provided. Utility function components include income w, respondents' characteristics z, and error component e. Respondent's utility increases when public goods provided with the payment t_j are higher than utility in the status quo:

$$u_{1j} = u_1(w_j - t_j, z_j, e_{1j}) > u_0(w_j, z_j, e_{0j}) \quad (3.2)$$

The probability of an individual response would be 'yes' if the following conditions hold:

$$\Pr(yes \mid t_j) = \Pr(u_1(w_j - t_j, z_j, e_{1j}) > u_0(w_j, z_j, e_{0j})) \quad (3.3)$$

From Eq. (3.1), we can rewrite this probability as follows:

$$\Pr(yes \mid t\ ) = \Pr(v_1(w_j - t_j, z_j) + e_{1j}) > v_0(w_j, z_j) + e_{0j}) \quad (3.4)$$

and assume that the utility function v_k is linear. We can then rewrite Eq. (3.4) as:

$$\Pr(yes \mid t\ ) = \Pr(\alpha_1 z_j + \beta_1(w_j - t_j) + e_{1j}) > \alpha_0 z_j + \beta_0 w_j + e_{0j}) \quad (3.5)$$

This then allows us to rearrange the above function as follows:

$$P\mathrm{r}(yes \mid t\ ) = \Pr((\alpha_1 - \alpha_0)z_j - \beta t_j) + e_{1j} - e_{0j} > 0) = \Pr(\alpha z_j - \beta t_j + e_j > 0 \quad (3.6)$$

Where $\alpha = \alpha_1 - \alpha_0$, and $e_j = e_{1j} - e_{0j}$ because the error terms are assumed to be independently and identically distributed, the probability of respondent choosing 'yes' can be estimated with:

$$Pr(yes\,|\,t_j) = \Pr(\alpha z_j - \beta t_j + e_j) > 0 = \Pr(e_j > -(\alpha z_j - \beta t_j)) = \Pr(e_j < (\alpha z_j - \beta t_j))$$

$$= F(\alpha z_j - \beta t_j) \qquad (3.7)$$

The function in Eq. (3.7) is then estimated using maximum likelihood procedures, and v assumes a linear form including income w, farm household's characteristics z and the final bid value. In this study, Multinomial Logistic Regression (MNL) and Binary Logistic Regression treatment models were initially employed to analyse the referendum format of the CVM. Details of such analysis models are discussed by Lancsar et al. (2017).

Table 3.2 Summary statistics for the model variables

Variable	Description	Mean	Min.	Max.	Standard deviation
Bid value	Vietnamese dong (1,000 VND)	150.453	50	250	70.789
Farm household income	Total income per year (1,000 VND)	107,594.8	7,500	711,100	102,445.3
Head of household's age	Years	47.410	24	81	9.926
Head of household's gender	0: Male, 1: Female	0.172	0	1	0.378
Household size	Number of people in household	4.285	1	10	1.274
Head of household's education	0=never attended school, 1=primary school, 2=secondary school, 3=high school, 4=bachelor degree and 5=post-graduate degree	2.190	0	5	1.146
Farming experience	Years	23.399	1	65	10.915

As stated above, in our CVM survey farm households were asked to respond to the willingness to pay bid value question in one of three ways: ‘Yes,’ ‘No’ or ‘Do not know’. In the analysis model α and β are coefficients, and *X* is a vector of the socio-economic explanatory variables related to an individual’s selection including: farm household income, head of household’s age, head of household’s gender, farm household size, head of household’s education and total farming experience (Table 3.1). The non-parametric technique is employed to estimate the mean values for WTP. This technique was suggested by previous researchers in the same survey area (Đan and Duyên, 2010; Khai and Yabe, 2014). Thus, we estimated mean willingness to pay values as follows:

$$n_j = \sum_{k=j+1}^{5} N_k \qquad (3.8)$$

where *N* is the sample size, N_j is the sub-sample size who chose B_j (with B_j as the bid value with *j*=1, 2, 3, .. *N*), and n_j is the sub-sample size that is willing to pay more than bid value B_j. Then, the survivor function at each B_j is:

$$S(B_j) = \frac{n_j}{N} \text{ (j=0 to 5)} \qquad (3.9)$$

Finally, the mean value for MRD farm households’ willingness to pay is estimated as follows:

$$MeanWTP = \sum_{j=0}^{5} S(B_j)(B_{j+1} - B_j) \qquad (3.10)$$

3.3 Results

3.3.1 Descriptive analysis results

The socioeconomic characteristics for each of the MRD farm household groups are presented in Table 3.2 below. To test for sample representativeness, the results are compared with data from the Vietnam Household Living Standard Survey (VHLSS) - a national survey of the Vietnamese population conducted every two years. In general, respondent characteristics in each group are consistent across the three groups, and with the VHLSS results. In the context of an MRD culture in which decision-makers are typically men, the majority of household heads interviewed were male. The average age of the head of household was 47 years. The mean head of household's education level was 2.05 for the current salinity-impacted group, 2.03 for the high future risk group, and 2.48 for the control group; indicating that MRD farmers have mainly achieved primary or secondary school-level educations. The majority were born immediately after the Vietnam war when much of the national and local infrastructure had been destroyed, and communities were trying to re-establish themselves. This may explain the relatively low education levels among respondents. In terms of farm household income, the control group (Group 3) had highest annual income at VND 112 million per annum (US$5022); compared to the salinity intrusion (Group 1) and high-risk groups (Group 2) which on average earned VND 104.5 million per annum (US$4753). This outcome, together with the higher variability in results as depicted by the standard deviation values, would suggest some negative farm income effects associated with current salinity and/or the risk of future salinity impacts.

Table 3.3 Socio-economic characteristic comparisons between this survey and the Vietnam Household Living Standard Survey (VHLSS)

Variables	**Mean value in VHLSS[28]**	**Mean study survey values**		
		Group 1 With SI	Group 2 High-risk SI	Group 3 No risk SI
Age	49.52	46.89	46.46	48.83
	(14.15)	(10.09)	(9.81)	(9.77)
Gender	0.27	0.20	0.23	0.10
	(0.44)	(0.40)	(0.42)	(0.29)
Education	1.29	2.05	2.03	2.48
	(1.89)	(1.17)	(1.14)	(1.08)
Farming experience	N/A	23.38	22.41	24.37
		(12.04)	(11.21)	(9.35)
Household size	2.15	4.31	4.41	4.15
	(1.29)	(1.12)	(1.23)	(1.43)
Farm household income	64,900.00	106,564.30	103,977.80	112,094.30
	(62,100.00)	(110,675.90)	(118,674.40)	(73,665.07)

Numbers in parentheses denote standard deviation values. For variable descriptions of the study, see Table 3.1. SI: salinity intrusion

In addition, to identify any differences in the mean values of the variables in Table 3.2 across the three farm households groups, we employed the one-way analysis of variance (ANOVA) and Tukey *post-hoc* tests. The ANOVA results confirmed no statistically significant differences between the three groups, except gender ($F(2,438)=5.28$, $p=0.0054$) and education level ($F(2,438)=7.13$, $p= 0.0009$). Similarly, the Tukey *post-hoc* test revealed slightly higher farm head of household education levels in the control group (Group 3), and slightly higher numbers of

[28] Vietnam Household Living Standard Survey 2010. There is a wider range of educational levels (1: Primary school, 2: Secondary school, 3: High school, 4 to 7: Vocational education, 8: College, 9: University, 10: Masters, 11: PhD, 12: other) used in the VHLSS, and this difference is taken into account in our comparison.

females in Groups 1 and 2. However, the differences are minimal and we therefore conclude that the analysis results from this study are broadly representative of the MRD farmer population.

3.3.2 Willingness to pay results

3.3.2.1 Reasons for unwillingness to pay

In terms of respondents' willingness to pay our study first examined reasons why respondents may be unwilling to pay for the goods of interest. Key reasons offered include a preference for alternative goods and programs, a lack of capacity to pay, and questions of government capacity to manage the proposed program(s). Table 3.3 summarises the reasons why some farm households are unwilling to contribute to the proposed salinity reduction program. The main reason households voted against a proposed program was their reported inability to afford the required payments. The second highest selected reason was a farm household perception that salinity intrusion reduction should primarily be the responsibility of the Vietnamese government. Approximately 20 per cent of farm households also did not believe that their contributions would be used to fund the program correctly. Finally, approximately 15 per cent of farm households in salinity-impacted areas voted against the program contributions because they felt that they could adapt to, and live with, MRD salinity intrusion.[29]

[29] Following discussion by Jorgensen (1999), we estimated the Model results using expanded zero-bid protest vote definitions that included program ineffectiveness beliefs and feeling that the respondent can deal with problem by themselves. The model estimates did not vary greatly from the original analyses and so were not included here. Although there are some other different protest reasons in the hypothetical market updated recently (e.g. Brouwer and Martin-Ortega, 2011), which also presented on Appendix 23, comaprisions and clarifications are also discussed in following Chapter 4.

Table 3.4 Reasons for voting against salinity reduction contributions in the MRD

Reasons	Group 1 With SI		Group 2 High-risk SI		Group 3 No risk SI	
	Number	%	Number	%	Number	%
I cannot afford that amount	31	49.21	27	33.75	40	38.83
I do not think the upgrading of dike-walls is worth doing	0	0	0	0	1	0.97
I do not think that amount I would pay will be actually used for this program	5	7.94	20	25.00	19	18.45
I think this is the responsibility of the government	16	25.40	31	38.75	39	37.86
I can deal with this using my own adaptation options	9	14.29	0	0	0	0
Other	2	3.17	2	2.50	4	3.88
Total	63	100	80	100	103	100

3.3.2.2 Willingness to pay and its determinants

Figure 3.2 summarizes the proportion of farm household responses to various bid levels offered in the survey. In general, the percentage of farm households answering ‘Yes’ decreases as the bid level increases. However, those MRD farms that are currently affected by salinity or facing a high risk of future impact were generally inclined toward a ‘Yes’ response; even at higher bid levels.

As expected, the proportion of farmers that indicated their unwillingness to contribute increased as bid levels were raised, but again with smaller total percentages from the currently-affected and high future risk groups. Finally, the proportion of farmers answering ‘Do not know’ to the bid levels rapidly falls to zero in the control group but remains positive for the other groups at relatively low levels (~4 per cent on average). These results suggest that MRD farmers recognize the significant risks and negative impacts associated with salinity intrusion, even when they are not yet exposed to salinity.

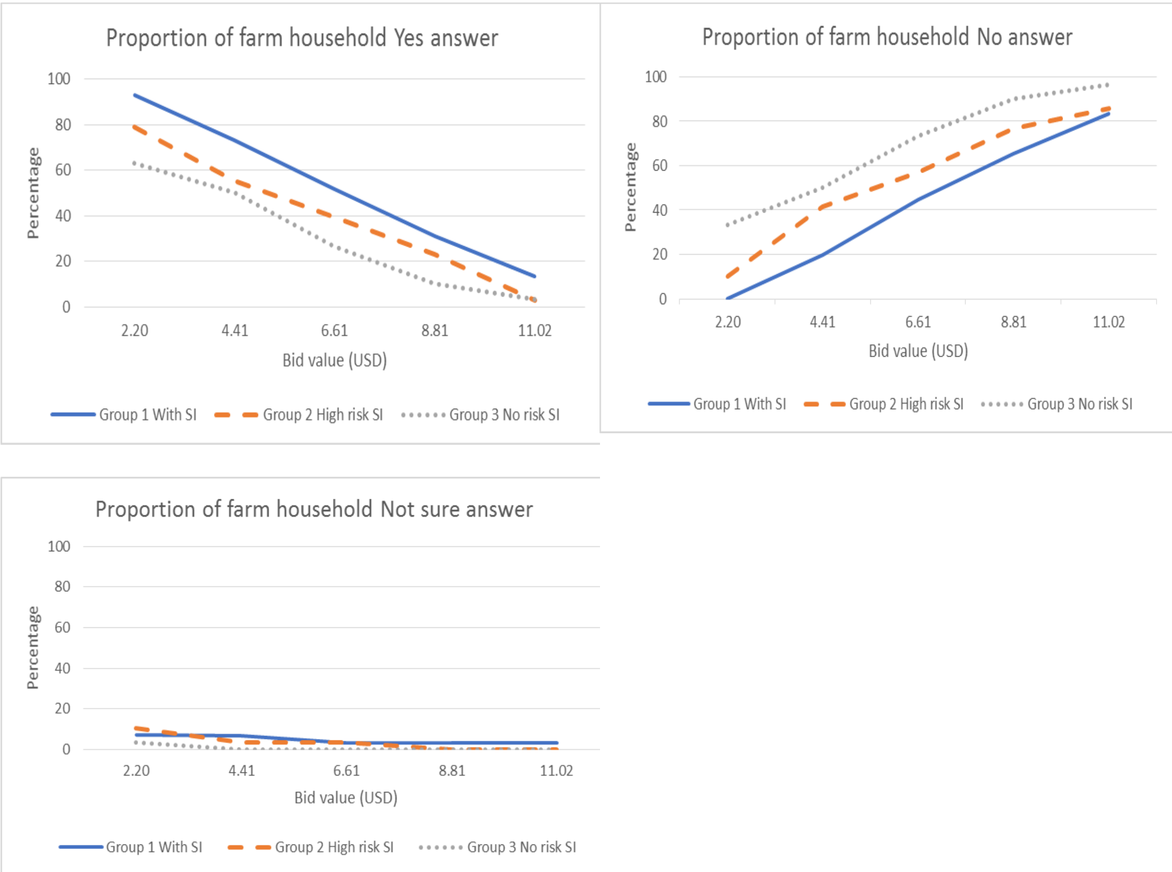

Figure 3.1 Proportion of farm household answers to each bid option

Factors that influence MRD farm households’ willingness to pay for salinity intrusion risk reduction are presented in Table 3.4. We estimate the results across three models: Model 1 is an MNL model with ‘No’ responses as the base-outcome, while Model 2 is a Binary Logistic Regression that reclassifies all ‘Do not know’ answers as a ‘No'. In Model 3, also in the form of a Binary Logistic Regression, ‘Do not know’ answers are deleted entirely from the dataset.

The results of model fit statistics showed that the likelihood ratio (LR) in three models are significant: $p<0.001$ in all Models, and Pseudo R-square values of 0.304, 0.294 and 0.338 in Models 1, 2 and 3 respectively. Hence, this result indicated a good fit, and all three Models are statistically significant and explained by the independent variables included. Further, and as detailed in Table 3.4, Variance Inflation Factor (VIF) values for each of the independent variables are smaller than 7.0, indicating that there are no significant multicollinearity issues with the modelling.

Table 3.5. Marginal effects of stated willingness to pay for salinity intrusion risk reduction[30]

Variables	Model 1 MNL approach 0= No (base outcome), 1= DK, 2=Yes			Model 2 Binary Logistic Regression 0=No/DK 1=Yes	Model 3 Binary Logistic Regression (DK deleted) 0=No, 1=Yes	
	0	1	2			VIF
Bid value	0.003***	-0.001**	-0.003***	-0.004***	-0.005***	1.02
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
Age	-0.007**	0.001	0.006*	0.008*	0.010**	3.01
	(0.003)	(0.001)	(0.003)	(0.005)	(0.005)	
Gender	0.017	0.021	-0.039	-0.074	-0.057	1.10
	(0.052)	(0.019)	(0.053)	(0.074)	(0.081)	
Education	0.016	-0.003	-0.013	-0.020	-0.025	1.13

[30]Unlike some other studies where all survey members are mailed the questionnaire (Messonnier, M.L, et al., 2000) a face-to face-survey was employed in this survey. A total of 450 farmers were contacted on site, 441 of whom agreed to take part in and completed the survey (four did not answer and five were incomplete and could not be used), with a 98% response rate. Then, it is unlikely that the possibility of sample nonresponse bias (SRB) exists.

When looking at sample selection bias (SSB) (it means there is a correlation between the determinants of survey responses and WTP). However, only a very small share of the sample (around 2% (nine farmers) of total observations did not answer and/or did not complete the survey, which was then removed from the final analysis. As a result, a Heckman two-stage (H2S) approach in the DC WTP is not necessary. Recall in this research, three particular sub-groups (stratified by salinity intrusion level) have been compared and, those who answer 'Do not know' have also been truncated to check the consistency among them (Table 3.5).

Another bias such as sample nonresponse bias (SNB) which requires a comparison of the distributions of socio-demographic characteristics of respondents and non-respondents. The SNB exists when there are differences among compared groups. However, as indicated in Table 3.3 and the discussion following this table, the differences are minimal among three groups of farm households and with Vietnam Household Living Standards Survey (VHLSS). As such, it is concluded that this data survey is highly representative of the MRD population, and it provides strong reason to believe that the differences between respondents and non-respondents or between "yes" responses and "protest vote" responses in any other classifications are broadly the same (See Appendix 22 for the results of Tests). As a result, there are no SRB, SNB and SSB presented in this analysis.

	(0.017)	(0.008)	(0.017)	(0.026)	(0.027)	
Farming experience	0.011***	-0.001	-0.009***	-0.014***	-0.017***	3.07
	(0.003)	(0.001)	(0.003)	(0.005)	(0.005)	
Household size	-0.005	0.006	-0.001	-0.001	0.007	1.05
	(0.015)	(0.006)	(0.015)	(0.022)	(0.024)	
Farm household income	-7.60e-07***	-1.29e-07	8.89e-07***	1.30e-06***	1.34e-06***	1.07
	(1.90e-07)	(1.30e-07)	(1.99e-07)	(0.000)	(0.000)	
Group	0.124***	-0.019	-0.105***	-0.160***	-0.191***	1.05
	(0.022)	(0.012)	(0.023)	(0.037)	(0.039)	
Log-Likelihood		-244.8378		-211.13328	-193.16083	
Pseudo R-square		0.3036		0.2937	0.3382	
Prob>chi2		0.0000		0.0000	0.0000	
N (sample size)		441		441	428	

***, ** and * indicate to statistically significant at 1%, 5% and 10% levels, respectively; Standard errors of marginal effects (dy/dx) are in parentheses

The results from the three models are broadly uniform. Consistent with economic theory, farm household income and bid value are strongly correlated with increased probability of willingness to pay; that is, high farm income correlates with a positive probability of willingness to pay. As expected, higher bid values are negatively correlated with a probability of willingness to pay in a manner that is consistent with other climate change impact studies (e.g. Wang, 1997) and willingness to pay studies from the MRD (Đan and Duyên, 2010; Khai and Yabe, 2014).

Interestingly, although older farmers are weakly associated with an increased probability of willingness to pay, farmers with more experience were generally less likely to be willing to pay toward salinity intrusion reduction programs. We did not expect to find this outcome; it may be because experienced MRD farmers feel capable of dealing with salinity intrusion on their own, or consider that local authorities cannot be trusted to manage the problem effectively. In any case, this result is supported by recent research on farmers' willingness to pay for rice farming insurance in the MRD (Thong, 2014). Finally, the negative coefficient for the group variable suggests that the probability of farm household willingness to pay increases with their proximity to current and expected salinity impact.

Results from the non-parametric estimation methods using equation (10) show that the highest willingness to pay level is associated with the group already experiencing high salinity intrusion (Table 3.5). Farm households in this group are willing to contribute approximately US$2.58 per month toward the salinity reduction program, while farms in the control group are only willing to contribute around half of that amount; i.e. US$1.32 per month. Across the three groups, annual farm household contribution to salinity reduction programs would average US$23.57. A Kruskal-Willis H test was employed to examine whether these WTP values were statistically different for the three farm household groups. The results showed a statistical difference between the three groups ($\chi^2(2) = 9.847$) at a strong significance level (p=0.0073), which is below 0.01.

Table 3.6 Mean of WTP by impact group

	Group 1 With SI	**Group 2 High-risk SI**	**Group 3 No risk SI**
Mean WTP per month (USD)	2.58 (58,562VND)	1.99 (45,172VND)	1.32 (30,000VND)
WTP annum (USD)	30.96	23.88	15.86
Proportion of WTP per total household income annum	0.65%	0.52%	0.32%

We can loosely compare this to research in the UK, where people were willing to pay a monthly premium of £4.46 (about US$5.77) for coastal defence projects (Jones et al., 2015). This finding is also somewhat comparable with a review of previous studies which indicated that annual willingness to pay for climate policy is in a range of between US$22 and US$437 per household in samples drawn from American, Asian and European populations (Johnson et al., 2010). Finally, in the literature surrounding climate change mitigation projects funded by higher energy prices, we note that Korea consumers are willing to pay US$3.21 per month for renewable energy (Lee and Heo, 2016), while Japanese consumers' median WTP for green electricity is about US$17 per month (Nomura and Akai, 2004); which align with the values reported here. In any case, the results of this study reveal a promising community participation attitude toward solving the sea-dike public funding deficit in Vietnam, offering a promising basis for policy-makers to establish appropriate projects/actions. However, there may be potential bias in this result, therefore, in order to declare any final official policy decision by Vietnamese government, different approach to classify protest response should be tested and compared.

Finally, our study also estimated relative economic sacrifice (RES) values to assess the robustness of the willingness to pay results, where $RES = B_i / Y_i$, and B_i is the chosen bid level, and Y_i is the farm household's total income. This RES is the ratio between the respondent's willingness to pay level and total per annum farm household income. The RES value for each farm household group was 0.0032 (salinity-impacted areas), 0.0034 (high future risk areas) and 0.0019 (control group areas). These values are relatively small and suggest that our willingness to pay estimates are not overstated. This conclusion is further supported also by an assessment of the ratio between mean willingness to pay and annual farm household income.

3.4 Discussion

The positive willingness to pay results reported here suggest that MRD farm households are concerned about the adverse impacts of salinity intrusion. While some larger MRD farm households may struggle to contribute, as reflected in our findings, there is little evidence of a large-scale protest. Based on our results, it is reasonable to conclude that the financial impact on most households would be minimal; approximately at the 0.65 of one per cent level of annual net farm income. The next issue to consider is the question of how much money might be needed to fund an effective salinity intrusion control program and how much households could contribute to the cost of running such a program. As shown in Figure 3.3, and according to Danh (2012), one option is to build around 1469 km of concrete sea-dikes. Accepting this as a possible scenario, and noting that:

a) it may be possible for many farmers to live with and adapt to salinity intrusion by doing such things as moving from rice production to fish or shrimp farming;
b) that a combination of earth dikes and mangroves may provide a more environmentally-friendly program and, after completion of a full economic evaluation of non-market benefits, may also provide a more socially beneficial solution; and

c) under the premise that some of this problem has been caused by the actions of people in other countries and that, as such, a significant international contribution to the cost of controlling salinity intrusion could be expected

d) it may be possible to conduct a more detail exploratory analysis of the feasibility of calling upon MRD households to fund much, if not all, of any MRD salinity intrusion control program.

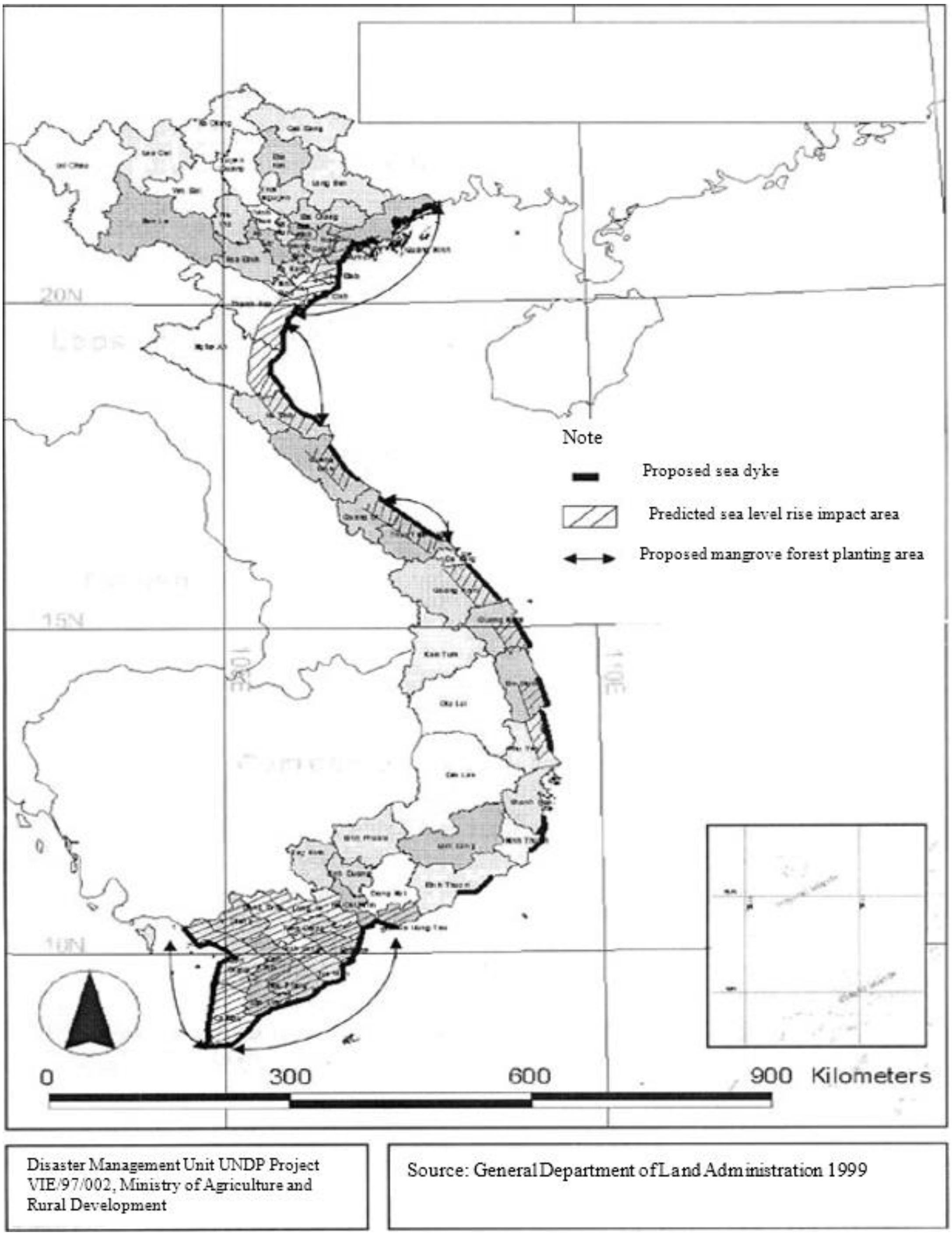

Figure 3.2 Sea dike map in Vietnam

Source: Adapted from Danh (2012)

Table 3.7 contains estimates of the costs of constructing and maintaining concrete sea-dike-walls across rural Vietnam, adapted from Danh (2012). A two-meter concrete sea-dike-walls requires approximately US$1.16 million per kilometre in construction costs. This increases to US$2.8 million per kilometre if the sea-dike-walls height is increased to four meters. Over the total length of MRD coastal area identified, program costs for concrete sea-dike-walls construction would require total funding of approximately US$1.7 billion for two-meter concrete sea-dike-walls; US$2.8 billion for three-meter concrete sea-dike-walls; and US$4.1 billion for four-meter concrete sea-dike-walls. Significantly, as a relatively poor country and where climate-induced sea level rise is the prime cause of the salinity intrusion problem, the Vietnamese Government should be able to borrow the money needed to build a sea-dike-walls system at 1.08 per cent[31] p.a. interest rate from Asian Development Bank (ADB), and repay the principle over a loan term 40 years. If this is the case, then the annual payment would be between $53m and $127m per annual (Table 3.7).

[31] This is the Weighted Average Cost of Capital (WACC) estimated by Asian Development Bank applied for Transport Corridor – Noi Bai – Lao Cai Highway Project loan for Vietnam.

Table 3.7 Total estimated sea-dike-wall construction costs, under three wall height scenarios [32]

	Height at 2m	Height at 3m	Height at 4m
Total dike-wall construction costs (in millions of US$ per km) in rural Vietnam	$1.16m	$1.93m	$2.79m
Total cost (for 1,469 km concrete sea-dikes)	$1,700m	$2,833m	$4,107m
Yearly payment required to service a 40-year ADB loan sufficient to build the sea-dikes[33] (interest rate at 1.08 percent per annum)	$52.56m	$87.60m	$126.99m
Required annual contribution per household to repay the ADB loan	$15.93	$26.54	$38.48

Source: Computed by authors and adapted from Danh (2012)

If the repayment figure is then equally divided across the 3.3 million farm households[34] currently located in the MRD (Ministry of Planning and Investment, 2015), it would result in a need to collect between US$16 and US$39 per farm household. However, if the contribution involves all households (including non-farm households) in the MRD, where a total of 4.7 million households are located, the annual payment period will be decreased from 40 to 30 years, and the annual contribution required per household would fall to between US$14 and US$35 per household. Clearly, this is a very crude estimate, and not sufficient to recommend

[32] Although this research was done and considered carefully, It is noted that the estimations may still affected by the uncertainty of climate variabilty and interest rate. Hence, the sensitivity analysis of negative changes in discount rate and salinity intrusion level is expected to conduct in my future research.

[33] Identified by function $A = US\$loan\_amount\left[i(1+i)^n\right] / \left[(1+i)^n - 1\right]$ where i is WACC and, n is number of loan years.

[34] the number of household in MRD is around 4.7 million in 2015 (The Vietnam General Statistic Office – www.gso.gov.vn), in which 69.3% are farm household in rural areas (Ministry of Planning and Investment).

the implementation of an MRD concrete sea-dike program. Nevertheless, the estimated per farm household contribution required to meet ADB loan repayment is less than the average stated willingness to pay levels found in our study. Therefore, our results suggest that in the absence of other public funds, private MRD farm household contributions may be sufficient to cover the cost of building a concrete sea-dike that would protect farm lands from climate change-induced sea level rise. The issue of whether this is equitable remains the subject of further analysis and discussion that we will address in future research. Nevertheless, the insights provided by this paper have important ramifications for Vietnam, other developing country contexts faced with salinity intrusion impacts, and broader climate change management policy.

3.5 Conclusions

This study estimates MRD farm household willingness to pay for salinity intrusion mitigation programs. The results reveal that more than fifty per cent of farm households are willing to contribute to a fund that could be used to reduce salinity intrusion risk, and that their willingness to pay is in proportion to expected salinity impacts. Farm households in current salinity intrusion-affected areas are more willing to pay for risk reduction programs than those farm households located in lower or no current risk areas. However, all farm households included in the study—including those who at present are unaffected by salinity intrusion—are willing to pay for an MRD salinity management program.

When assessed in aggregate, the total amount of money that farm households are prepared to pay is significant, and may be sufficient to cover the total costs of such a program. Care must be taken, however in the interpretation of this result. While the payment vehicle adopted in this study suggests feasibility, work on the most appropriate government arrangements requires further analysis. Careful research, for example, on the merits of establishing a separate salinity intrusion control authority versus the use of an existing government structure is needed. Similarly, there is a need to consider how best to involve farmers in any program that they pay for. Further, the question of whether or not MRD farm households should be made to pay for the adverse effects of global climate change and upstream development is an important ethical and legal question to resolve. It is our intention to address these issues in future research papers.

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Chapter 4 - Statement of Authorship

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Name of Principal Author (Candidate)	Tien Dung Khong		
Contribution to the Paper	Led and conducted data collection, performed analysis and interpreted data, wrote the manuscript and acted as the corresponding author.		
Overall percentage (%)	65%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	25/06/2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate to include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100%, less the candidate's stated contribution.

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Contribution to the Paper	Supervised development of work, helped to evaluate and write the manuscript.		
Signature		Date	25/06/2018

Chapter 4 : Indirect versus Direct Questioning: A salinity intrusion case study

Abstract

People's willingness to pay values can be inflated where there is any desire to look good in the eyes of others. This is termed social desirability bias, and is common in willingness to pay methods involving face to face interviews. Recently developed inferred valuation approaches may serve to reduce social desirability bias effects on hypothetical and real stated values. Economic applications of inferred valuation approaches are relatively limited in the literature, and evidence of value muting benefits is mixed. This paper specifically examines commitment cost drivers of value disparities related to willingness to pay for salinity intrusion mitigation programs in the Mekong River Delta of Vietnam. Dichotomous choice personal interviews were conducted across farmer groups with different exposure to salinity intrusion impacts. Consequentiality thus ranged across the sample, increasing the risk of hypothetical bias and free-riding incentives; which may also serve to inflate conventional willingness to pay values. Inferred valuation approaches were adopted to identify willingness to pay disparities across the sample range. Inferred valuation estimates were up to 17 per cent lower than conventional estimates of willingness to pay, and averaged about seven per cent lower across the groups. Public policy implications for future salinity intrusion mitigation program are discussed.

Keywords: inferred valuation, indirect questioning, Mekong River Delta, salinity intrusion, contingent valuation

JEL classification Q51, Q54

Highlights

- Social desirability bias in CVM estimates is checked for robustness using IV techniques
- Indirect questions reveal lower values than conventional direct questions
- Determinants of WTP are broadly consistent across different valuation approaches
- Policy-makers should employ direct and indirect techniques to increase the feasibility of public good policy implementation

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4.1. Introduction

Contingent valuation methodology (CVM) is widely used to estimate the values people place on public goods through their reported willingness to pay (accept) to receive (give up) that good. The inconsequential (i.e. hypothetical) nature of many public good value estimation studies often leads to a high probability of inflated estimates (Johnston et al., 2017b). Value estimates can be inflated by a factor of two to three (Loomis, 2011) when respondents base their bids on the benefits of the proposed public good, and discount the costs (Carlsson et al., 2010). Contingent valuation responses may also reflect some willingness to pay (WTP) for the moral satisfaction of contributing towards the cost of providing access to public goods (Kahneman and Knetsch, 1992). Moral satisfaction will be derived by people concerned about how their responses will be perceived by others—providing them with a 'warm glow' (Andreoni, 1989)—rather than how they think they will enjoy consuming the good (Levitt and List, 2007). This effect has come to be known as social desirability bias.

The presence of an interviewer in WTP studies may amplify social desirability bias effects on stated values, especially where respondents think that those values will please the interviewer or be consistent with societal norms (Leggett et al., 2003). List (2006) suggests that the theory of self-interest describes pro-social behaviour in field (real) settings, whereas social preference theories related to fairness, trust, and reciprocity describe laboratory (hypothetical) behaviour. This relates well to Fisher (1993), who argued that people wish to be held in good regard, but are less concerned about the impression that others make. Where stated WTP values may also be sensitive to the estimation method used (Bengochea-Morancho et al., 2005), increased utility from responses perceived as pleasing to an interviewer is likely related to both social desirability and hypothetical bias (Lusk and Norwood, 2009b). As such, inferred values aimed at shifting the value perspective of an individual to that of others might provide some capacity to address biases associated with people wishing to be held in high regard or conforming to social norms.

Lusk and Norwood (2009a) thus theorise moral utility as a driver of inflated WTP values, and advocate inferred valuation approaches that, consistent with other studies (e.g. Epley and Dunning, 2000), may more accurately forecast actual behaviour in the market. Testing their theory, Lusk and Norwood (2009a; 2009b) provide evidence that inferred valuations are lower than conventional approaches, indicating the importance for public policy development of capturing value estimates with different approaches to ensure robust outcomes. In a subsequent study, Carlsson et al. (2010) also observe differences between hypothetical and real money donation payments, with lower values for others' perceived payment preferences—and stronger for female respondents. Olynk et al. (2010) test people's stated values for credence attributes in food products, arguing that inferred values provided more accurate reflections of consumer value than direct questioning (e.g. CVM). Among rural landscape protection products with less obvious motives for socially-distorting values Yadav et al. (2013) also found that inferred values were lower than personal values.

However, other studies identify different outcomes. For example, Stachtiaris et al. (2012) found that inferred values can be susceptible to inconsistent (reversed) preference orderings (e.g. lottery pricing and choices), and higher inferred values were elicited from respondents considering high commitments costs in a food market setting with credence value goods. Drichoutis et al. (2016) study the value implications of carbon-neutral foods using WTP/WTA estimates derived from a range of approaches including IV to explore if the gap (disparity) between the two can be muted. They find that the payment card elicitation method performs better than the inferred approach, and that dichotomous choice approaches are more prone to value gaps. Gregg and Wheeler (2018) also employ inferred valuations to assess ecosystem benefits from small wetlands near urban areas, finding only a slight lowering of values from the inferred approach. They suggest that other methods (e.g. log-normal transformations) may offer alternative means to address social desirability biases. Finally, higher inferred WTP values are reported by Torres-Torres-Miralles et al. (2017) for olive agro-ecosystem services in natural reserves in southern Spain. Interestingly, those with low commitment costs did report lower inferred WTP values, suggesting scope for further testing of commitment cost effects on WTP.

The basis for commitment cost-effects on WTP values can be found in Lusk and Norwood (2009a), where a matrix capturing normative motivation (high/low) and commitment costs (high/low) is provided. In all cases of high normative motivation (e.g. face to face interviews), the matrix hypothesises that inferred WTP should be ≤ own WTP values regardless of commitment costs. This is expanded somewhat by Yadav et al. (2013), who suggest three reasons for WTP/IV estimate disparities: i) experienced respondents may anticipate others' tendency to inflate values, and lower the disparity; ii) if respondents believe others will free ride this may increase the disparity; and iii) more information (or lower commitment costs) should drive lower disparity between real and hypothetical stated values.

In this paper we therefore explore commitment cost effects on stated WTP values from both conventional CVM and inferred valuation (IV) approaches. The context for our study is the Mekong River Delta (MRD) region of southern Vietnam, where reductions in upstream flows are allowing salinity intrusion to negatively impact on agricultural and aquaculture industries. We examine farmer WTP via a provision point mechanism (PPM) for a public good program that would facilitate sea-dike construction, enhancement, and ongoing maintenance to mitigate MRD salinity intrusion. A PPM frames public goods with pre-determined costs (the threshold or provision point). If respondent contributions cover or exceed those threshold costs, then the public good will be provided. If the contributions fall short, then the program will not be implemented (Marks and Croson, 1998); thus accurate WTP estimates are of crucial importance or program funding success.

It is argued that the use of PPM approaches result in efficient allocations of public goods (Bagnoli and Lipman, 1989), increased positive contributions regardless of the information provided (Marks and Croson, 1999), and improved voluntary contribution methods in terms of combatting hypothetical bias impacts (Krishnamurthy, 2001). However, framing public goods with a PPM presents each respondent with a fundamentally different incentive structure (Ledyard, 1995), particularly if group interest is the principal motivation for contributing. As a small decrease in individual contributions may result in a large decrease in public good provision, the dominant strategy will be to contribute at higher than (perhaps) plausible levels (Marwell and Ames, 1980). This can lead to demand overestimation, and threaten public good provision if actual contributions are insufficient or diminish over time (Marks and Croson, 1999). While consequentiality coupled with a dichotomous choice elicitation method may reduce hypothetical bias (Carson and Groves, 2007, Carson and Hanemann, 2005), group interest and normative motives from face to face interviews may increase social desirability bias effects on stated WTP values. Further, where PPM has been tested in the field, one-shot approaches have incentivised larger groups to contribute more (Rondeau et al., 1999), open-ended and dichotomous-choice responses have resulted in higher than actual contribution rates (Poe et al., 2002), and cheap talk hypothetical bias mitigation measures were only effective at higher payment levels (i.e. US$9-US$18) (Murphy et al., 2005).

An earlier PPM study of farmers' willingness to pay (WTP) for salinity intrusion mitigation projects in the MRD found widespread positive contributions, even among unaffected MRD farmers (Chapter 3). However, the stated bid-levels were relatively low (i.e. US$1.32-US$2.58 per month) across the three farmer groups, suggesting potential public-policy funding constraints for salinity intrusion projects if the PPM approach has overestimated true WTP. Therefore, the aims of this paper are to: i) identify WTP value disparities between conventional CVM an IV approaches within the context of a PPM survey conducted across farmers with high group interest motives; ii) test the hypothesised relationship between commitment costs and WTP value disparities; iii) test Yadav's et al.'s (2013) assertions about the drivers of WTP value disparity; and iv) provide public policy advice based on our findings. We begin with some further information about the context of this study.

4.2 Case study: Mekong River Delta salinity intrusion

This study was based on a survey conducted in the Mekong River Delta (MRD), in Southern Vietnam. Approximately 18 million people live in the MRD; with around 70 per cent located in rural areas that are dependent on farm income. Vietnam is one of the largest rice exporters in the world, and MRD rice production (56% of total) is a key contributor to both the Vietnamese and MRD economies. MRD rice production is currently affected by increased salinity within the Delta caused by diminishing upstream flows as a result of dam construction and increased water extraction. This allows saline water to intrude further inland (Danh and Khai, 2014), creating significant negative externalities for agricultural and domestic water supplies. The total affected area is currently estimated at about 620,000 hectares including 90,000 hectares of rice paddy fields across many provinces (Figure 4.1), as well as other areas of vegetable, fruit crops and aquaculture. This leaves little capacity for adaptation or diversification by MRD farmers.

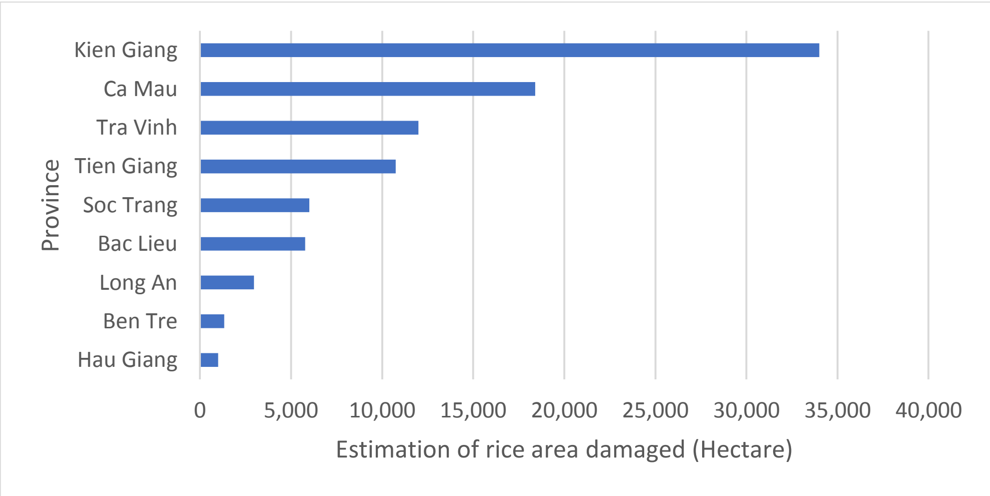

Figure 4.1 Estimation of paddy fields damaged by MRD salinity intrusion, February 2016

Source: Ministry of Agriculture and Rural Development of Vietnam 2016

Some sea-dikes have already been constructed along the edge of the MRD and, where they exist, salinity control only requires enhancement. In most areas where salinity intrusion needs to be mitigated, new earthen and concrete sea-dikes will have to be built (Danh, 2012). This approach is supported by the Dutch-Vietnamese Mekong Delta Plan; the Japan International Cooperation Agency (JICA)-funded Climate Change Master Plan; and the Mekong Delta Water Resource Plan (Vietnam Government, 2013). It has been estimated that an investment of around US$1.7 billion would be needed to build a two-meter high sea-dike, and that US$4.1 billion would be required to put four-meter high sea-dikes in place (See Chapter 3). While conceptually possible, the Vietnamese government has indicated that it does not have the financial resources to fund such a project (Danh, 2012; Danh and Khai, 2014) unless significant foreign financial assistance is offered. Moreover, officials are quick to point out that, even if assistance can be found, they would struggle to provide the annual funding necessary for sea-dike operation, enhancement and maintenance (Jones et al., 2015).

One possible solution to the funding issue is to require farmers, as the principal beneficiaries of such sea-dike structures, to contribute to the costs of construction, enhancement and maintenance. To this end, a recent study using conventional CVM estimates investigated MRD farm household willingness to make monthly payments to a fund that would pay for such a program (See Chapter 3. Farmers were told that without sufficient contributions, the salinity mitigation program would not be implemented. The study concluded that farm households were positively inclined to contribute, and that these contributions would be sufficient to cover a 30-40 year repayment period, and ongoing maintenance.

As PPM approaches may inflate stated WTP value approaches, especially in the group interest context of this particular study, it will be important to test the upper bounds on real WTP via inferred value methods. However, as the study includes three groups of farmers with different exposure to salinity intrusion (different commitment costs), it will also be possible to test any consequentiality effects on stated WTP values. Our research will also determine if there are any differences between the CVM and IV estimation methods in the socio-demographic factors that influence positive farmer WTP responses. This may provide some further insight into Yadav et al.'s (2013) disparity drivers. Finally, the findings from this study will have useful public policy implications by understanding the potential for community contributions toward public good programs in developing countries, as well as the need to check the robustness of those contribution estimates with additional robustness tests.

4.3 Methods

4.3.1 Data collection

The data for this research was collected via a face to face field survey of MRD farm households in late 2016. Prior to the data collection commencement, the questionnaire was pre-tested using pilot survey methods. Local enumerators with experience in conducting CVM research were carefully selected from staff and senior students from the Can Tho University School of Economics and the Department of Agriculture and Rural Development.

After initial pre-testing with farm households in target areas using an open-ended dichotomous choice CVM questionnaire, a group of five final discreet bid values were selected including VND50,000, VND100,000, VND150,000, VND200,000 and VND250,000; which are equivalent to US$2.20, $2.40, $6.60, $8.81 and $11.01 respectively.[35] The final questionnaire was separated into three main sections: farm households' socio-demographic characteristics, perceptions of MRD salinity intrusion impacts, and the willingness-to-pay contribution questions. In the willingness-to-pay section, respondents were provided with a provision point mechanism scenario which involved telling them that a coastal sea-dike system would be constructed to mitigate the effects of salinity intrusion on agriculture if sufficient contributions were achieved. The payment vehicle was framed as a mandatory contribution that would be managed by a Board including local government, local and international consultants, and non-government organization representatives.[36] Both foreign investment repayments and ongoing annual operation, maintenance and enhancement costs were treated as being covered by the farmer contributions. It is noted that based on the suggestions of local experts from Department of Agriculture and rural development and Can Tho University who are familiar with local farmers, the introduction of the payment method prior WTP question aims to improve the practicality of WTP scenario.

[35] US$1 dollar = 22,712 Vietnamese dong (VND) at November 20, 2017.

[36] The payment vehicle proposed in this study would be a future mandatory agricultural fee, variations of which have previously been applied in MRD agricultural areas and coordinated by local government officials. In addition, since some areas in MRD have not covered by the national electricity system, the agricultural fee was suggested by local people and local government officers during PRA and pilot survey as the most effective payment method. Hence, either electricity bill or agricultural fee will not necessary introduce unnecessary uncertaity or undermined the incentive-compatibility of the design as mentioned.

An *ex-ante* hypothetical bias correction was employed using a *cheap talk* script for all respondents. This version of cheap talk is based on a popular 'short and neutral' version (Aadland and Caplan, 2006; Do and Bennett, 2007; Khai and Yabe, 2014) since long cheap talk scripts may not be effective (Carlsson et al., 2010). Respondents were also asked how they would vote if there were a referendum on whether or not to implement this plan. They were informed that it would require a monthly contribution from them to implement the program. Their responses to this referendum question were collected using a dichotomous choice question, based on a randomly-selected bid value from the range discussed above.[37] In the conventional CVM referendum, respondents were first asked: "*Would you be willing to contribute to a fund which requires every farming household to pay ……… Vietnamese Dong (VND) per month? Remember that this payment reduces the amount of money you could spend on other goods and services*" (which we code as *Own* perception).

The responses could take one of three forms: 'Yes', 'No' or 'Do not know'. While the most appropriate CVM response form is still being debated (Alberini and Kahn, 2006), we recognise that current recommendations suggest avoiding single-bounded dichotomous choice responses (Johnston et al., 2017a). However, as discussed above, questionnaire pre-testing revealed issues with farmer comprehension of open-ended responses given their relatively low education levels.

[37] CVM survey questions were designed and revised in view of the low education of farm households in MRD and the fact of results from pilot survey and recommendation from agricultural experts in survey areas. Hence, the single-bound dichotomous approach was employed. However, as Bateman, I.J. and Willis, K.G. (cds.) indicated that before any potential monetary valuation can play even a heuristic role in policay implication and/or cost-benefit policy analysis, further design changes and testing are required, hence, the author expects to check the robustness of this approach in future research.

Thus, on the basis of local advice from agricultural experts, we proceeded with a dichotomous choice response featuring cognitively-easier answering properties (Alberini and Kahn, 2006; Mitchell and Carson, 1989). Finally, a random sampling procedure was employed to achieve appropriate representation, while a referendum style format was also expected to increase MRD farm household understanding of, and ease in, providing responses to questions (Arrow et al., 1993; Competition Commission, 2010).

In the IV section, the question was framed as indirect responses to elicit farm household opinions. Immediately following the conventional CVM question above, farm households were asked to predict what level of payment[38] their neighbours might be willing to contribute to the salinity intrusion mitigation program using the following question: "*Do you think your neighbour's household would be willing to pay ………. VND per month toward this fund?*" (which we code as *Neighbour* perception)[39]. This provided us with the inferred value data. All farm households included in the survey were chosen randomly from lists provided by local government agencies. After data cleaning, a final sample of 441[40] farm households was stratified by salinity intrusion level to be included in the analysis. This comprised 146 observations from salinity intrusion areas where significant impacts

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[38] The bids varied randomly among three groups, however, follow up questions were asked respondents to respond to the same bid levels. In term of data clasification when combine Chapter 3 and Chapter 4, it may considered the aggregate data generated in this thesis as panel data. However, in order to check and focus only on the validity of inferred valuation methodology, this thesis only performs WTP models independently.

[39] In the IV section, respondents were also asked to reflect on what they thought their neighbours might think them willing to contribute, via the following question: "*What do you think your neighbour might think you are willing to pay ………. in VND per month toward this fund*?" (Which we code as *Reflected Self* perception - Predicting neighbour's belief about the respondents' WTP). The results of this proposed estimate technique are presented in Appendices 1-3.

[40] Number of farm households in the sample was calculated by formula $n = z^2_{1-\alpha/2} P(1-P) / d^2$

are already present (Cau Ke district); 145 observations from areas with high future risk of salinity intrusion (Tra On district and part of Cau Ke district); and 150 observations from a control group where salinity intrusion is not yet a significant concern (Vinh Thanh district).

4.3.2 Data analysis

Based on the discussion in Carlsson et al. (2010), we expected that respondents would use their own preferences to state/predict others' preferences. As a result of this assumption, the utility function for indirect approaches is discussed below. This study adopts modified conventional utility function *U* (Lusk and Norwood, 2009a) as follows:

$$U = wM(A,H) + (1-w)V(I,E), \qquad (4.1)$$

where *M* is an additional normative component or moral norms value (see for example Ajzen et al., 2004; Czajkowski et al., 2017; Meyerhoff and Liebe, 2006) as a function of action undertaken *A* with consequences, and level of honesty *H*. *M* implies that additional utility, and thus willingness to pay for goods can be present where societal influence exists and is recognised. Indirect utility *V* is a function of income *I* and the public good *E*, while *w* is a constant that represents the weight placed on morality versus consumption. Carlsson et al. (2010) further define a respondent's utility function with inferred valuation as follows:

$$U = wM(A=0) + (1-w)V(I + (WTP^I - E[WTP^F])^{-2}, E), \qquad (4.2)$$

where WTP^F is an unbiased other person's willingness to pay, and $(WTP^I - E[WTP^F])^{-2}$ is a simplified function representing an assumption in which respondents are paid based on their prediction accuracy (Lusk and Norwood, 2009a). According to Lusk and Norwood (2009a), there is an unlikely existence of utility from respondents when predicting other people's willingness to pay for a good, or in this situation $\partial M / \partial A = 0$. Hence, inferred valuation may generate more accurate WTP values by asking respondents to predict other peoples' willingness to pay. Notably, willingness to pay from inferred valuation WTP^I reveals no effect of moral norms on WTP values, while conventional self-reported willingness to pay WTP^H can generate higher values when hypothetical bias exists. The objective of this study therefore is to test whether or not the following concept is present:

$$WTP^H = WTP^I \qquad (4.3)$$

In the referendum approach used by this study, a form of Logit model is employed to analyze the dichotomous choice approach and estimate the respondent's WTP. The dichotomous choice responses are also regressed against independent variables to identify the determinants of the probability of WTP for proposed plan, with a vector of bid levels and socio-demographic variables *X* including: farm household's income, farm household head's farming experience, education level, gender, farm household size and location (Table 4.1).

Table 4.1 Description of variables in regression models

Variables	Value	Description
Dependent variable	1=Yes, 0=No/Do not know	The probability of farm household's WTP for salinity intrusion risk mitigation project
Bid	VND50,000; 100,000; 150,000; 200,000 and 250,000 (equivalent to US$2.20, $4.40, $6.60, $8.81 and $11.01)	Value of bid (in Vietnamese Dong)
Household head gender	1: Female, 0: Male	Head of the household's gender
Household head education	0=never attended school, 1=primary school, 2=secondary school, 3=high school, 4=bachelor degree and 5=post-graduate degree	Head of household's education level
Household head farming experience	Numeric variables	Head of household's years spent working on farm
Farm household size	Numeric variables	Number of farm household family members
Farm household income	Numeric variables	Farm household's annual income (in VND)
Farm location	Dummy: 1=salinity intrusion area; 0: others	Location of rice farm in relation to current salinity intrusion risk

We next obtain mean WTP values by employing both parametric and non-parametric approaches. Non-parametric value estimations are applied in order to validate and increase the confidence of the parametric estimations. In the non-parametric estimation, let *N* denote the number of farm households in the sample, N_j the sub-sample size who choose the level of bids B_j (j=1, 2, 3, 4 and 5*)*, and n_j the number of households with WTP higher than the level of bids B_j. We then identify our summed WTP values using the following function:

$$n_j = \sum_{k=j+1}^{5} N_k \qquad (4.\ 4)$$

The mean willingness to pay value is then estimated using the functions below:

$$Mean\_WTP = \sum_{j=0}^{5} S(B_j)(B_{j+1} - B_j) \qquad (4.5)$$

where $$S(B_j) = \frac{n_j}{N} \text{ (j=0 to 5)} \qquad (4.6)$$

Next, a parametric method was employed to estimate WTP values using a Logit model. We follow an approach suggested by Lancsar et al. (2017), Haab, T. C. and McConnell, K. E. (2002), and Hanemann (1984), where utility is a function of income w, respondents' characteristics z, and an error component e.

When a public good is provided via private contributions t_j, derived from the probability of a respondent choosing 'yes' as below:

$$\alpha_1 z_j + \beta(w_j - t_j) + e_{j1} = \alpha_0 z_j + \beta(w_j) + e_{j0}, \qquad (4.7)$$

then the mean WTP is estimated using the following function:

$$\text{Mean WTP} = e(WTP \mid \alpha, \beta, z_j) = \frac{\alpha z_j}{-\beta} \qquad (4.\ 8)$$

Finally, an approach for dealing with protest responses (i.e. where respondents refused outright to engage with the question in any way—or to free ride) was also considered in this study. There are different treatments to distinguish and exclude protest responses from WTP value estimations. While some authors treat all 'No' answers as real no responses (Imber et al., 1991), others eliminate all 'Zero' bids (Romer, 2000). However, these treatments may lead to incorrect public policy suggestions or sample-selection bias. In this study, besides testing for 'Do not know' response impacts on the value estimates, we follow the suggestions of Jorgensen et al. (1999) and Khai and Yabe (2014) who argue to exclude protest responses from the estimation of the WTP determinants based on market or referendum model adoption and/or protest statements (Dziegielewska and Mendelsohn, 2007).

The protest response exclusion process adopted in this study was based on a follow-up survey question which asked respondents who were not willing to pay to state the reasons why. Then, we excluded observations where respondents indicated that issues other than salinity intrusion risk reduction were more important. However, the number of protest response drawn from this statement remains small (around three per cent in the 'No' response group), and the results from the regression models are roughly the same as those from the original analysis. Hence, it can be concluded that the sample selected in this study experienced minimal protest response bias[41]. Finally, any respondents who indicated that the provision

[41] In this thesis, this point may be considered as one of the potential biases (then will be checked in next Footnote) when considering protest reasons based on different classifications, especially different environmental goods where the responsibility of the government is compulsory (Brouwer and Martin-Ortega, 2011) and/or optional based on different type of goods in developing countries context and modelling by econometric modelling order to distinguish zero values and protest

of this public good is the government's responsibility (about 35 per cent in the 'No' response group) were not excluded from the analysis data because of the mandatory payment method used in this referendum model.

4.4 Results and Discussion

4.4.1 Presence of SDB impacts in the estimated willingness to pay

A Kruskal-Wallis H test was conducted to determine if the estimated WTP values were statistically different across the three MRD groups, and two different methodological approaches. Recall that we have applied the code *Own* to the conventional CVM approach, and *Neighbour* to the predicted WTP valuations for a farmer's neighbour. The test results showed a statistically significant difference in the reported WTP values between the two approaches ($\chi^2(2)$ =8.338, p=0.0155), and also between the three survey groups ($\chi^2(2)$ =6.587, p=0.037) (Table 4.2).

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response separately (Strazzera et. al., 2003). This conclusion, however, based on our classification including farmers who believe that this is the responsibility of the government or they do not believe that money may be used for other programs have still been included in the analysis. This is supported by the fact that protest rates based on this classification decrease when salinity intrusion increase (by three times). However, the result of this suggested approach is shown in Appendix 23 and discussed below. This approach, however, did not change WTP values elicited by the non-parametric approach".

Table 4.2 Kruskal-Wallis H test results for WTP value comparisons, by method and group[42]

	Chi-squared with ties	d.f	Probability
Method approaches (Own, Neighbour[(1)])	8.338	2	0.0155
Different groups (Salinity impacted, High Future Risk, and Control[(2)])	6.587	2	0.0370
Different groups within Own[(3)]	9.847	2	0.0073
Different groups within Neighbour[(3)]	12.797	2	0.0017

[(1)] Number of observations in each methodological approach is 441 households.

[(2)] Aggregate number of observations in the Salinity Impacted, High Future Risk and Control groups are 438, 435 and 450 farm households respectively.

[(3)] Number of observations in the Salinity Impacted, High Future Risk and Control groups are 146, 145 and 150 households respectively.

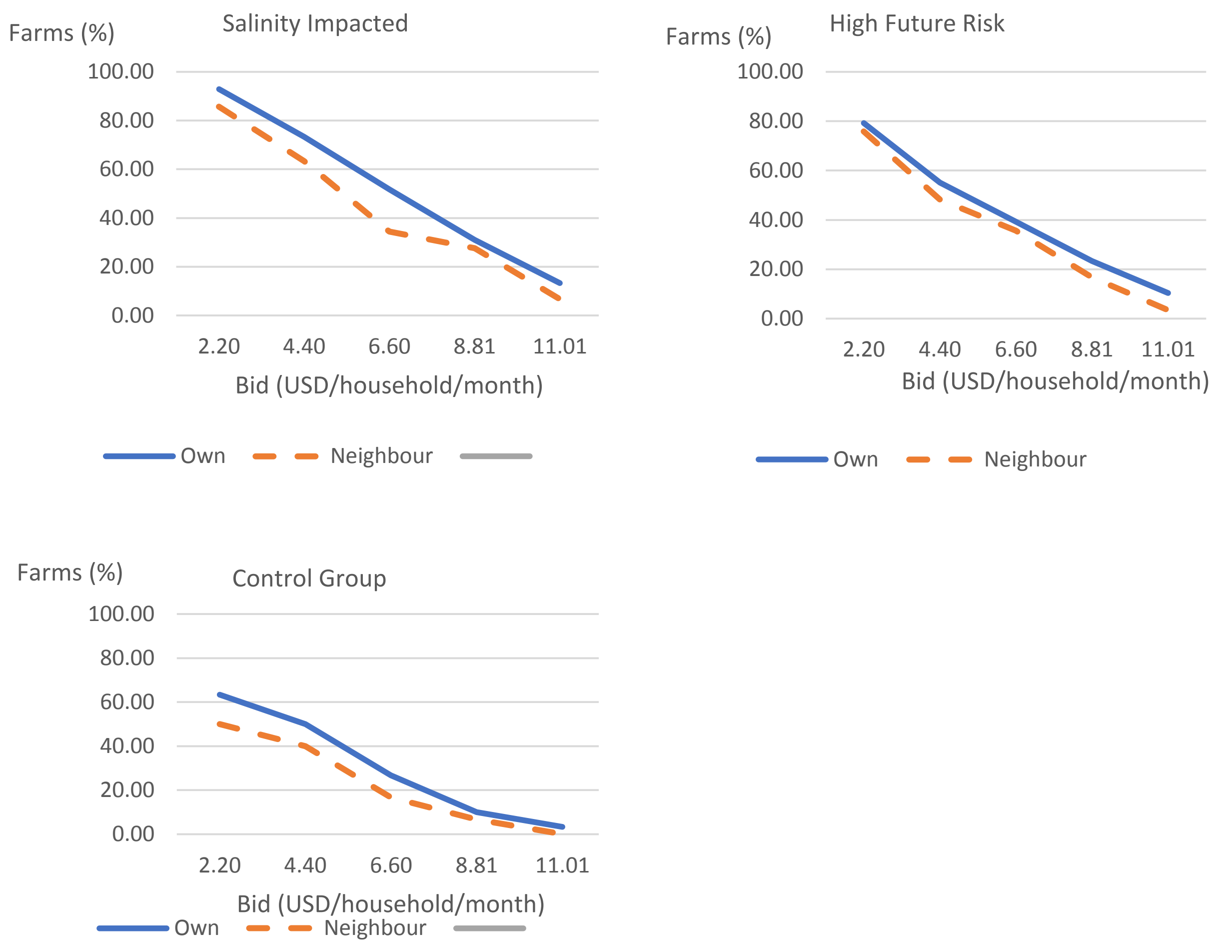
These differences are plausible given that responses are derived from different sets of factors, and that there is no reason for us to assume that people's expectations about the responses of others are based on fully-informed rational predictions. Given these differences, it is necessary to quantify them in order to provide useful input to MRD policy decisions about the upper bounds of farmer WTP contributions toward salinity intrusion mitigation programs.

4.4.2 Quantified differences between the WTP estimates

We next sought to quantify the magnitude of the differences between the two approaches. An initial evaluation of the reported WTP across bid values and groups

[42] Even though KW as a form of non-parametric test may not be the best for this particular type of data, I performed confidence interval test to check the robustness of KW (Appendix 20) among 3 groups. The results reveal the consistent results with the KW test.

revealed some differences between the direct (CVM) and indirect (IV) questioning (Figure 4.2). For example, in the areas currently impacted by salinity intrusion, 52 per cent of farm households voted to contribute a mean amount to the mitigation program in the *Own* value preferences, while the IV approaches reduced the contribution level to about 41 per cent for the *Neighbour* prediction approach.



Note: *Own* = Preferences via conventional CVM; *Neighbour* = Predicting their neighbour's WTP

Figure 4.2 Distribution of proportion of farm households 'Yes' answer for the proposed program by bid levels and different respondent groups

For those with a high future risk of salinity impacts, the initial positive responses were lower than for respondents that are currently affected, as we would expect; yet still positive in terms of willingness to contribute. For this high future impact group, the *Own* valuation returns a positive mean contribution participation level of around 39%, which is slightly above the *Neighbour* values (36%). For the Control group the differences remain positive with regards to willingness to contribute, but with clearer disparity across the methods employed: *Own* (27%) and *Neighbour* (17%). Overall, the tendency to participate at higher bid levels decreased for each of the groups, regardless of salinity intrusion impacts, which is consistent with utility theory and some other studies in the literature.

We then calculated the mean monthly contribution toward the mandatory salinity intrusion mitigation program based on the non-parametric method outlined above. Results revealed that the mean *Own* reported willingness to contribute to the mitigation program was around US$2.58, US$1.99 and US$1.32 per farm household group. For the *Neighbour* value perceptions the estimate responses are consistently lower. For example, when asked what respondents thought their neighbours would be willing to contribute on a monthly basis to the program, the mean contribution was estimated at US$2.02, US$1.59 and US$0.91 for the current salinity intrusion-affected group, the high future risk group, and the control group respectively (Figure 4.3).

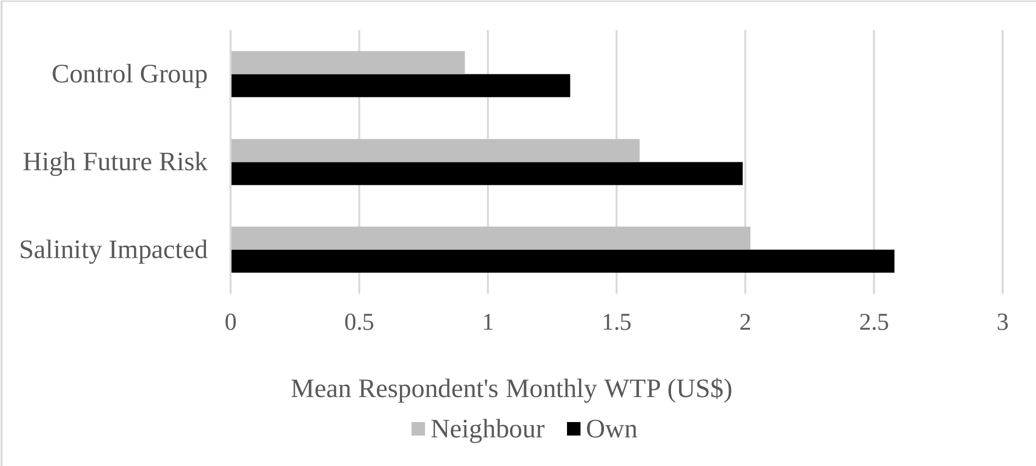


Figure 4.3 Farm household WTP differences by Group and valuation approach

These results support Lusk and Norwood's hypothesis that, in value-seeking approaches with high normative motivation, IV estimates will result in muted values compared against conventional measures regardless of the commitment costs. However, our results differ from those of Torres-Miralles et al. (2017) and Yadav et al. (2013) which state that people with lower commitment costs should result in the lowest value disparity. In our study, the lowest disparity was reported by the High Future Risk farmers, who arguably sit in the middle of a spectrum of commitment costs in this case. This suggests that value muting benefits from applications of IV approaches may in fact not be straightforward nor linear across large homogenous groups.

Results of parametric testing indicate that the contributions estimated using conventional CV (US$5.40) and IV (US$4.42) provide conservative bounds to actual willingness to contribute by non-parametric, and useful insights for policymakers considering the final mandatory monthly contribution levels and/or the timeframe for the project cost recovery. The results are consistent with the theory of CVM estimates where non-parametric estimates use the lower-bound value of bid ladders, and the dominant strategy should be to contribute at lower levels. If we consider: i) estimated contributions as a proportion of total farm income; ii) historic income growth in the MRD; and iii) land value impacts from salinity intrusion, then we may better understand some of the motivations for farmer willingness to contribute towards this program. Mean farm annual income in the MRD during this study was set at VND107,595,000 or approximately US$4,740. The monthly contribution by MRD farmers thus equates to approximately 0.065 per cent of mean annual income, which brings the relatively small real differences between CVM and IV estimates in this case into context.

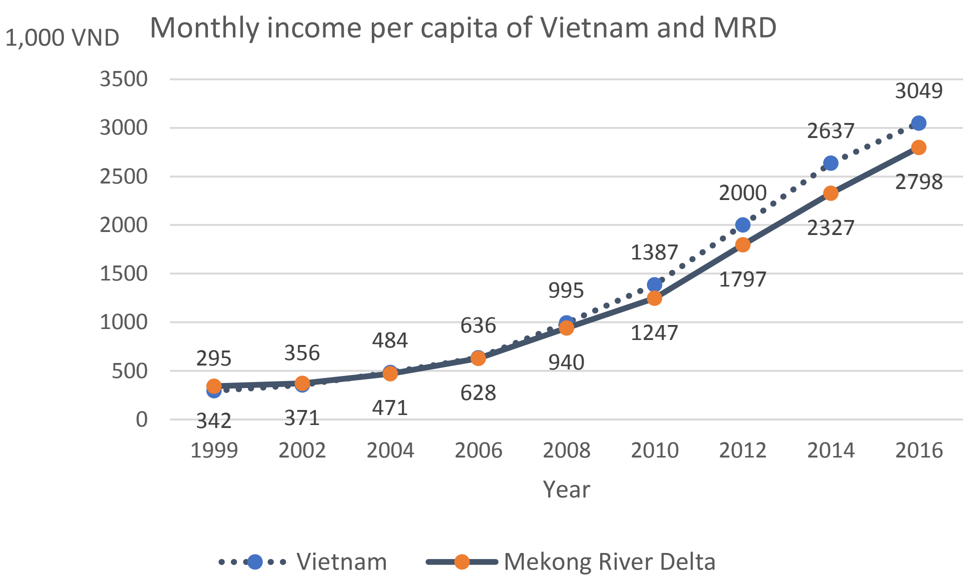


Figure 4.4 Monthly per capita income, Vietnam and MRD 1999-2016

Source: Based on data from the General Statistics Office of Vietnam (www.gso.gov.vn).

Further, income growth in Vietnam and the MRD has been positive in recent decades; although MRD rates in growth have been slightly lower than those of the wider Vietnamese population at 1.85 and 1.35 for the nation and the MRD respectively (Figure 4.4). This growth in monthly income more than offsets our CVM and IV estimated contributions by MRD farmers to salinity intrusion public goods, making their positive participation even more plausible with relatively low levels of impact on other private investments.

Finally, if we consider reported land value impacts from salinity intrusion as captured in our survey data, approximately 75 per cent of MRD farmers perceive salinity intrusion will have some negative impact on their future land value (Table 4.3). Although actual land values are not available for Vietnam, any salinity mitigation project would logically improve perceived farm land values in the MRD, motivating positive contributions at higher levels. Therefore we conclude that, although social desirability and hypothetical bias may have impacted on our CVM estimates as indicated by the differences between those and our IV estimates for the same sample, the differences are not large and may have little bearing upon the final contribution levels or scope of salinity mitigation public good provision in the MRD.

Table 4.3 Salinity intrusion impacts on MRD farm households

	Dimensions	Scale (from 1 = not at all to 7 = extreme effects)						
		1	2	3	4	5	6	7
Household issues	Income	0	0.45	2.27	4.76	5.44	13.38	68.25
	Housing value	15.19	4.76	12.24	23.36	9.75	27.44	7.26
	Farm land value	**6.59**	**4.09**	**3.86**	**11.82**	**9.55**	**12.95**	**51.14**
	Agriculture output and productivity	0	2.05	2.73	5.00	7.73	25.00	57.50
	Water supply for agricultural activities	0	0.45	7.94	5.67	9.52	29.93	46.49
	Water supply for daily lives	6.38	6.38	3.64	17.31	13.90	32.35	20.05
	Physical health	7.26	8.39	9.98	28.80	19.73	19.73	6.12
	Mental health (worrying)	0.91	2.72	4.54	14.51	18.37	30.39	28.57
	Households' habitation environment	6.58	2.27	7.94	35.15	18.14	24.26	5.67
Regional issues	Regional food security	5.67	3.40	4.54	16.78	15.42	38.32	15.87
	Regional economic	3.40	3.17	7.94	14.51	13.83	29.48	27.66
	Regional habitation environment	6.80	4.31	8.62	20.18	19.27	31.07	9.75

4.4.3 Testing other suggested determinants of willingness to pay disparity

Returning to Yadav et al.'s (2013) drivers of value disparity, we examined a range of socio-economic WTP determinants. A Logit model was employed to identify the factors that affected positive WTP. The dependent variable was classified as a 0 for any 'No' and 'Do not know' responses, and as a 1 for any 'Yes' responses. As stated above, although 'Do not know' WTP responses are important and should not be summarily dismissed (Competition Commission, 2010; Wang, 1997), in this instance only a small number of such responses were reported and thus, following tests for statistically significant differences (Table 3.5), we grouped the two categories together. The independent variables included: the WTP bid value; the gender, education level, and farming experience of the farm household head; the number of household members; farm income; and farm location. To determine which factors influenced the positive probability of reported WTP for MRD salinity intrusion programs, we estimated the regression function below:

$$\begin{aligned} Prob(yes) &= \alpha_0 + \alpha_1 bid + \alpha_2 gender + \alpha_3 education \\ &+ \alpha_4 farming\_experience + \alpha_5 household\_size + \alpha_6 income + \alpha_7 location \end{aligned} \quad (4.9)$$

In this equation increasing bid values, household size, farmer experience, and farm location are expected to have a negative impact on the probability of farm households' willingness-to-pay. Conversely, a farmer's education and household income are all expected to have positive impacts on WTP probability. Farmer gender is less easy to predict. Before including any of the variables into the regression model, all of the independent variables were assessed using Variance Inflation Factors (VIF) to check for the presence of any correlation between them. The results showed that all VIF values are lower than four, which suggested that there is no multicollinearity among the independent variables included in the regression analysis.

The regression results indicated that the models are statistically significant and that the dependent variables are explained by the included independent variables. However, as shown in Table 4.4, there are some similar factors driving positive farm household WTP across the two models, and some notable differences. As expected, and consistent with utility theory, the coefficient of increasing WTP bid values are negative and statistically significant at 1% level, indicating that when bid values increase the probability of voting 'Yes' decreases between the models. These results are consistent with economic theory in which income and bid values are also key factors of WTP (Johnson et al., 2010; Wang, 1997). Note also that the bid curve estimates for the models are the same—further enforcing our view that in real terms there are limited differences between the CVM and IV response value estimates. In addition, the coefficients of farm household income are positive and statistically significant at the 1% level, indicating an increased probability of WTP to contribute to the mitigation program. These results are consistent across the models, and reflect previous studies' results (e.g. Lusk and Norwood, 2010). Finally, the farm location variable in two models was also statistically significant and positive, implying an increase in the WTP probability when risk levels increase. Household education and size are all similar across the models, but statistically insignificant. These results are also supported by previous studies that evaluated environmental WTP value perceptions (Stone et al., 2008). The statistical significance for household head experience between the *Own* and *Neighbour* models is important for our purposes. This may be evidence that when the perspective of experienced farmers (in this case) is shifted onto others, that WTP is reduced along with value estimate disparity. When we consider the average disparity between the three groups (~2%) this suggests that more experienced groups may in fact drive lower disparity outcomes. This will require further investigation.

Table 4.4 Coefficients and Marginal effects (dy/dx) of MRD farm household WTP for salinity intrusion programs, by estimation approach

Dependent variable: WTP (1=Yes, 0=No/Do not know)	Model 1 *Own*		Model 2 *Neighbour*		VIF
Independent Variables	Coefficient	ME (dy/dx)	Coefficient	ME (dy/dx)	
Bid value	-0.0192*** (0.0020)	-0.0045*** (0.00046)	-0.0201*** (0.0021)	-0.0039*** (0.0004)	1.01
Household head's gender	-0.2292 (0.3329)	-0.0525 (0.0744)	0.0903 (0.3413)	0.0179 (0.0687)	1.10
Household head's education	-0.1268 (0.1082)	-0.0296 (0.0253)	-0.0475 (0.1142)	-0.0093 (0.0224)	1.11
Household head's farming experience	-0.0354*** (0.0122)	-0.0082*** (0.0028)	-0.0208* (0.0126)	-0.0041* (0.0024)	1.14
Farm household size	0.0058 (0.0945)	0.00136 (0.0221)	0.0656 (0.0989)	0.0128 (0.0193)	1.03
Farm household income	5.71e-06*** (1.31e-06)	1.34e-06*** (0.0000)	6.09e-06*** (1.29e-06)	1.19e-06*** (0.0000)	1.07
Farm location	0.9759*** (0.2584)	0.2323*** (0.0608)	0.8943*** (0.2648)	0.1855*** (0.0568)	1.01
Constant	2.5627*** (0.6563)	-	1.3585** (0.6654)	-	-
Log-Likelihood	-215.01699		-201.07744		
Pseudo R-square	0.2807		0.2871		
Prob>chi2	0.0000		0.0000		
N (sample size)	441		441		

Notes: ***, **, and * is statistically significant at 1%, 5% and 10% levels, respectively. The standard deviation in parentheses. Marginal effects of Logit model are not available for the constant term.

However, there is little difference between the models as well. Farm household head's gender impacts on reported WTP change direction between the models, but are not statistically significant in any way.

Finally, as 'Do not know' responses are suggested to be distinct from 'Yes' and 'No' answers (Arrow et al., 1993; Carson et al., 1998; Wang, 1997), we employed a second set of regressions to identify determinants of WTP where all of the 'Do not know' answers were truncated as a means of capturing protest or free-riding responses. Although an appropriate method for analysing such data is continuing to be discussed and explored in the literature (Alberini and Kahn, 2006), by truncating 'Do not know' respondents, we aim to test if protesters or free-riders[43] had any identifiable impact on farm households' willingness to pay disparity. The estimation results of truncated models are reported in Table 4.5.[44]

Small differences were observed across the marginal effects of the models, especially those of Model 1. However, the results indicate that the signs and values of the marginal effects of independent variables are roughly the same as before. A somewhat unexpected result is that of Model 1, where farm head of household experience associates with negative WTP probabilities, statistically significant at the 1% level. This may be explained by the fact that farm field size per MRD household is small, that there is a lack of farmer cooperation activities, and hence farmers in this area tend to deal with problems by themselves. Another possible reason is that previous agricultural support and/or climate change mitigation projects have been implemented under the responsibility of central government authorities. As a result, some experienced farm households treat this proposed project as the responsibility of more distant government officials, and may perceive that they should not have to contribute toward these programs themselves.

[43] Other issues related to benefit/costs (e.g. public environmental benefits/costs) is expected to addressed in my future research

[44] Additional Logit regression model result (Appendix 23- Coefficients and Marginal effects (dy/dx) of MRD farm household WTP for salinity intrusion programs, Protest "3 and 4" removed), in which protest farmers (those chose reasons 3&4 suggested by Examiner One) were removed. As indicated in the regression results, although some small changes are observed in coefficient values, the sign and statistical significance of coefficients do not change (In Appendix 23: Number of observation is 311, the number of protest response farmers are: 21, 51 and 58 in Group 1, 2 and 3, respectively). Noted that: (1) This is only applicable for Conventional CVM since IV 1 and 2 did not include protest question; (2) WTP values revealed by non-parametric method did not change since this method did not include 'No' response; and (3) since some protest response based on this classification has been removed in Appendix 23, WTP values revealed from this increase to US$ 7.1. For space conservation reasons, this value is used for comparison purposes only.

However, the mandatory nature of this project would capture these farmers into a positive contribution outcome. These results are consistent across the two models, as well as before and after the 'Do not know' responses were truncated. This finding indicates that neither eliminating protest bids or the 'Do not know' responses has any significant effect on WTP determinants.

Those currently facing salinity intrusion may believe that other farmers will free ride at their expense, supported by their reporting the highest level of value disparity across the groups. While this may support Yadav et al.'s (2013) suggested drivers of differences, the model estimates here are less clear and mixed in terms of strength—most likely due to the limited level of protest voting that occurred under our use of a PPM approach. Overall though, some disparity in the values is evident, and we therefore argue that IV has value muting benefits for policy robustness checking.

Table 4.5 Coefficients and Marginal effects (dy/dx) of MRD farm households WTP for salinity mitigation ('Do not know' responses truncated)

Dependent variable: WTP (1=Yes, 0=No)	Model 1 *Own*		Model 2 *Neighbour*	
Independent Variables	Coefficient	ME (dy/dx)	Coefficient	ME (dy/dx)
Bid value	-0.0217***	-0.0051***	-0.0219***	-0.0043***
	(0.0022)	(0.0005)	(0.0022)	(0.0004)
Household head's gender	-0.1330	-0.0311	0.1079	0.0215
	(0.3520)	(0.0814)	(0.3552)	(0.0721)
Household head's education	-0.1519	-0.0359	-0.0423	-0.0083
	(0.1122)	(0.0266)	(0.1167)	(0.0229)
Household head's farming experience	-0.0437***	-0.0103***	-0.0269**	-0.0053*
	(0.0131)	(0.0031)	(0.0133)	(0.0026)
Farm household size	0.0426	0.0101	0.0941	0.0185
	(0.0994)	(0.0235)	(0.1029)	(0.0202)
Farm household income	5.87e-06***	1.39e-06***	6.16e-06***	1.21e-06***
	(1.36e-06)	(0.0000)	(1.32e-06)	(0.0000)
Farm location	1.1384***	0.2726***	1.036***	0.2174***
	(0.2747)	(0.0639)	(0.2771)	(0.0600)
Constant	3.0333***	-	1.6291**	-
	(0.6941)		(0.6884)	
Log-Likelihood	-198.21565		-189.83402	
Pseudo R-square	0.3209		0.3169	
Prob>chi2	0.0000		0.0000	
N (sample size)	428		431	

Notes: ***, **, and * is statistically significant at 1%, 5% and 10% levels, respectively.

Standard deviation in parentheses.

4.5 Conclusions

Salinity intrusion is negatively impacting Mekong River Delta (MRD) farm household livelihood and income, which mainly depends on agricultural activities. This study aims to investigate farm household willingness to pay for a salinity intrusion risk reduction project under a mandatory payment vehicle and provision point mechanism approach. To mitigate any social desirability or hypothetical bias arising from our dichotomous choice CVM responses we employed a cheap talk script, and then tested the robustness of the CVM responses using inferred valuation

(IV) estimates. Our results indicate disparities between mean WTP values obtained from direct and indirect questions consistent with theory related to commitment costs. While we also find that more-experienced respondents may mute value disparity outcomes in this case, the potential for free-riding concerns to increase disparity is less clear; particularly under the use of the mandatory contribution arrangements in this study. However, in real dollar term, any disparity may not significantly alter the actual contribution levels by MRD farmers. We would suggest that Vietnamese government officials take our findings into account when setting the final mandatory contribution level and/or the cost recovery timeframe for salinity intrusion mitigation projects in the MRD.

The reported differences in WTP values between direct and indirect questioning detailed herein have several other implications. First, these results suggest that indirect questioning approaches offer some useful robustness tests of possibly social desirability and/or hypothetical biased (inflated) WTP estimates in conventional CVM. Second, the use of inferred valuation techniques suggests some usefulness for assessing robustness in PPM-framed studies, although further research is needed to confirm this. Third, while the findings from this study may not be strong enough to conclude the use of indirect questions as a measurement improvement of CVM, this study contributes empirical evidence to the growing debate around inferred valuation and indirect WTP approaches.

Identifying farm households' willingness to contribute to climate change risk reduction can play an important role in enabling future intervention projects. However, while CVM remains one of the most popular methods for eliciting stated values for non-market goods, inferred valuation methods should be carefully considered as an instrument to, at least, back-up conventional CVM dependent upon the characteristics of the research question and sample population. Differences between an initially promising capacity for MRD farm households to contribute monthly payments in support of international loan repayments and ongoing operation and maintenance costs, and any new upper bounds on those contributions, will be of interest to Vietnamese policymakers. The quantification of the contribution upper bound described herein provides improved robustness for the project's financial assessment, and may simply require an extension of the loan terms associated with any funding investment (See Table 3.7 and Page 102).

In brief, policymakers should carefully consider all of the elicited WTP values reported here to implement appropriate salinity mitigation policy in the MRD. Facing the dilemma of choosing between two estimated values, we suggest using any (conservative) lower value. Also, when aggregating data in which mean WTP is converted across the MRD population, the total values should be based on the specific socioeconomic characteristics of farm households in this area, as well as any others who would be beneficiaries from this plan.

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Chapter 5 : Summary, Conclusions and Implications

5.1 Summary of Key Findings

Producing approximately 45 per cent of Vietnam's rice, and contributing about 85 per cent to Vietnam's rice export income annually, the Mekong River Delta plays a vital role in Vietnam's economy. This significant contribution, however, is being threatened by increasing salinity intrusion.

Salinity intrusion is caused primarily by three independent processes:

1) climate change-induced sea level rise;
2) declines in river flow as a result of upstream dam construction and increased interception as a result of changes in land-use patterns; and
3) rising local water extraction.[45].

Salinity intrusion, however caused, has a detrimental impact on MRD rice and other forms of agricultural production and, as it worsens, threatens domestic farm income and national export earnings.

Several mitigation and adaptation strategies have been proposed to prevent/reduce the impact of salinity intrusion in the MRD. The complicated characteristics of salinity intrusion coupled with the scale of the problem and its budget implications are challenging the Vietnamese government's capacity to manage this issue. While both "hard" and "soft" policy options are under consideration, the main question is one of whether or not there should be further investment in the use of sea dikes to reduce salinity intrusion. To this end, and aware

[45] Konikow (2011), in a less well recognised research, draws attention to a fourth cause. He estimates that since 1900 as much as 12.6mm of mean sea level rise has been caused by groundwater depletion.

that the MRD coastline is more than 1,000kms long with many earthen sea dikes already in place it seems appropriate to describe the proposed investment as a sea dike "enhancement" program. In some places, new dikes will need to be built, in other places they will need to be replaced, while elsewhere existing dikes may only need to be raised and be concreted.

In order to consider this issue and, in an attempt to assist policy-makers and local authorities to deal with the problem, this thesis uses a stratified random survey of 441 farm households, to:

(1) Identify farm households' perceptions and adaptation strategies in response to salinity intrusion in the MRD[46].

(2) Estimate farm households' willingness to pay (WTP) for salinity intrusion risk reduction, and the factors that affect their WTP decisions.

(3) Estimate consistent and conservative WTP values without bias by comparing two different valuation response techniques: conventional contingent (CV) and inferred valuation (IV) methodologies.

The results from this research are presented primarily as papers in a form ready for publication. Addressing the first objective, Chapter 2 examines farm household perceptions, adaptation behaviour and the determinants of salinity intrusion into the MRD.

Objective two is addressed in Chapter 3, where a referendum contingent valuation methodology is employed to determine how much farm households might be willing to pay for or at least contribute to the cost of investments that might

[46] That is, the study seeks to examine the perceived impacts of salinity intrusion at farm household and regional levels, provide descriptions of those adaptation measures which have already been applied, and, also, to discover farm households' intentions/preferences for adaptation in future.

reduce salinity intrusion risk and identify the factors affecting the probability of WTP.

The third objective, addressed in Chapter 4, is designed to test the robustness of stated WTP values by comparing two different valuation response techniques: conventional CVM and IV approaches. An appendix to this chapter also suggests a new type of IV technique (coded as *Reflected Self Perception*)—although it is now recognised that a significant amount of development work would need to be undertaken ahead of expanded empirical applications in the field. This will therefore be the subject of future research on the part of the author.

The findings from Chapter 2 reveal that farm households do understand the impact of salinity on their livelihoods, and also on the region. Some farm households in salinity intrusion areas have already adopted a range of adaptation strategies. However, the effectiveness of these short-term autonomous adaptation strategies varies by farm. It needs to also be understood that while farmers can adapt, the "hard" sea dike option is available only if a collective decision is made.

Another important finding from this chapter is that farm households already have an incentive to contribute to 'hard' policy adaptation and mitigation measures. Hence, it is recommended that if local authorities are interested in getting farmers to contribute to the cost of sea dike maintenance and enhancement programs they can begin by working to enhance local awareness of the increasing impact of salinity intrusion. The more they do this, the lesser the need for national and international contributions to the cost of sea-dike construction and maintenance.

A Poisson regression model is used in Chapter 2 to explore the factors that influence farm households' adaptation measure decisions and the determinants of farm households' agreement level to expected public adaptation strategies. Results from this model reveal that factors positively affecting an increased number of private/autonomous adaptation strategies include age, salinity intrusion impacts on farmland value, housing value, physical health, regional economy and habitation environment. Further, six factors were found to negatively influence adaptation strategy adoption including: a willingness to pay for a proposed risk reduction plan, household size, household head experience, impacts on mental health, regional food security; and the local environment. Although all of these factors are consistent with other climate risk research, some influences were not as expected. These influences, however, can largely be explained by the unique characteristics of local farm households, and the specific nature/effects of salinity intrusion.

An ordered logit model is also employed to estimate farm households' agreement level regarding public adaptation strategy. As expected, farm household WTP is positive and statistically significant for the heightening sea dikes and, where necessary, the building of concrete ones. This finding proposes research questions for the next two analysis Chapters in this thesis.

The analysis in Chapter 3 investigated farm households' preferences for 'hard' policy options aimed at salinity risk reduction via sea-dike construction, operation and maintenance. The findings indicate that more than 50 per cent of farm households were willing to contribute to a fund that could be used for reducing salinity intrusion in the MRD. Surprisingly, farm households living in the high-risk and those farmers in control areas where salinity intrusion is not expected to be a problem in the next 15 years, are willing to contribute to this fund; although not to the same extent. Overall, it is found that the aggregate WTP may be sufficient to cover the threshold contributions needed to fund the proposed program. Similarities with WTP values collected by other climate change risk reduction researchers confirm the validity of this analysis. Our findings are consistent with economic theory. The proportion of farm households voting for the program decreases as the bid level increases.

Three different models were estimated employing Multinominal Logistic models (MNL) and Binary Logistic regressions in order to reveal the determinants of the probability of positive farm households' willingness to pay. The results of these regressions show that the determinants of willingness to pay are broadly consistent across three different models. Importantly, as our findings could have real-world investment implications, the bid value, farming experience, farm household income and farm location determinants in the study are broadly consistent with studies that have been conducted by others.

The analysis in Chapter 4 tests the robustness of the study's willingness to pay value estimates by comparing conventional Contingent Valuation Method (CVM) and Inferred Valuation (IV) techniques. While employing *cheap talk* scripts for all three hypothetical questions, CVM WTP value estimates were compared with IV WTP estimates. Overall, the findings from this analysis suggest IV approaches result in lower estimates than conventional WTP. In absolute terms, however, the differences between the estimations are relatively small; that is, while there were up to 17 per cent differentials among the estimates, when put back into the context of contributions as a proportion of farm income, they appear to be inconsequential with regard to the question of whether or not farmers should be asked to contribute.

Finally, a Binary Logistic regression model was employed to elicit the determinants of the probability of positive WTP. The regression results once again are consistent with other climate change risk reduction research. Although very small changes in significant factors were observed across the *Own* and *Neighbour* models, both models are broadly consistent. Besides asking for careful consideration when employing a methodology to elicit WTP values, Chapter 4 concludes with the requirement for an extension of the loan terms from international investors (e.g. World Bank, Asian Development Bank, international aid).

5.2 Methodological Insights

CVM is used extensively in the field to measure economic losses and environmental values, especially in developed country contexts (Alberini and Kahn, 2006). In developing country contexts, economic valuation techniques to environmental problems for evaluating environmental aspects of projects and policies are available (Whittington, D., 2010, Georgiou, S., et. al 1997). However, applying these to investigations of public goods in climate change mitigation and adaptations are less common and, arguably, the risk of bias is greater. It is for this reason, that the research on the development of ways to reduce and, hopefully, overcome biases, seems warranted.

To this end, the questionnaire as reported in Chapter 3 used a *cheap talk* script in all versions of the hypothetical questions and suggested a mandatory payment vehicle (in the form of an agricultural fee) as suggested by Carson and Groves (2007) and Loomis (2014). Besides using a parametric approach to test the robustness of the willingness to pay value estimations. The results of the relative economic sacrifice (RES) index which compares the WTP to total income showed that this index value was very small, indicating there is no overestimation in the WTP values in this survey.

In Chapter 4 this thesis goes further and tests over-estimation of WTP by using an IV approach to test the robustness of the WTP form as against the conventional CVM approach. In an attempt to improve on current IV techniques, this research suggests an extra approach (in Chapter 4 appendix) to test a novel form of IV by asking respondents to reflect on what they thought their neighbour might think them willing to contribute (is coded as *Reflected Self Perception).* It is stressed that in each case, this question was asked ***after*** the respondent had been asked what their neighbour would pay. Nevertheless, the findings reveal that there are differences among the WTP values elicited by the conventional CVM and IV approaches. In this case, however, the differences between the two different forms of IV are minimal in absolute terms. In addition, the determinants identified from regression models were broadly consistent across the three different models. Although it is therefore suggested that policymakers should carefully consider all of the stated WTP values in this thesis, in this case the use of IV techniques does offer a way to test the robustness of WTP estimates.

Briefly, this study employed three *ex-ante* survey designs to reduce the hypothetical bias including:

(1) a referendum format with the agricultural fee as a mandatory payment vehicle;

(2) employing a *cheap talk* script with all of the respondents; and

(3) using IV to test for any remaining hypothetical bias impacts.

The combination of all three *ex-ante* approaches as a way to validate stated values is revealed in the results. Hence, stated preferences in future applied economics research might be well-served by using IV estimates as a method to check the robustness of conventional CVMs. The alternative form of IV approach suggested by this study, namely *Reflected Self Perception*, may result in the provision of more robust estimates of WTP but requires significant theoretical development and justification ahead of future empirical tests. However, this thesis offers a novel consideration of consequentiality impacts on value disparity, which provides interesting insights and opportunities for future testing in other contexts/issues.

In addition, to the *cheap talk* script and provision point mechanism (PPM) payment vehicles as *ex-ante* instruments provided to all farm households, respondents were provided with information

(1) about the contribution value (i.e. a single-shot bid value),

(2) in the form of a confirmation that their neighbour will also be required to pay/vote, and also

(3) information about the likely effectiveness of the proposed risk reduction project.

While there were no controls to confirm the influence of this information on WTP estimates, this information was presented in a manner designed to produce conservative WTP values. In retrospect and with the benefit of hindsight it is suggested that the combination of the *ex-ante* strategies mentioned above and IV approaches may offer a better way to develop estimates of stakeholder willingness to contribute to the cost of large-scale public risk reduction projects.

In brief, it is concluded that the methodology information presented in this thesis may be helpful in assisting to improve the design of surveys where hypothetical bias could be an issue. I see this as an issue that requires and would benefit from further research.

5.3 Lessons and insights for the Mekong River Delta and other low-lying irrigation regions

The findings from this thesis provide the following four key observations for consideration by decision-makers and stakeholders interested in reducing salinity intrusion risks in the MRD and, also, in other deltas where similar problems exist.

The first observation is that it is possible to involve farm households in risk reduction projects since their willingness to contribute is positive. However, it is also necessary to consider the best way to get farm households involved in such programs. While beyond the scope of this thesis, it is suggested that an examination of the determinants WTP probabilities by farm household type could be used to do this.

The second main observation that can be made is that the amount of money households may be willing to contribute towards the cost of a salinity intrusion dike enhancement and management program is very large and may be sufficient to justify the development of such a program.

The third main observation is that since farm households in the MRD already have an incentive to participate in adaptation and mitigation activities, local authorities might be interested in developing and implementing policies that encourage participation. In other words, local community participation in the development of climate change risk reduction programs seems possible. However, in order to improve the total level of farmer participation, it may be necessary to begin with programs designed to enhance awareness. This could include specialised training programs and/or media promotions using television, radio, and newspapers that are delivered in a manner that is consistent with the socio-economic demographic characteristics of farm households collected, including age, experience, household size and farmers' perceived risks.

The fourth observation is that the absolute value of the WTP should be considered carefully, based on the respondents' income and/or their perceptions about the impacts of climate risk on their asset values. In the case of the MRD and when moral issues of who is to blame are put to one side, it appears that farm households could be called upon to pay for the full cost of salinity intrusion risk reduction.

In addition to these four general observations, several more detailed observations can be made. First, as farm households in different salinity intrusion risk areas perceive the salinity risk differently, there is a risk that misconceptions and misinvestments could be made because the information provided to local authorities, television, radio and other traditional information channels is inconsistent. Further benefits may be achievable if farm households are provided with training that helps them to understand the full range of adaptive strategies available to them – especially as some are still hesitant to change from current rice farming strategies to other forms of farming (e.g. aquaculture, livestock and off-farm activities).

Second, it is suggested that a variable form of payment method for the climate change risk reduction project could expand the options for farm households. For example, farmers could be asked to pay either through cash (bid levels) or labour (working days per month or year) contributions in order to perform collective actions to reduce the risk of salinity intrusion. Since the target contribution amount could be relatively large for individual farmers, it may be difficult for those farm households to contribute one-off amounts. Hence, monthly/annual contributions may be more suitable when combined with an option to contribute labour for construction, maintenance and strengthening of the sea dike system.

Third, if a sea-dike enhancement program is implemented, free-rider incentives will need to be managed. To this end and if free-rider problems are to be minimised, the survey data collected suggests that, consistent with the payment vehicle adopted by this study, an obligatory contribution from the rice field/farm households' home should be collected by local not national authorities[47]. One way of doing this would be to implement a collection program that is similar in structure to the popular agricultural fee which used to apply in the MRD several years ago.

Lastly, the results also indicate that the transparency and accountability of local authorities' decisions are important. In this thesis, it was found that more than 20 per cent of farm households do not believe their contribution would be used correctly to fund the program. If this issue can be solved by increasing trust, then real willingness-to-pay for the proposed project may be higher. To increase farmer trust, Marshall et al. (2017) have suggested that community-based governments can

[47] In order to enhance the contribution effectiveness, this payment vehicle is recommended by local government officials and farm households during focus group disscussion based on local characteristics.

help improve contribution motivation by ensuring that every farm household and stakeholder is well-informed about the project, and involved via the inclusion of local representatives on the management committee.

5.4 Limitations and Future Research

By employing the same questionnaire or a variant of it, a future study could be expanded to consider other dimensions of the problem not covered by this thesis:

Firstly, in the MRD, the WTP for risk reduction could be expanded to cover other categories of climate change impact, for example, erosion and storm damage. In other areas of Vietnam, and other developing countries, WTP for "collective" climate change risk reduction projects may be significant. In order words, it is recommended that future researchers examine contribution rates across numerous climate change scenarios, where farm households (level 1) are nested by type of climate change impact (level 2), and region or other physical characteristics (level 3). This could be treated as a multilevel regression, or multilevel logistic regression in the case of WTP estimates. Secondly, time series data might be collected in order to enable comparisons between stated intentions and actual responses to changes in productivity caused by climate change.

A limitation of this study is the use of single discrete choice (DC) format questions. Although this method was approved and recommended by the US NOAA (Arrow et al., 1993), and was provided as a single-shot value mechanism (Poe et al., 2002), it still has some recognised limitations (Johnston et al., 2017). In the case of the MRD where farm households' education level is quite low, it is arguable that a single DC is not the most appropriate mechanism. Therefore, future research projects could track actual implementation and then compare the results to the findings from this research. Information on the difference between hypothetical referendums and actual payments in developing countries is urgently needed.

Researchers could also survey farm households who have not taken part in either the hypothetical survey and/or are outside a real program area. By comparing across these three groups, several new observations can be anticipated. First, the robustness of the hypothetical referendum can be checked across the three groups. Second, researchers will be able to assess the influence of a hypothetical survey on a real program.

In closing, one further observation needs to be made. In this thesis, a significant but unexpected correlation was found between concerns about salinity intrusion and mental health. Further quantitative research on this issue seems justified – especially in developing country river deltas.

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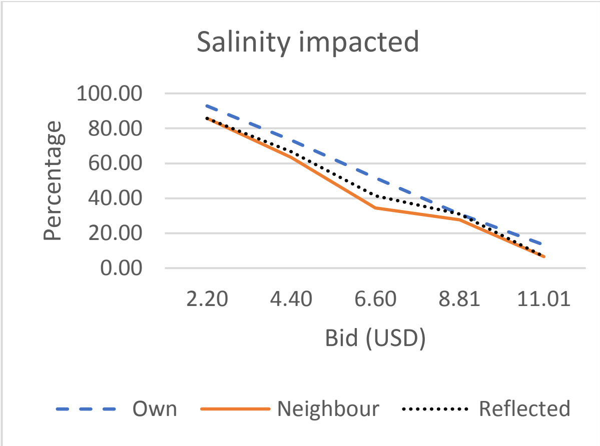
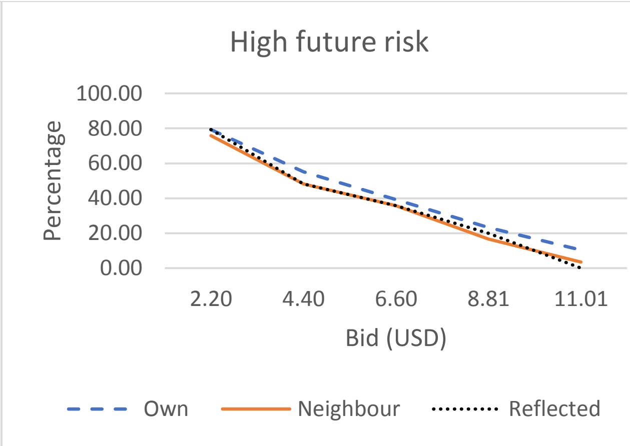
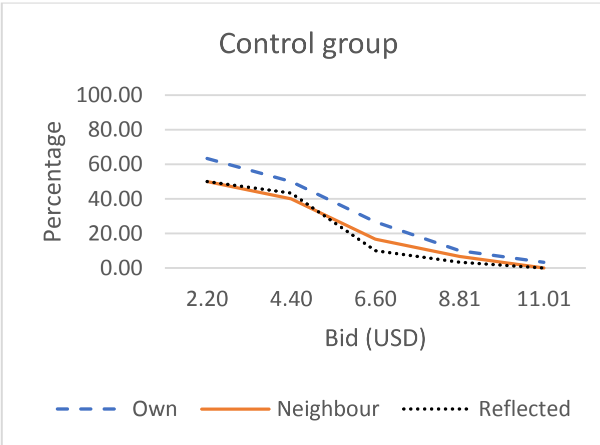
Appendices

Appendix 1. Distribution of proportion of farm households 'Yes' answer for the proposed program by bid levels and different respondent groups (by estimation approach)

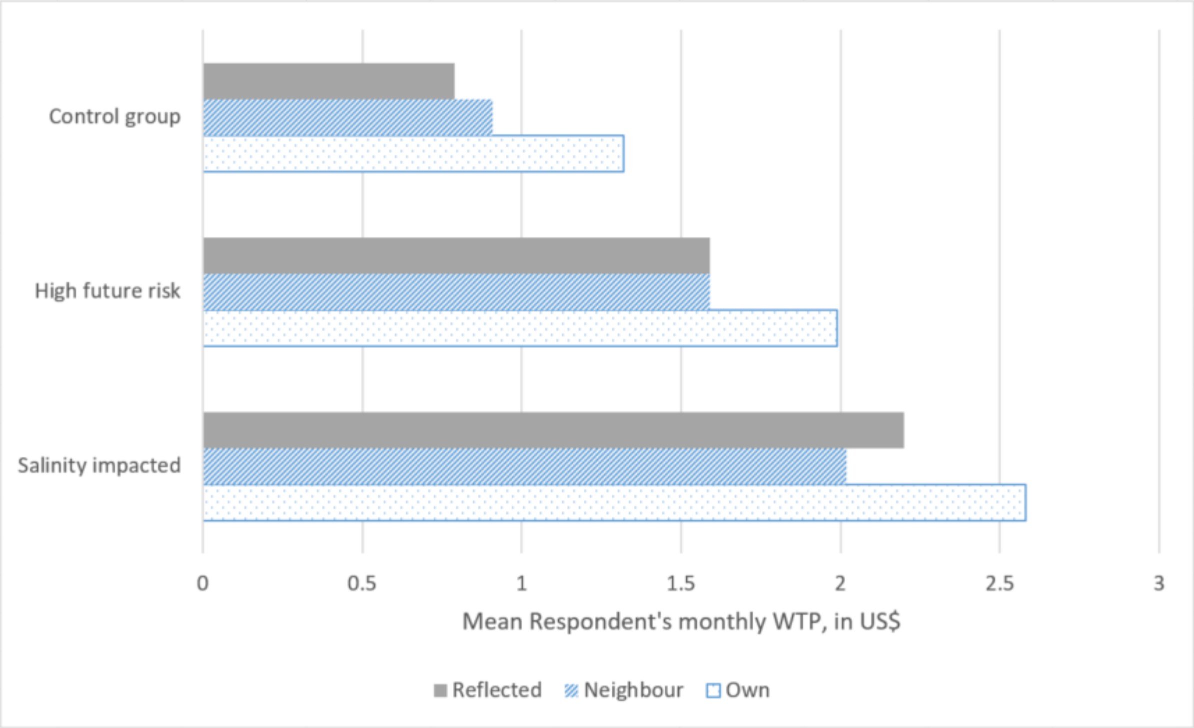






Note: *Own* = Preferences via conventional CVM; *Neighbour* = Predicting their neighbour's WTP; *Reflected Self* = Predicting neighbour's belief about the respondents' WTP

Appendix 2. Farm household WTP differences by Group and valuation approach (by estimation approach)



Appendix 3. Coefficients and Marginal effects (ME) (dy/dx) of MRD farm household WTP for salinity intrusion programs, by estimation approach (by estimation approach)

Dependent variable: WTP (1=Yes, 0=No/Do not know)	Model 1 *Own*		Model 2 *Neighbour*		Model 3 *Reflected Self*		VIF
Independent Variables	Coefficient	ME (dy/dx)	Coefficient	ME (dy/dx)	Coefficient	ME (dy/dx)	
Bid value	-0.0192*** (0.0020)	-0.0045*** (0.00046)	-0.0201*** (0.0021)	-0.0039*** (0.0004)	-.0208*** (.0021)	-.0041*** (.0004)	1.01
Household head's gender	-0.2292 (0.3329)	-0.0525 (0.0744)	0.0903 (0.3413)	0.0179 (0.0687)	.0780 (.3437)	.0156 (.0697)	1.10
Household head's education	-0.1268 (0.1082)	-0.0296 (0.0253)	-0.0475 (0.1142)	-0.0093 (0.0224)	-.0592 (.1150)	-.0117 (.0228)	1.11
Household head's farming experience	-0.0354*** (0.0122)	-0.0082*** (0.0028)	-0.0208* (0.0126)	-0.0041* (0.0024)	-.0175 (.0126)	-.0034 (.0024)	1.14
Farm household size	0.0058 (0.0945)	0.00136 (0.0221)	0.0656 (0.0989)	0.0128 (0.0193)	.0532 (.0985)	.0105 (.0195)	1.03
Farm household income	5.71e-06*** (1.31e-06)	1.34e-06*** (0.0000)	6.09e-06*** (1.29e-06)	1.19e-06*** (0.0000)	5.08e-06*** (1.24e-06)	1.01e-06*** (.0000)	1.07
Farm location	0.9759*** (0.2584)	0.2323*** (0.0608)	0.8943*** (0.2648)	0.1855*** (0.0568)	1.1025*** (.2680)	.2328*** (.0580)	1.01
Cons	2.5627*** (0.6563)	-	1.3585** (0.6654)	-	1.5352** (.6687)	-	-
Log-Likelihood		-215.01699		-201.07744		-200.38518	
Pseudo R-square		0.2807		0.2871		0.2945	
Prob>chi2		0.0000		0.0000		0.0000	
N (sample size)		441		441		441	

Notes: ***, **, and * is statistically significant at 1%, 5% and 10% levels, respectively. The standard deviation in parentheses. Marginal effects of Logit model are not available for the constant term.

Appendix 4. Farm households survey Questionnaire (English)

THE UNIVERSITY *of* ADELAIDE

SURVEY QUESTIONNAIRE
(CONFIDENTIAL)

Economic analysis of farm households' perception, adaptation strategies and attitudes to Salinity intrusion risk in the Mekong River Delta (MRD)

Good morning/afternoon/evening! We are conducting a research about salinity intrusion perception, adaptation behaviour and attitudes to salinity intrusion risk in the Mekong River Delta.

You have been randomly selected to undertake this survey. Your participation in this survey is voluntary and highly appreciated.

We will ask you about your family, farm and salinity intrusion risk. The estimated survey time is about one hour. All survey information will be kept confidential and will only be used for research purposes. Your identity will be kept confidential and not linked to your responses.

You are free to discontinue the survey at any time if you wish.

If you have any further questions, please contact Mr. Tien Dung Khong via email: ktdung@ctu.edu.vn or tiendung.khong@adelaide.edu.au or by phone: +84 939 006 222

Do you agree with the conditions defined in the Participants Information Sheet?

a. I agree *(Proceed to next question)* b. I do not agree *(Stop the interview)*

Have you lived here and farmed for more than 3 years?

b. Yes *(Proceed to part A)* b. No *(Stop the interview)*

Name of interviewer		Date of interview	
Name of respondent		Phone of respondent	
Address of respondent			

A. Socio-economic and demographic characteristics

A1. We would like to know some information about you

Household head name	Age	Sex	Marital status	Years in school	Primary occupation	Secondary occupation	Years working/helping in farm work
	Years	Male-1 Female-2	1: single 2: married 3: widow/widower 4: divorced 5: separated 6: N/A	0: never attended school 1: primary school 2: secondary school 3: high school 4: bachelor degree 5: post-graduate degree	1: agriculture 2: non-agriculture 3: other, please specify	Please specify	

	Sharing time allocated for the following activities in 2015 (%)		
Household head name	Farming (%)	Off-farming (%)	Others (including education, rest, travel, etc…) (%)

A2. Please indicate all family members who (1) have lived together at least 6 months in the last 12 months in the house and (2) are taking food from the same kitchen and (3) are contributing to the households' income and/or drawing from it……………………(persons)

A2.1 How many members in your family are doing non-agriculture?...................................(persons)

A2.2 How many children less than 15 years olds in your family?.................(persons)

A3. What is your religion?

1. Buddhism
2. Catholic
3. Christian
4. Hoa Hoa Buddhism
5. Ancestor worship
6. No religion
7. Other, please specify

A4. What ethnic group do you belong to:

1. Kinh
2. Khmer

3. Hoa
4. Cham

5. Other, please specify

A5-A7.

	Plot 1	Plot 2	Plot 3
A5. How much agricultural land does your family own (ha/m^2)?			
A6. Are you farming on your own land or rented land?			
- Owned land	□	□	□
- Rented	□	□	□
A7. How far is this land from (km):			
- Local market			
- Main road			
- School			

A8. How much planted rice area did your family cultivate in 2015:
Crop 1 (ha/m^2):……………From:……….to…………....Type of variety:………………..
Crop 2 (ha/m^2):……………From:……….to…………... Type of variety:……………….
Crop 3 (ha/m^2):……………From:……….to…………... Type of variety:………………..

A9. Is any of your family a member of organization/association?

Household member name	Name of organization/association	When joined?	Position in organization/association?
	1: Farmer union 2: Women's union 3: Other, please specify	Year	1: Member 2: Manager 3: Other, please specify

A10. Is there any kind of insurance available in your area (*excepted mandatory motorbike insurance*)?

Kind of insurance	Administration authority	Joined (1: yes, 0: no)	When joined? (year)	Premium (1.000 VND)

A11. Have you or your family members taken part in any kind of agricultural training?

Household member	Name of training	Date	How long (days)?

B. Salinity intrusion perception and adaptation strategies

Part 1: Farm household perception

B1. In the last 3 years, have you seen salinity intrusion on any of your plots?

1. Yes
2. No *(Proceed to B3)*

	2014		2015		2016	
	From (month)	To (month)	From (month)	To (month)	From (month)	To (month)
Plot 1						
Plot 2						
Plot 3						

B2. For the worst effected plot, to what extent do you think salinity intrusion has affected to your households to date in the following dimensions, please choose from 1 (No effect) to 7 (Extreme effect)?

Items	No effect	Low effect	Somewhat effect	Neutral	Moderate effect	Very effect	Extreme effect
Household's issues							
Income	1	2	3	4	5	6	7
Housing value	1	2	3	4	5	6	7
Farm land value	1	2	3	4	5	6	7
Agriculture output and productivity	1	2	3	4	5	6	7
Water supply for agricultural activities	1	2	3	4	5	6	7
Water supply for daily lives	1	2	3	4	5	6	7
Physical health	1	2	3	4	5	6	7
Mental health (worrying…)	1	2	3	4	5	6	7
Households' habitation environment	1	2	3	4	5	6	7
Regional issues							
Regional food security	1	2	3	4	5	6	7
Regional economic	1	2	3	4	5	6	7
Regional habitation environment	1	2	3	4	5	6	7
Other, please specify	1	2	3	4	5	6	7

B3. In the next 3 years, if salt-water will intrude/continue to intrude into your area, to what extent do you think salinity intrusion will affect to your family in the following dimensions without any adaptation measures, please choose from 1 (No effect) to 7 (Extreme effect)?

Items	No effect	Low effect	Somewhat effect	Neutral	Moderate effect	Very effect	Extreme effect
Household's issues							
Income	1	2	3	4	5	6	7
Housing value	1	2	3	4	5	6	7
Farm land value	1	2	3	4	5	6	7
Agriculture output and productivity	1	2	3	4	5	6	7
Water supply for agricultural activities	1	2	3	4	5	6	7

Items	No effect	Low effect	Somewhat effect	Neutral	Moderate effect	Very effect	Extreme effect
Water supply for daily lives	1	2	3	4	5	6	7
Physical health	1	2	3	4	5	6	7
Mental health (worrying…)	1	2	3	4	5	6	7
Households' habitation environment	1	2	3	4	5	6	7
Regional issues							
Regional food security	1	2	3	4	5	6	7
Regional economic	1	2	3	4	5	6	7
Regional habitation environment	1	2	3	4	5	6	7
Other, please specify	1	2	3	4	5	6	7

B4. Can you sort the prime causes of salinity intrusion in order of seriousness?

Type of problem	From LESS important (1) to MOST important (4)
Sea level rise	
River flow change (upstream development)	
Drought	
Increase water demand in MRD	

B5. How confident are you about the above answer?

1 - Not confident
2 - Confident
3 - Very confident

B6. As you believe, how has salinity intrusion changed over the last 3 years?

a. Increase b. Decrease
c. Unchanged d. Do not know

B7. How confident are you about the above answer?

1 - Not confident
2 - Confident
3 - Very confident

B8. In the next 3 years, how do you think salinity intrusion will change?

a. Increase b. Decrease
c. Unchanged d. Do not know

B9. How confident are you about the above answer?

1. Not confident
2. Confident
3. Very confident

Part 2. Autonomous response to salinity intrusion

<u>For households in salinity intrusion risk areas or not affected areas, proceed to B16</u>

B10. During the last 3 years, how have you adapted to salinity intrusion? Please describe if you have applied the measure to your farm and choose from 1 (very ineffective) to 7 (Very effective)? *(Interviewer will select based on how respondent describes and tick all appropriate adaptation types)*

	Very ineffective	Moderately ineffective	Slightly ineffective	Neutral	Slightly effective	Moderately effective	Very effective
Group 1. Non-engineering adaptation measures							
Changing planting time	1	2	3	4	5	6	7
Using short-term varieties	1	2	3	4	5	6	7
Re-planting	1	2	3	4	5	6	7
Changing to salt-tolerant varieties	1	2	3	4	5	6	7
Changing fertilizer schedule	1	2	3	4	5	6	7
Changing fertilizer using	1	2	3	4	5	6	7
Changing chemical schedule	1	2	3	4	5	6	7
Changing chemical using	1	2	3	4	5	6	7
Changing irrigation schedule	1	2	3	4	5	6	7
Group 2. Engineering adaptation measures							
Heightening, maintaining individual dike	1	2	3	4	5	6	7
Dredging canals on farm	1	2	3	4	5	6	7
Build/repair well	1	2	3	4	5	6	7
Group 3. Hydro management adaptation measures							
Increased water storage in dam, pond	1	2	3	4	5	6	7
Increased filtering water	1	2	3	4	5	6	7
Appling saving water technique	1	2	3	4	5	6	7
Buying water from bordered areas	1	2	3	4	5	6	7
Group 4. Other adaptation measures							
Getting information from local authorities	1	2	3	4	5	6	7

	Very ineffective	Moderately ineffective	Slightly ineffective	Neutral	Slightly effective	Moderately effective	Very effective
Getting information from TV, radio about warning information	1	2	3	4	5	6	7
Human insurance (for injury and illness)	1	2	3	4	5	6	7
Agriculture insurance	1	2	3	4	5	6	7
Changing from rice to aquaculture	1	2	3	4	5	6	7
Changing from rice to livestock	1	2	3	4	5	6	7
Participate off-farm activities	1	2	3	4	5	6	7
Migrate to other places	1	2	3	4	5	6	7

B11. What were the main problems you had in undertaking these responses?

a. Funds

b. Technical information

c. Labour

d. Policies from local authorities

e. Information about salinity intrusion and adaptation measures

f. Other, please specify

B12. Can you sort the above problems in order of seriousness?

Type of problem	From LESS important (1) to MOST important (5)
Fund	
Technical information	
Labour	
Policies from local authorities	
Information about salinity intrusion and adaptation measures	
Other	

B13. What are the reasons for not responding to salinity intrusion?

a. Lack of funds

b. Lack of technical information

c. A shortage of labour

d. Other problems are more important (i.e. pollution)

e. It happened suddenly

f. God will protect my household

g. Other, please specify

B14. Can you sort the above problems in order of seriousness?

Type of problem	From LESS important (1) to MOST important (5)
Lack of funds	
Lack of technical information	
A shortage of labour	
Other problems are more important (i.e. pollution)	
It happened suddenly	
God will protect my household	
Other	

B15. When your family applied these adaptation measures, please indicate spending cost for each adaptation measures, please choose from 1 (Not costly at all) to 7 (Very costly)

	No cost			**Neutral**			**Very costly**
Group 1. Non-engineering adaptation measures							
Changing planting time	1	2	3	4	5	6	7
Using short-term varieties	1	2	3	4	5	6	7
Re-planting	1	2	3	4	5	6	7
Changing to salt-tolerant varieties	1	2	3	4	5	6	7
Changing fertilizer schedule	1	2	3	4	5	6	7
Changing fertilizer using	1	2	3	4	5	6	7
Changing chemical schedule	1	2	3	4	5	6	7

	No cost			**Neutral**			**Very costly**
Changing chemical using	1	2	3	4	5	6	7
Changing irrigation schedule	1	2	3	4	5	6	7
Group 2. Engineering adaptation measures							
Heightening, maintaining individual dike	1	2	3	4	5	6	7
Dredging canals on farm	1	2	3	4	5	6	7
Build/repair well	1	2	3	4	5	6	7
Group 3. Hydro management adaptation measures							
Increased water storage in dam, pond	1	2	3	4	5	6	7
Increased filtering water	1	2	3	4	5	6	7
Appling saving water technique	1	2	3	4	5	6	7
Buying water from bordered areas	1	2	3	4	5	6	7
Group 4. Other adaptation measures							
Getting information from local authorities	1	2	3	4	5	6	7
Getting information from TV, radio about warning information	1	2	3	4	5	6	7
Human insurance (for injury and illness)	1	2	3	4	5	6	7
Agriculture insurance	1	2	3	4	5	6	7
Changing from rice to aquaculture	1	2	3	4	5	6	7
Changing from rice to livestock	1	2	3	4	5	6	7
Participate off-farm activities	1	2	3	4	5	6	7
Migrate to other places	1	2	3	4	5	6	7

B16. In the future, do you think you will apply any of the following adaptation measures to salinity intrusion? Please choose from 1 (Strongly disagree) to 7 (Strongly agree)

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Group 1. Non-engineering adaptation measures							
Changing planting time	1	2	3	4	5	6	7
Using short-term varieties	1	2	3	4	5	6	7
Re-planting	1	2	3	4	5	6	7
Changing to salt-tolerant varieties	1	2	3	4	5	6	7
Changing fertilizer schedule	1	2	3	4	5	6	7
Changing fertilizer using	1	2	3	4	5	6	7

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Changing chemical schedule	1	2	3	4	5	6	7
Changing chemical using	1	2	3	4	5	6	7
Changing irrigation schedule	1	2	3	4	5	6	7
Group 2. Engineering adaptation measures							
Heightening, maintaining individual dike	1	2	3	4	5	6	7
Dredging canals on farm	1	2	3	4	5	6	7
Build/repair well	1	2	3	4	5	6	7
Group 3. Hydro management adaptation measures							
Increased water storage in dam, pond	1	2	3	4	5	6	7
Increased filtering water	1	2	3	4	5	6	7
Appling saving water technique	1	2	3	4	5	6	7
Buying water from bordered areas	1	2	3	4	5	6	7
Group 4. Other adaptation measures							
Getting information from local authorities	1	2	3	4	5	6	7
Getting information from TV, radio about warning information	1	2	3	4	5	6	7
Human insurance (for injury and illness)	1	2	3	4	5	6	7
Agriculture insurance	1	2	3	4	5	6	7
Changing from rice to aquaculture	1	2	3	4	5	6	7
Changing from rice to livestock	1	2	3	4	5	6	7
Participate off-farm activities	1	2	3	4	5	6	7
Migrate to other places	1	2	3	4	5	6	7

Part 3: Public respond to salinity intrusion risk

B17. Has the local government in your area implemented any of the following adaptation measures to deal with salinity intrusion risk? Please describe and evaluate the effectiveness by choosing from 1 (Very ineffective) to 7 (Very effective)

	Very ineffective	Moderate ineffective	Slightly ineffective	Neutral	Slightly effective	Moderatel y effective	Very effective
Implementation and heightening current sea dike system	1	2	3	4	5	6	7

	Very ineffective	Moderate ineffective	Slightly ineffective	Neutral	Slightly effective	Moderately effective	Very effective
Converting into concrete sea dike	1	2	3	4	5	6	7
Implementation and heightening sluice gates/ River mouth gates	1	2	3	4	5	6	7
Mangrove forest reforestation	1	2	3	4	5	6	7
Implementation and upgrading fresh water supply system	1	2	3	4	5	6	7
Supporting short-term varieties	1	2	3	4	5	6	7
Supporting salt-tolerant varieties	1	2	3	4	5	6	7
Supporting changing crops	1	2	3	4	5	6	7
Supporting water storage tank/container	1	2	3	4	5	6	7
Training	1	2	3	4	5	6	7
Damage subsidy	1	2	3	4	5	6	7
Implementation early warning system	1	2	3	4	5	6	7
Propaganda program on TV, radio and newspapers	1	2	3	4	5	6	7

B18. In the future, suppose that the local authorities will invest/continue to invest in the following adaptations to respond to increasing salinity intrusion, to what extent do you agree with the following adaptation measures by choosing from 1 (Strongly disagree) to 7 (Strongly agree)?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Implementation and heightening current sea dike system	1	2	3	4	5	6	7
Converting into concrete sea dike	1	2	3	4	5	6	7
Implementation and heightening sluice gates/ River mouth gates	1	2	3	4	5	6	7
Mangrove forest reforestation	1	2	3	4	5	6	7
Implementation and upgrading fresh water supply system	1	2	3	4	5	6	7
Supporting short-term varieties	1	2	3	4	5	6	7
Supporting salt-tolerant varieties	1	2	3	4	5	6	7
Supporting changing crops	1	2	3	4	5	6	7
Supporting water storage tank/container	1	2	3	4	5	6	7
Training	1	2	3	4	5	6	7
Damage subsidy	1	2	3	4	5	6	7
Implementation early warning system	1	2	3	4	5	6	7

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Propaganda program on TV, radio and newspapers	1	2	3	4	5	6	7

C. Farm households' income sources

C1. Please indicate all your family's income from following activities in 2015

Income activities	How much Gross revenue did your household get from this activity? (1)	How much Total cost did your household spend on this activity? (2)	How much profit did your household get from this activity? (3) = (1) - (2)	How has the importance of this activity changed over the last 3 years?
	1.000 VND/year	1.000 VND/year	1.000 VND/year	1.Increase 2.Unchanged 3.Decrease
Rice production				
Aquaculture				
Livestock and animal product sales				
Off-farm wage				
Pension				
Others, please specify				

C2. Have households received any kind of subsidy in the past 3 years?

Kind of subsidy	Amount per unit (1.000 VND)	Units	Who is the sponsor for that?
Technical support			
Food			

Farming input			
Salinity intrusion subsidy			
Other, please specify			

C3. Please indicate all spending of your family in 2015:

Household expenditure	Total cost/year	How has this spending changed from the last 3 years?
	1.000 VND	1.Increase 2.Unchanged 3.Decrease
Education		
Health care		
Daily food		
Clothes		
Assets		
House maintaining		
Gas, electricity, water, etc.		
Special events		
Other, please specify		

C4. Do your family have the following asset in 2015?

	Yes		Yes		Yes		Yes
Tractor		Mobile phone		Refrigerator		Air conditioner	
Harvesting machine		Motorcycle		Washing machine		Wherry/Vo Lai	
Seeding machine		Colour TV		Computer/Laptop		Other, please specify	

D. Farm households willingness to pay for salinity intrusion risk reduction

Detailed description of the situation will be offered to the respondents and then a brief discussion will help respondents become aware of possible biases in their answers.

Proposed plan:

Currently, the local government has invested in several adaptation options to manage salinity intrusion, including sea dike systems and river mouth sluices established in parallel with mangrove forest rehabilitation. However, there is a lack of financial resources to implement these projects in all of the necessary areas of the Delta. If the government had additional funds from households such as yourself, they could:

i) Convert current earthen sea dikes to concrete structures

ii) Establish and restore mangrove forest areas in coastal areas to protect sea dikes and enhance ecosystem values.

iii) Investment in the construction of river mouth sluices to reduce intrusion

Suppose this salt water risk reduction fund is created and you are invited to contribute. This fund will be managed by a council including local government, local and international consultants and non-government organizations. This council will decide whether to invest in concrete sea dikes, mangrove forest areas in relevant positions in the Mekong River Delta, or investment in river mouth sluice construction. These measures might help to protect your farming area from salinity intrusion risk.

Cheap talk script (Aadland and Caplan 2006, Do and Bennett 2007)

As you prepare to answer the next few questions, please keep in mind the following three things. First, keep in mind your household budget. How much would your household be able to afford as a contribution to this fund? Second, keep in mind that there are other adaptation measures for salinity intrusion which we have not outlined above. Third, keep in mind that previous studies have found that the options people say they prefer are sometimes different from the options that they would actually select when the program takes place and requires a real payment to be made. For these reasons, when choosing the options please imagine that your household will actually have to pay for the contribution you choose.

D1. Which do you think is the most appropriate mechanism to collect this fee?

a. Electricity bill

b. Agricultural service fee

c. Other, please specify

D2. Would you be willing to vote for a legislated fund which requires every farming household to pay ….Vietnamese Dong/month? Remember that this contribution reduces the amount of money you could spend on other goods and services.

□ Yes, proceed to D4
□ No, proceed to D3
□ Do not know, If so, please give the reason?
....

D3. Why would not you vote for this fund, please nominate the most important reason (see Lo and Jim 2015)?

□ a. I cannot afford that amount
□ b. I do not think the upgrading of sea dike is worth doing
□ c. I do not think that amount I would pay will be actually used for this program
□ d. I think this is the full responsibility of the government
□ e. I think other adaptation measures are more efficient than this program
□ f. I can live with this by own adaptation options
□ g. Other things are more important

D4. What is the highest amount you could spend to this program instead of spending on other goods or services? ....…………..Vietnamese Dong/month

D5. Do you believe that your votes will be taken into account by the authorities?

□ Yes
□ No
□ Do not know

D6. Do you think your neighbour would be willing to vote for this fund?

□ Yes *proceed to D7*
□ No *proceed to D8*
□ Do not know, *proceed to D8*

D7. How much do you think your neighbour's household would be willing to pay for this fund?

……………Vietnamese Dong/month

D8. Would your neighbours think you are willing to vote for this fund?

□ Yes *proceed to D9*
□ No
□ Do not know

D9. Do you think how much your neighbour might think you are willing to pay for this fund?

……………Vietnamese Dong/month

--- Thank you very much for your help! ---

Appendix 5. Farm households survey Questionnaire (Vietnamese)

BẢNG CÂU HỎI
(*BẢO MẬT*)

Phân tích kinh tế về nhận thức, hành vi thích ứng và thái độ đối với rủi ro xâm nhập mặn của nông hộ ở đồng bằng sông Cửu Long

Xin chào cô/chú/anh/chị! Chúng tôi đang thực hiện nghiên cứu về nhận thức, hành vi thích ứng và thái độ đối với rủi ro xâm nhập mặn ở đồng bằng sông Cửu Long.

Được sự giới thiệu của UBND huyện và các cán bộ chuyên gia nông nghiệp tại địa phương, cô/chú/anh/chị được lựa chọn ngẫu nhiên để tham gia phỏng vấn. Chúng tôi đánh giá cao ý kiến và sự tham gia của cô/chú/anh/chị.

Chúng tôi sẽ hỏi ý kiến của cô/chú/anh/chị các thông tin về gia đình, hoạt động nông nghiệp và rủi ro xâm nhập mặn. Thời gian phỏng vấn sẽ kéo dài khoảng một giờ. Thông tin thu thập sẽ chỉ được dùng cho việc nghiên cứu và sẽ được giữ cẩn thận.

Nếu cô/chú/anh/chị có câu hỏi gì, xin vui lòng liên hệ Nhóm thu thập số liệu qua email: ktdung@ctu.edu.vn hoặc điện thoại: 0939006222

Cô/chú/anh/chị có đồng ý với các thông tin cung cấp trong bảng thông tin đáp viên không?

c. Đồng ý *(tiếp tục phỏng vấn)* b. Không đồng ý *(dừng phỏng vấn)*

Cô/chú/anh/chị đã sống ở đây và làm ruộng trên 3 năm chưa?

d. Đã trên 3 năm *(Tiếp tục)* b. Ít hơn 3 năm *(Dừng phỏng vấn)*

Tên phỏng vấn viên		Ngày phỏng vấn	
Tên đáp viên		Số điện thoại đáp viên	
Địa chỉ đáp viên			

A. Thông tin về đặc điểm nông hộ

A1. Vui lòng cho biết một số thông tin về chủ hộ:

Tên chủ hộ	Tuổi	Giới tính	Tình trạng hôn nhân	Trình độ học vấn cao	Nghề nghiệp chính	Nghề nghiệp phụ	Số năm kinh nghiệm làm ruộng
	Bao nhiêu tuổi	1-Nam 2-Nữ	1-Độc thân 2-Đã kết hôn 3-Mất vợ/chồng 4-Ly dị 5-Ly thân 6-Khác	0-không đi học 1-cấp 1 2-cấp 2 3-cấp 3 4-trung cấp cao đẳng 5-đại học 6-sau đại học	1-Làm ruộng 2-Chăn nuôi 3-Nuôi trồng thủy sản		Năm

Tên chủ hộ	Thời gian dành cho các hoạt động sau trong năm 2015 **(Tổng là 100%)**		
	Nông nghiệp (%)	Phi nông nghiệp (%)	Khác (gồm đi học, nghỉ ngơi, du lịch…) (%)

A2. Có bao nhiêu thành viên trong gia đình mình (cùng sống trong nhà ít nhất 6 tháng trong vòng 1 năm qua, cùng ăn chung, cùng đóng góp hoặc chi tiêu trong số tiền của gia đình):…………………(người)

A2.1 Trong số đó, có bao nhiêu thành viên trong gia đình mình có làm nghề khác ngoài làm ruộng, chăn nuôi và nuôi trồng thủy sản?............................ (người)

A2.2 Trong số đó, có bao nhiêu trẻ em dưới 15 tuổi?............................ (người)

A3. Chú/cô/anh/chị theo tôn giáo nào?

1. Đạo Phật
2. Đạo Thiên Chúa
3. Đạo Tin lành
4. Đạo Hòa hảo
5. Đạo ông bà
6. Không tôn giáo
7. Khác

A4. Chú/cô/anh/chị thuộc dân tộc nào?

1.Kinh 3. Hoa 5. Khác (ghi rõ)

2.Khmer 4. Chăm

A5-A7

	Khu đất 1	Khu đất 2	Khu đất 3
A5. Gia đình mình sở hữu bao nhiêu đất nông nghiệp (ha/m^2)?			
A6. Gia đình mình làm ruộng trên đất thuê hay đất sở hữu?			
- Đất sở hữu	□	□	□
- Đất thuê	□	□	□
A7. Khoảng cách từ mảnh đất này đến các địa điểm sau bao xa (km):			
- Chợ gần nhất			
- Đường chính/đường liên tỉnh			
- Trường học gần nhất			

A8. Gia đình mình trồng bao nhiêu diện tích lúa trong năm 2015?

Vụ 1 (ha/ m^2):……………. Từ tháng…….đến tháng…….. Loại giống lúa:…………………

Vụ 2 (ha/ m^2):……………. Từ tháng……..đến tháng……. Loại giống lúa:…………………

Vụ 3 (ha/ m^2):……………. Từ tháng……..đến tháng……. Loại giống lúa:…………………

A9. Có người nào trong gia đình mình là thành viên của các hội nhóm, cơ quan tại địa phương không?

Tên	Tên của hội nhóm/cơ quan	Tham gia khi nào	Vị trí trong hội nhóm/cơ quan
	1-Hội nông dân 2-Hội phụ nữ 3-Khác, ghi rõ	Năm	1-Thành viên 2-Quản lý 3-Khác, ghi rõ

A10. Trong khu vực mình có các loại hình bảo hiểm nào mà cô/chú/anh/chị biết đến **(ngoại trừ bảo hiểm xe gắn máy bắt buộc)**

Loại bảo hiểm	Cơ quan quản lý	Tham gia (1-Có, 0-Không)	Tham gia khi nào?	Phí tham gia (1.000 đồng/năm)

A11. Có thành viên nào trong gia đình mình được tập huấn về nông nghiệp không?

Tên thành viên	Tên khóa tập huấn	Tháng/năm tập huấn	Tập huấn bao nhiêu ngày (số ngày)?

B. Nhận thức về xâm nhập mặn và hành vi thích ứng

Phần 1: Nhận thức của nông hộ

B1. Trong 3 năm qua, đất ruộng gia đình mình đã từng bị xâm nhập mặn chưa?

3. Có
4. Chưa *(chuyển qua B3)*

	2014		2015		2016	
	Từ tháng	Đến tháng	Từ tháng	Đến tháng	Từ tháng	Đến tháng
Khu đất 1						
Khu đất 2						
Khu đất 3						

B2. Cô/chú/anh/chị đánh giá mức độ thiệt hại của xâm nhập mặn đến gia đình mình ở các khía cạnh sau như thế nào theo các mức độ? Vui lòng chọn từ 1 (không ảnh hưởng) đến 7 (ảnh hưởng rất nhiều).

Các khía cạnh	**Không ảnh hưởng**			**Ảnh hưởng vừa phải**			**Ảnh hưởng rất nhiều**
Vấn đề liên quan đến nông hộ							
Thu nhập	1	2	3	4	5	6	7
Giá trị nhà	1	2	3	4	5	6	7
Giá trị đất ruộng	1	2	3	4	5	6	7
Năng suất và sản lượng nông nghiệp	1	2	3	4	5	6	7
Nguồn cung nước cho nông nghiệp	1	2	3	4	5	6	7
Nguồn cung nước sinh hoạt hằng ngày	1	2	3	4	5	6	7
Sức khỏe thể chất	1	2	3	4	5	6	7
Sức khỏe tinh thần (lo lắng…)	1	2	3	4	5	6	7
Môi trường sống của gia đình	1	2	3	4	5	6	7
Vấn đề liên quan khu vực							
Ảnh hưởng an ninh lương thực khu vực	1	2	3	4	5	6	7
Ảnh hưởng kinh tế khu vực	1	2	3	4	5	6	7
Ảnh hưởng môi trường sống trong khu vực	1	2	3	4	5	6	7
Khác, ghi rõ	1	2	3	4	5	6	7

B3. Trong những năm tới, nếu xâm nhập mặn xảy ra trên địa bàn, nếu không có biện pháp thích ứng nào, cô/chú/anh/chị đánh giá mức độ thiệt hại của xâm nhập mặn đến gia đình mình ở các khía cạnh sau như thế nào?

Các khía cạnh	**Không ảnh hưởng**			**Ảnh hưởng vừa phải**			**Ảnh hưởng rất nhiều**
Vấn đề liên quan đến nông hộ							
Thu nhập	1	2	3	4	5	6	7
Giá trị nhà	1	2	3	4	5	6	7
Giá trị đất ruộng	1	2	3	4	5	6	7
Năng suất và sản lượng nông nghiệp	1	2	3	4	5	6	7

Các khía cạnh	**Không ảnh hưởng**			**Ảnh hưởng vừa phải**			**Ảnh hưởng rất nhiều**
Nguồn cung nước cho nông nghiệp	1	2	3	4	5	6	7
Nguồn cung nước sinh hoạt hằng ngày	1	2	3	4	5	6	7
Sức khỏe thể chất	1	2	3	4	5	6	7
Sức khỏe tinh thần (lo lắng…)	1	2	3	4	5	6	7
Môi trường sống của gia đình	1	2	3	4	5	6	7
Vấn đề liên quan khu vực							
Ảnh hưởng anh ninh lương thực khu vực	1	2	3	4	5	6	7
Ảnh hưởng kinh tế khu vực	1	2	3	4	5	6	7
Ảnh hưởng môi trường sống khu vực	1	2	3	4	5	6	7
Khác, ghi rõ	1	2	3	4	5	6	7

B4. Theo ý kiến của gia đình, vui lòng sắp xếp thứ tự các nguyên nhân của xâm nhập mặn theo mức độ quan trọng?

Nguyên nhân	Từ ít quan trọng nhất (1) tới quan trọng nhất (4)
Nước biển dâng	
Xây dựng đập ở thượng nguồn (Thay đổi dòng chảy)	
Hạn hán	
Tăng nhu cầu sử dụng nước ở đồng bằng sông Cửu Long	

B5. Cô/chú/anh/chị có tự tin về câu trả lời trên?

1 - Rất tự tin
2 - Tự tin
3 - Không tự tin

B6. Trong 3 năm qua, gia đình mình đánh giá tình hình xâm nhập mặn thay đổi như thế nào?

a. Tăng b. Giảm
c. Không đổi d. Không biết

B7. Cô/chú/anh/chị có tự tin về câu trả lời trên?

1 - Rất tự tin

2 - Tự tin

3 - Không tự tin

B8. Trong 3 năm tới, gia đình mình đánh giá xâm nhập mặn sẽ thay đổi như thế nào?

a. Tăng b. Giảm

c. Không đổi d. Không biết

B9. Cô/chú/anh/chị có tự tin về câu trả lời trên?

1. Rất tự tin
2. Tự tin
3. Không tự tin

Part 2. Biện pháp thích ứng của nông hộ đối với xâm nhập mặn

<u>Đối với các hộ chưa bị xâm nhập mặn, chuyển qua câu B16</u>

B10. Trong 3 năm qua, gia đình mình nếu đã áp dụng các biện pháp sau để thích ứng với xâm nhập mặn, vui lòng đánh giá hiệu quả của các biện pháp thích ứng, chọn từ 1 (rất không hiệu quả) đến 7 (rất hiệu quả)

	Rất không			**Hiệu quả vừa**			**Rất hiệu quả**
Nhóm 1. Các biện pháp phi kỹ thuật							
Thay đổi lịch thời vụ	1	2	3	4	5	6	7
Sử dụng giống ngắn ngày	1	2	3	4	5	6	7
Xuống giống lại	1	2	3	4	5	6	7
Dùng giống kháng mặn	1	2	3	4	5	6	7
Thay đổi lịch bón phân	1	2	3	4	5	6	7
Thay đổi lượng phân sử dụng	1	2	3	4	5	6	7
Thay đổi lịch phun thuốc	1	2	3	4	5	6	7
Thay đổi lượng thuốc sử dụng	1	2	3	4	5	6	7
Thay đổi thời gian bơm nước	1	2	3	4	5	6	7
Nhóm 2. Các biện pháp kỹ thuật							
Tu bổ, sữa chữa đê điều	1	2	3	4	5	6	7
Nạo vét kênh nội đồng	1	2	3	4	5	6	7
Khoan mới hoặc sửa chữa giếng nước	1	2	3	4	5	6	7
Nhóm 3. Các biện pháp quản lý nước							
Tăng cường trữ nước trong mương, ao	1	2	3	4	5	6	7
Sử dụng các biện pháp lọc nước sạch	1	2	3	4	5	6	7

	Rất không			Hiệu quả vừa			Rất hiệu quả
Áp dụng các biện pháp tiết kiệm nước	1	2	3	4	5	6	7
Mua/xin nước từ các vùng lân cận	1	2	3	4	5	6	7
Nhóm 4. Các biện pháp khác							
Nghe thông tin từ chính quyền địa phương	1	2	3	4	5	6	7
Nghe thông tin cảnh báo trên Tivi, báo, radio	1	2	3	4	5	6	7
Mua bảo hiểm con người (tai nạn và bệnh tật)	1	2	3	4	5	6	7
Mua bảo hiểm nông nghiệp	1	2	3	4	5	6	7
Chuyển sang nuôi trồng thủy sản (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Chuyển sang chăn nuôi (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Tham gia hoạt động phi nông nghiệp khác	1	2	3	4	5	6	7
Di cư đến nơi khác	1	2	3	4	5	6	7

B11. Các vấn đề trở ngại/khó khăn chính khi áp dụng các biện pháp ứng phó trên là gì (nhiều lựa chọn)?

a. Tiền vốn

b. Kỹ thuật

c. Nhân công

d. Các chính sách từ các cơ quan hữu quan

e. Thông tin về xâm nhập mặn và các biện pháp thích ứng

f. Khác, ghi rõ

B12. Vui lòng sắp xếp các yếu tố trên theo mức độ quan trọng?

Yếu tố	Từ ít quan trọng nhất (1) tới quan trọng nhất (5)
Tiền vốn	
Kỹ thuật	
Nhân công	
Các chính sách từ các cơ quan hữu quan	
Thông tin về xâm nhập mặn và các biện pháp thích ứng	

Khác, ghi rõ	

B13. Các lý do không áp dụng các biện pháp ứng phó?

a. Thiếu tiền vốn

b. Thiếu kỹ thuật

c. Thiếu nhân công

d. Vấn đề khác quan trọng hơn (như ô nhiễm)

e. Xâm nhập mặn xảy ra bất ngờ

f. Ông Trời sẽ bảo vệ gia đình tôi

g. Khác, ghi rõ

B14. Vui lòng sắp xếp các yếu tố trên theo mức độ quan trọng?

Yếu tố	Từ ít quan trọng nhất (1) tới quan trọng nhất (6)
Thiếu tiền	
Thiếu kỹ thuật	
Thiếu nhân lực	
Vấn đề khác quan trọng hơn (như ô nhiễm)	
Xâm nhập mặn xảy ra bất ngờ	
Ông Trời sẽ bảo vệ gia đình tôi	
Khác, ghi rõ	

B15. Khi gia đình áp dụng các biện pháp thích ứng trên, vui lòng đánh giá chi phí bỏ ra để thực hiện theo mức độ, vui lòng chọn từ 1 (Không tốn kém chi phí gì) đến 7 (rất tốn kém chi phí)

	Không tốn chi			**Chi phí vừa phải**			**Rất tốn chi phí**
Nhóm 1. Các biện pháp phi kỹ thuật							
Thay đổi lịch thời vụ	1	2	3	4	5	6	7
Sử dụng giống ngắn ngày	1	2	3	4	5	6	7
Xuống giống lại	1	2	3	4	5	6	7
Dùng giống kháng mặn	1	2	3	4	5	6	7
Thay đổi lịch bón phân	1	2	3	4	5	6	7
Thay đổi lượng phân sử dụng	1	2	3	4	5	6	7
Thay đổi lịch phun thuốc	1	2	3	4	5	6	7

	Không tốn chi			Chi phí vừa phải			Rất tốn chi phí
Thay đổi lượng thuốc sử dụng	1	2	3	4	5	6	7
Thay đổi thời gian bơm nước	1	2	3	4	5	6	7
Nhóm 2. Các biện pháp kỹ thuật							
Tu bổ, sữa chữa đê điều	1	2	3	4	5	6	7
Nạo vét kênh nội đồng	1	2	3	4	5	6	7
Khoan mới hoặc sửa chữa giếng nước	1	2	3	4	5	6	7
Nhóm 3. Các biện pháp quản lý nước							
Tăng cường trữ nước trong mương, ao	1	2	3	4	5	6	7
Sử dụng các biện pháp lọc nước sạch	1	2	3	4	5	6	7
Áp dụng các biện pháp tiết kiệm nước	1	2	3	4	5	6	7
Mua/xin nước từ các vùng lân cận	1	2	3	4	5	6	7
Nhóm 4. Các biện pháp khác							
Nghe thông tin từ chính quyền địa phương	1	2	3	4	5	6	7
Nghe thông tin cảnh báo trên Tivi, báo, radio	1	2	3	4	5	6	7
Mua bảo hiểm con người (tai nạn và bệnh tật)	1	2	3	4	5	6	7
Mua bảo hiểm nông nghiệp	1	2	3	4	5	6	7
Chuyển sang nuôi trồng thủy sản (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Chuyển sang chăn nuôi (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Tham gia hoạt động phi nông nghiệp khác	1	2	3	4	5	6	7
Di cư đến nơi khác	1	2	3	4	5	6	7

B16. **Trong tương lai**, nếu gia đình mình cần sử dụng các biện pháp thích ứng để giảm rủi ro thiệt hại của xâm nhập mặn, gia đình dự tính sẽ sử dụng biện pháp nào, vui lòng chọn từ 1 (chắc chắn không áp dụng) đến 7 (chắc chắn sẽ áp dụng)

	Chắc chắn không			Có thể có hoặc không			Chắc chắn sẽ áp dụng
Nhóm 1. Các biện pháp phi kỹ thuật							
Thay đổi lịch thời vụ	1	2	3	4	5	6	7
Sử dụng giống ngắn ngày	1	2	3	4	5	6	7
Xuống giống lại	1	2	3	4	5	6	7

	Chắc chắn không			Có thể có hoặc không			Chắc chắn sẽ áp dụng
Dùng giống kháng mặn	1	2	3	4	5	6	7
Thay đổi lịch bón phân	1	2	3	4	5	6	7
Thay đổi lượng phân sử dụng	1	2	3	4	5	6	7
Thay đổi lịch phun thuốc	1	2	3	4	5	6	7
Thay đổi lượng thuốc sử dụng	1	2	3	4	5	6	7
Thay đổi thời gian bơm nước	1	2	3	4	5	6	7
Nhóm 2. Các biện pháp kỹ thuật							
Tu bổ, sữa chữa đê điều	1	2	3	4	5	6	7
Nạo vét kênh nội đồng	1	2	3	4	5	6	7
Khoan mới hoặc sửa chữa giếng nước	1	2	3	4	5	6	7
Nhóm 3. Các biện pháp quản lý nước							
Tăng cường trữ nước trong mương, ao	1	2	3	4	5	6	7
Sử dụng các biện pháp lọc nước sạch	1	2	3	4	5	6	7
Áp dụng các biện pháp tiết kiệm nước	1	2	3	4	5	6	7
Mua/xin nước từ các vùng lân cận	1	2	3	4	5	6	7
Nhóm 4. Các biện pháp khác							
Nghe thông tin từ chính quyền địa phương	1	2	3	4	5	6	7
Nghe thông tin cảnh báo trên Tivi, báo, radio	1	2	3	4	5	6	7
Mua bảo hiểm con người (tai nạn và bệnh tật)	1	2	3	4	5	6	7
Mua bảo hiểm nông nghiệp	1	2	3	4	5	6	7
Chuyển sang nuôi trồng thủy sản (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Chuyển sang chăn nuôi (1 phần hay toàn bộ)	1	2	3	4	5	6	7
Tham gia hoạt động phi nông nghiệp khác	1	2	3	4	5	6	7
Di cư đến nơi khác	1	2	3	4	5	6	7

Part 3: Biện pháp thích ứng của cộng đồng đối với xâm nhập mặn

B17. Trong thời gian qua, gia đình có biết chính quyền các cấp đã áp dụng các biện pháp nào sau đây để thích ứng với xâm nhập mặn? Nếu có, vui lòng đánh giá lợi ích của biện pháp bằng cách chọn số từ 1 (rất không hiệu quả) đến 7 (rất hiệu quả)

	Rất không			Hiệu quả vừa phải			Rất hiệu quả
Thiết lập và nâng cấp hệ thống đê biển	1	2	3	4	5	6	7
Chuyển đổi từ đê đất sang đê bê tông	1	2	3	4	5	6	7
Nâng cấp hệ thống cống/cửa sông	1	2	3	4	5	6	7
Phục hồi hệ thống rừng ngập mặn	1	2	3	4	5	6	7
Đầu tư/nâng cấp hệ thống lọc, cung cấp nước sạch	1	2	3	4	5	6	7
Hỗ trợ giống ngắn ngày	1	2	3	4	5	6	7
Hỗ trợ giống kháng mặn	1	2	3	4	5	6	7
Hỗ trợ chuyển đổi cây trồng khác	1	2	3	4	5	6	7
Hỗ trợ bồn/dụng cụ chứa nước	1	2	3	4	5	6	7
Hỗ trợ thiệt hại	1	2	3	4	5	6	7
Tập huấn	1	2	3	4	5	6	7
Xây dựng hệ thống cảnh báo sớm	1	2	3	4	5	6	7
Tuyên truyền trên báo, ti vi, radio	1	2	3	4	5	6	7

B18. **Trong tương lai**, nếu chính quyền các cấp áp dụng các biện pháp sau để giảm rủi ro xâm nhập mặn, gia đình vui lòng đánh giá lợi ích của các biện pháp này theo mức độ bằng cách chọn từ 1 (Rất không có lợi ích) đến 7 (rất có lợi ích)?

	Rất không có lợi ích			Lợi ích vừa phải			Rất có lợi ích
Thiết lập và nâng cấp hệ thống đê biển	1	2	3	4	5	6	7
Chuyển đổi từ đê đất sang đê bê tông	1	2	3	4	5	6	7
Nâng cấp hệ thống cống/cửa sông	1	2	3	4	5	6	7
Phục hồi hệ thống rừng ngập mặn	1	2	3	4	5	6	7
Đầu tư/nâng cấp hệ thống lọc, cung cấp nước sạch	1	2	3	4	5	6	7
Hỗ trợ giống ngắn ngày	1	2	3	4	5	6	7
Hỗ trợ giống kháng mặn	1	2	3	4	5	6	7
Hỗ trợ chuyển đổi cây trồng khác	1	2	3	4	5	6	7
Hỗ trợ bồn/dụng cụ chứa nước	1	2	3	4	5	6	7
Hỗ trợ thiệt hại	1	2	3	4	5	6	7
Tập huấn	1	2	3	4	5	6	7
Xây dựng hệ thống cảnh báo sớm	1	2	3	4	5	6	7
Tuyên truyền trên báo, ti vi, radio	1	2	3	4	5	6	7

C. Nguồn thu nhập của nông hộ

C1. Vui lòng liệt kê các nguồn thu nhập của gia đình mình từ các hoạt động sau trong năm 2015

Nguồn thu nhập	Tổng số tiền thu được từ các hoạt động này (1)	Tổng chi phí cho hoạt động này (2)	Lợi nhuận thu được (3) = (1) - (2)	Nguồn thu này trong 3 năm qua thay đổi ra sao?
	1.000 đồng/năm	1.000 đồng/năm		1.Tăng 2.Giảm 3. Không đổi
Làm ruộng				
Nuôi trồng thủy sản				
Chăn nuôi gia súc, gia cầm				
Lương từ hoạt động ngoài làm ruộng, chăn nuôi, trồng trọt				
Tiền cấp dưỡng				
Khác, ghi rõ				

C2. Gia đình mình có nhận trợ cấp gì trong 3 năm qua không?

Loại trợ cấp	Giá trị/đơn vị (1.000 đồng)	Đơn vị (lần..)	Ai cung cấp/tài trợ?
Hỗ trợ kỹ thuật			
Hỗ trợ thực phẩm			
Đầu vào cho hoạt động nông nghiệp			
Hỗ trợ thiên tai nông nghiệp			
Khác, ghi rõ			

C3. Vui lòng liệt kê các khoản chi tiêu của gia đình trong năm 2015:

Loại chi tiêu	Tổng chi tiêu/năm	Khoản chi tiêu này thay đổi như thế nào trong 3 năm qua?
	1.000 đồng	1.Tăng 2. Giảm 3. Không đổi
Giáo dục		
Chăm sóc y tế		
Thực phẩm hàng ngày		
Quần áo		
Chi đầu tư sửa chữa, nâng cấp nhà cửa		
Gas, điện, nước…		
Khác, ghi rõ		

C4. Gia đình mình có các loại đồ đạc sau đây không?

	Có/Không		Có/Không		Có/Không		Có/Không
Máy cày		Máy cắt		Máy bơm nước		Tàu/ghe	
Xe máy		Ti vi		Tủ lạnh		Máy giặt	
Máy tính/laptop		Máy lạnh		Điện thoại bàn/di động		Khác, ghi rõ	

D. Sẵn lòng chi trả của nông hộ cho việc giảm rủi ro xâm nhập mặn

Kế hoạch đề nghị:

Giả sử, hiện tại các nhà khoa học đang đề nghị đầu tư vào các biện pháp công trình để hạn chế rủi ro xâm nhập mặn cho khu vực đồng bằng Sông Cửu Long. Tuy nhiên, để thiết lập cần một nguồn tài chính dồi dào. Nếu gia đình mình đóng góp cho hoạt động này, nó sẽ giúp thực hiện các biện pháp công trình sau:

iv) Nâng cấp hệ thống đê hiện tại thành đê bê tông

v) Thiết lập và tái tạo rừng ngập mặn để bảo vệ đê và nâng cao giá trị sinh thái

vi) Đầu tư các cống cửa sông để ngăn mặn

Giả sử quỹ giảm rủi ro xâm nhập mặn này được thiết lập và gia đình mình được mời tham gia đóng góp. Quỹ này sẽ được quản lý bởi một ủy bản bao gồm chính quyền, các nhà tư vấn trong và ngoài nước và các tổ chức phi chính phủ. Ủy ban này sẽ quyết định đầu tư vào hệ thống đê biển bằng bê tông và phục hồi hệ thống rừng ngập mặn cũng như là hệ thống cống ngăn mặn ở vị trí thích hợp ở đồng bằng sông Cửu Long. Các hoạt động này sẽ giúp cho nông hộ giảm thiểu rủi ro xâm nhập mặn.

Trước khi gia đình mình trả lời các câu hỏi dưới đây, xin vui lòng ghi nhớ các điều sau. Thứ nhất, chú ý tới nguồn tiền của gia đình. Gia đình có thể chi tiêu bao nhiêu cho khoản này? Thứ hai, nhớ rằng cũng có một vài biện pháp thích ứng khác mà chúng tôi chưa liệt kê ở trên. Thứ ba, vui lòng nhớ rằng các nghiên cứu trước chỉ ra rằng sự lựa chọn của hộ gia đình trong thực tế có thể khác với sự chọn lựa mà họ đã nói. Vì những lý do đó, khi trả lời câu hỏi, vui lòng tưởng tượng là gia đình thật sự sẽ đóng góp cho quỹ này.

D1. Nếu có đóng góp, gia đình mình nghĩ cách gì là thích hợp nhất để thu nguồn quỹ này?

a. Hóa đơn điện

b. Phí nông nghiệp

c. Khác, ghi rõ

D2. Gia đình mình sẵn lòng để đóng vào quỹ này không? Nên nhớ rằng sự đóng góp này sẽ làm giảm lượng tiền mà gia đình có thể dùng để chi tiêu cho các hàng hóa và dịch vụ khác.

□ Có, chuyển qua D4

□ Không, chuyển qua D3

□ Không biết, vui lòng cho biết lý do?

....

D3. Tại sao gia đình mình không chịu đóng góp cho quỹ này?

□ a. Tôi không có khả năng chi trả cho quỹ này

□ b. Tôi không nghĩ nâng cấp đê biển là tốt

□ c. Tôi không nghĩ số tiền này sẽ được sử dụng cho việc này

□ d. Tôi nghĩ đây là trách nhiệm của các các cơ quan hữu quan

□ e. Tôi nghĩ các biện pháp khác sẽ hiệu quả hơn

□ f. Tôi có thể tự áp dụng các biện pháp thích ứng riêng

□ g. Những việc khác quan trọng hơn

D4. Lượng tiền cao nhất mà gia đình có thể đóng góp là bao nhiêu?

..................................………..1.000 đồng/tháng

D5. Gia đình có tin tưởng rằng nhóm biện pháp này sẽ được thực hiện bởi các cơ quan hữu quan?

□ Có

□ Không

□ Không biết

D6. Gia đình mình có nghĩ hàng xóm của gia đình sẽ sẵn sàng đóng góp cho quỹ này?

□ Có, *chuyển qua câu D7*
□ Không, *chuyển qua câu D8*
□ Không biết, *chuyển qua câu D8*

D7. Gia đình mình nghĩ hàng xóm sẽ sẵn lòng chi trả bao nhiêu cho quỹ này?

……………1.000 đồng/tháng

D8. Cô/chú/anh/chị nghĩ hàng xóm sẽ nghĩ gia đình mình có sẵn lòng chi trả cho quỹ này không?

□ Có, chuyển qua câu *D9*
□ Không
□ Không biết

D9. Cô/chú/anh/chị nghĩ hàng xóm gần nhà mình sẽ nghĩ gia đình mình sẵn lòng đóng góp bao nhiêu tiền cho quỹ này?

……………1.000 đồng/tháng

--- Xin chân thành cám ơn gia đình rất nhiều ---

Appendix 6. Human Research Ethics approval

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY
THE UNIVERSITY OF ADELAIDE

LEVEL 4, RUNDLE MALL PLAZA
50 RUNDLE MALL
ADELAIDE SA 5000 AUSTRALIA

TELEPHONE +61 8 8313 5137
FACSIMILE +61 8 8313 3700
EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

15 June 2016

Professor M Young
School: The Centre for Global Food and Resources

Dear Professor Young

ETHICS APPROVAL No: **H-2016-123**

PROJECT TITLE: **Economic analysis of farm households' perception, adaptation behaviour and attitudes to salinity intrusion risk in the Mekong River Delta (MRD)**

The ethics application for the above project has been reviewed by the Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions) and is deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* involving no more than low risk for research participants. You are authorised to commence your research on **15 Jun 2016**.

Ethics approval is granted for three years and is subject to satisfactory annual reporting. The form titled *Annual Report on Project Status* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. Prior to expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforeseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

PROFESSOR RACHEL A. ANKENY
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

DR JOANNA HOWE
Co-Convenor
Low Risk Human Research Ethics Review Group
(Faculty of Arts and Faculty of the Professions)

THE UNIVERSITY of ADELAIDE

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EMAIL hrec@adelaide.edu.au

CRICOS Provider Number 00123M

Applicant:	Professor M Young
School:	The Centre for Global Food and Resources
Project Title:	Economic analysis of farm households' perception, adaptation behaviour and attitudes to salinity intrusion risk in the Mekong River Delta (MRD)

The University of Adelaide Human Research Ethics Committee
Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)

ETHICS APPROVAL No: H-2016-123 App. No.: 0000021669

APPROVED for the period: 15 Jun 2016 to 30 Jun 2019

Thank you for the response dated 9.6.16 to the matters raised. It is noted this study will be conducted by Tien Dung Khong, PhD candidate.

PROFESSOR RACHEL A. ANKENY Co-Convenor Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)	DR JOANNA HOWE Co-Convenor Low Risk Human Research Ethics Review Group (Faculty of Arts and Faculty of the Professions)

Appendix 7. Participation Information Sheet (English)

THE UNIVERSITY of ADELAIDE

PARTICIPANT INFORMATION SHEET

PROJECT TITLE: Economic analysis of farm households' perception, adaptation behaviour and attitudes to salinity intrusion risk in the Mekong River Delta (MRD)

HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2016-123
PRINCIPAL INVESTIGATOR: Prof Mike Young
CO-INVESTIGATOR: Dr Adam Loch
Dr Jayanthi Thennakoon
STUDENT RESEARCHER: Tien Dung Khong
STUDENT'S DEGREE: PhD

Dear Participant,

You are invited to take part in the research project described below.

What is the project about?

This research aims to identify how farm households adapt to salinity intrusion and examine their decision on paying for risk reduction associated with salinity intrusion (e.g. from rising sea levels or reduced freshwater outflow pressure as a result of diminished upstream flows). The results from this study will assist policy makers in MRD in development of more effective policies to reduce salinity intrusion risk.

Who is undertaking the project?

This research will form the basis for the degree of Doctor of Philosophy for Tien Dung Khong at the University of Adelaide, Australia under the supervision of Prof Mike Young, Dr Adam Loch (Centre for Global Food and Resources) and Dr Jayanthi Thennakoon (external adjunct supervisor). This PhD research is made possible under funding provided by AusAID, managed by the Department of Foreign Affairs and Trade in the form of a scholarship to Tien Dung Khong.

The survey team for this research is trained staff and final year students from the Department of Agricultural Economics, College of Economics, the Can Tho University, Vietnam with experience in data collection.

Why am I being invited to participate?

We are conducting research into the effects of salinity intrusion on household's activities and looking for household's adaptation and willingness to pay for this risk reduction. The findings from this survey aims to contribute to future agricultural policies in the MRD, particularly in Bac Lieu, Ben Tre, Hau Giang and Kien Giang provinces. As a household from that area you have been randomly selected to participate in the survey.

What will I be asked to do?

You will be invited to participate in this survey at your home and your participation is strictly voluntary. There are no penalties for not participating, and your selection will be on a random basis. You will be asked questions about your farm activities, any impacts of salinity intrusion on your farm, your adaptation methods to it and willingness to pay for salinity intrusion risk reduction.

How much time will the project take?

The estimated face to face survey time is about 50-60 minutes. There will be no follow up visits.

Are there any risks associated with participating in this project?

All information will be kept confidential. The only cost to you will be the time it takes to complete this survey about one hour. However, the questionnaire is designed and structured to minimize total survey time.

What are the benefits of the research project?

The results from this study will assist policy makers in the MRD in their development of more effective policies to reduce salinity intrusion risk across affected agricultural areas. As a result, it may help households in this area to successfully adapt to any climate change impacts specific to salinity intrusion (e.g. reduced water quality, reduced farm land areas, reduced farm income etc.).

Can I withdraw from the project?

Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the survey at any time. You will not be penalised in any way, nor will that choice to withdraw be used against you in any way.

What will happen to my information?

Only the project supervisors and research student associated with this research project will have access to participant data during the collection, recruitment phase and data analysis phase. The results of this survey will only be reported in aggregate. Further, because the sample size is large we are certain that your identity and anonymity/confidentiality will be maintained.

The project outcomes will be made publicly accessible through a PhD dissertation and journal articles. All records and materials will be held by the principal supervisor (Prof Young) at Centre for Global Food and Resources, Faculty of the Professions, University of Adelaide in Australia in a password protected computer for at least 5 years, consistent with the Australian Code for the Responsible Conduct of Research.

A summary of research results will be distributed to local government.

Who do I contact if I have questions about the project?

In Australia:

1. Prof Mike Young, Centre for Global Food and Resources, University of Adelaide
Phone: +61 8 8313 5279 (mike.young@adelaide.edu.au)
2. Dr Adam Loch, Centre for Global Food and Resources, University of Adelaide
Phone: +61 8 8313 9131 (adam.loch@adelaide.edu.au)
3. Dr Jayanthi Thennakoon, Centre for Global Food and Resources, University of Adelaide
Phone: +61 434017673 (jayanthi.thenakoon@adelaide.edu.au)

In Vietnam:
Mr. Tien Dung Khong, Department of Agricultural Economics, College of Economics, the Can Tho University
Phone: +84 939 006222 or +84 7103 838831 (ktdung@ctu.edu.vn or tiendung.khong@adelaide.edu.au)

What if I have a complaint or any concerns?
The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2016-xxx). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult Prof Mike Young (in Australia) or Mr Tien Dung Khong (in Vietnam) whose contact details are included above. Alternatively, you can contact the Human Research Ethics Committee's Secretariat on phone +61 8 8313 6028 or by email to hrec@adelaide.edu.au or Mr Vo Thanh Danh from Research Institute for Climate Change – MEKONG, Vietnam on +84918508192 or email: vtdanh@ctu.edu.vn if you wish to speak with an independent person regarding concerns or a complaint, the University of Adelaide's policy on research involving human participants, or your rights as a participant. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If I want to participate, what do I do?
Please read the information in the complaint form, participant information sheet and consent form carefully. If you accept the conditions defined in these forms, please sign and return consent form to interviewer – we can provide you with a copy. Then, the face-to-face survey will commence.

Yours sincerely,
Prof Mike Young
Dr Adam Loch
Dr Jayanthi Thennakoon
Mr Tien Dung Khong

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Appendix 8. Participation Information Sheet (Vietnamese)

THE UNIVERSITY of ADELAIDE

BẢNG THÔNG TIN ĐÁP VIÊN
(PARTICIPANT INFORMATION SHEET)

TÊN ĐỀ TÀI: Phân tích kinh tế về nhận thức của nông hộ, hành vi ứng phó và thái độ đối với rủi ro xâm nhập mặn ở đồng bằng sông Cửu Long (ĐBSCL)
MÃ SỐ PHÊ DUYỆT CỦA HỘI ĐỒNG VỀ ĐẠO ĐỨC TRONG NGHIÊN CỨU LIÊN QUAN ĐẾN CON NGƯỜI: H-2016-123
NGHIÊN CỨU CHÍNH: Giáo sư Mike Young
ĐỒNG NGHIÊN CỨU: Tiến sĩ Adam Loch
Tiến sĩ Jayanthi Thennakoon
NGHIÊN CỨU SINH: Khổng Tiến Dũng
CẤP HỌC: Tiến sĩ

Đáp viên thân mến,

Ông/Bà được mời để tham gia dự án nghiên cứu được mô tả dưới đây.

Dự án này nghiên cứu gì?

Dự án nghiên cứu này có mục tiêu xác định việc các nông hộ thích ứng như thế nào đối với hiện tượng xâm nhập mặn và đánh giá quyết định chi của nông hộ cho việc giảm thiểu rủi ro của hiện tượng này (như nước biển dâng hoặc khan hiếm nước ngọt do ảnh hưởng từ thượng nguồn). Kết quả của nghiên cứu này sẽ hỗ trợ cho các nhà lập chính sách tại ĐBSCL trong việc đề xuất và triển khai những chính sách có hiệu quả trong việc giảm thiểu rủi ro xâm nhập mặn.

Ai thực hiện nghiên cứu này?

Nghiên cứu này thuộc chương trình nghiên cứu sinh của Ông Khổng Tiến Dũng tại trường Đại học Adelaide, Úc, dưới sự hướng dẫn của Giáo sư Mike Young, Tiến sĩ Adam Loch (Trung tâm nghiên cứu Lương thực toàn cầu), và tiến sĩ Jayanthi Thennakoon (hướng dẫn bên ngoài).
Nghiên cứu sinh này được tài trợ bởi AusAID, quản lý bởi Bộ Thương Mại và Ngoại giao Úc.

Nhóm điều tra viên cho nghiên cứu này là các cán bộ và sinh viên năm cuối thuộc Bộ môn Kinh tế Nông nghiệp, Khoa Kinh tế, trường Đại học Cần Thơ, Việt Nam, nhóm nghiên cứu này có nhiều kinh nghiệm trong việc thu thập số liệu và đã được tập huấn và đào tạo bài bản.

Tại sao tôi được mời phỏng vấn?

Chúng tôi đang thực hiện dự án nghiên cứu về ảnh hưởng của xâm nhập mặn đến hoạt động và tìm hiểu hành vi thích ứng và sẵn long chi trả để giảm thiểu rủi ro. Kết quả của nghiên cứu nhằm giúp phát triển chính sách nông nghiệp trong vùng ĐBSCL, cụ thể là ở các tỉnh Bạc Liêu, Bến Tre, Hậu Giang và Kiên Giang. Vì là nông hộ cư ngụ ở các khu vực này, nên Ông/Bà đã được chọn ngẫu nhiên để tham gia.

1

Tôi sẽ được hỏi về những điều gì?
Ông/Bà sẽ được mời tham gia trả lời phỏng vấn tại nhà và sự tham gia là tuyệt đối tự nguyện. Không có bất cứ hình phạt nào nếu không tham gia và ông bà được chọn ngẫu nhiên. Ông/Bà sẽ được hỏi các thông tin về hoạt động nông nghiệp, ảnh hưởng của xâm nhập mặn lên đồng ruộng, phương pháp thích ứng và sẵn lòng chi trả cho sự giảm thiểu rủi ro này.

Buổi phỏng vấn sẽ kéo dài trong bao lâu?

Thời gian dự kiến là khoảng 50 đến 60 phút. Sẽ chỉ phỏng vấn một lần duy nhất.

Có rủi ro nào không khi tham gia trả lời phỏng vấn?
Tất cả thông tin liên quan sẽ được giữ bí mật. Ông/Bà chỉ phải bỏ thời gian khoảng 1 giờ để trả lời phỏng vấn. Tuy nhiên, bảng câu hỏi đã được thiết kế để giảm thiểu thời gian trả lời.

Lợi ích từ dự án này là gì?
Kết quả của dự án này sẽ hỗ trợ các nhà làm chính sách ở ĐBSCL trong việc phát triển những chính sách có hiệu quả nhằm giảm thiểu rủi ro xâm nhập mặn vào hoạt động sản xuất nông nghiệp. Do đó, dự án có thể giúp nông hộ thích ứng với các ảnh hưởng từ xâm nhập mặn (bao gồm giảm chất lượng nước, giảm diện tích gieo trồng, giảm thu nhập v.v).

Tôi có thể xin ngừng phỏng vấn không?
Đáp viên trong nghiên cứu này tham gia hoàn toàn tự nguyện. Nếu Ông/Bà đồng ý tham gia, Ông/Bà có thể dừng bất cứ lúc nào. Ông/Bà sẽ không bị bất kỳ ảnh hưởng nào khi muốn dừng hoặc không tham gia trả lời.

Các thông tin của tôi sẽ được sử dụng như thế nào?
Chỉ các thành viên trong dự này mới được quyền tiếp cận bộ dữ liệu trong suốt quá trình khảo sát, phân tích và công bố kết quả. Kết quả nghiên cứu sẽ chỉ được trình bày bằng số tổng hợp. Hơn nữa, vì số quan sát là rất lớn nên chúng tôi đảm bảo rằng khả năng để xác định thông tin cá nhân của đáp viên là rất khó, do vậy các thông tin cá nhân sẽ được giữ kín.

Kết quả của dự án sẽ được công bố trong luận văn tiến sĩ và các bài báo. Tất cả các tài liệu liên quan sẽ được giữ bởi Giáo sư hướng dẫn chính (Giáo sư Young) ở trung tâm lương thực toàn cầu và tài nguyên, Khoa chuyên nghiệp, Đại học Adelaide ở Úc trong một máy tính có mật khẩu ít nhất là 5 năm, phù hợp với điều luật của nước Úc về Nghiên cứu Khoa học có trách nhiệm.

Một bản báo cáo tóm tắt cũng sẽ được gửi đến chính quyền địa phương khi hoàn tất.

Tôi sẽ liên hệ với ai nếu tôi có thắc mắc về dự án này?
Ở Úc:

1. Giáo sư Mike Young, Trung tâm lương thực toàn cầu và tài nguyên, trường Đại học Adelaide

Điện thoại: +61 8 8313 5279 (mike.young@adelaide.edu.au)

2. Tiến sĩ Adam Loch, Trung tâm lương thực toàn cầu và tài nguyên, trường Đại học Adelaide

Điện thoại: +61 8 8313 9131 (adam.loch@adelaide.edu.au)

3. Tiến sĩ Jayanthi Thennakoon, Trung tâm lương thực toàn cầu và tài nguyên, trường Đại học Adelaide

Điện thoại: +61 434017673 (jayanthi.thenakoon@adelaide.edu.au)

Ở Việt Nam:
Ông Khổng Tiến Dũng, Bộ môn Kinh tế Nông nghiệp, Khoa Kinh tế, trường Đại học Cần Thơ
Điện thoại: +84 939 006222 hoặc +84 7103 838831
(ktdung@ctu.edu.vn or tiendung.khong@adelaide.edu.au)

Nếu như có khiếu nại hoặc quan tâm tôi sẽ liên hệ với ai?
Nghiên cứu này đã được phê duyệt bởi Hội đồng về Đạo đức nghiên cứu có liên quan đến con người ở trường Đại học Adelaide (Mã số phê duyệt H-2016-xxx). Nếu Ông/Bà có câu hỏi hoặc vấn đề gì liên quan đến việc tham gia trả lời phỏng vấn, hoặc muốn có bất kỳ quan tâm, khiếu nại nào về dự án, Ông /Bà có thể thông báo với Giáo sư Mike Young (ở Úc) hoặc Ông Khổng Tiến Dũng (Ở Việt Nam) như địa chỉ ở trên. Mặt khác,Ông/Bà có thể liên hệ với ban thư ký Hội đồng về Đạo đức nghiên cứu liên quan đến con người qua số điện thoại +61 8 8313 6028 hoặc email gửi tới hrec@adelaide.edu.au hoặc Ông Võ Thành Danh thuộc Viên nghiên cứu Biến đối khí hậu – MEKONG, Việt Nam ở số +84918508192 hoặc email: vtdanh@ctu.edu.vn nếu Ông/Bà muốn nói chuyện với một người độc lập với dự án về sự quan tâm hoặc khiếu nại đó, hoặc các chính sách của Trường về các nghiên cứu liên quan đến con người hoặc quyền lợi của Ông/Bà. Bất cứ câu hỏi, khiếu nại hoặc quan tâm của Ông/Bà sẽ được giữ kín và tìm hiểu kỹ. Ông/Bà sẽ được thông báo kết quả.

Nếu tôi muốn tham gia phỏng vấn, tôi sẽ làm gì?
Vui lòng đọc kỹ thông tin trên bản khiếu nại, bản thông tin đáp viên, và bản giấy chấp thuận. Nếu Ông/Bà đồng ý với các điều khoản trên các bản thông tin đó, vui lòng ký và gửi lại cho phỏng vấn viên. Sau đó, sẽ bắt đầu trả lời câu hỏi.

Trân trọng,
Giáo sư Mike Young
Tiến sĩ Adam Loch
Tiến sĩ Jayanthi Thennakoon
Ông Khổng Tiến Dũng

Appendix 9. Consent Form (English)

THE UNIVERSITY of ADELAIDE

Human Research Ethics Committee (HREC)

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	**Economic analysis of farm households' perception, adaptation behaviour and attitudes to salinity intrusion risk in the Mekong River Delta (MRD)**
Ethics Approval Number:	**H-2016-123**

2. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

4. Although I understand the purpose of the research project it has also been explained that involvement may not be of any benefit to me.

5. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

6. I understand that I am free to withdraw from the project at any time.

7. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: ____________________ Signature: _______________________ Date:___________

Researcher/Witness to complete:

I have described the nature of the research to_______________________________________
(print name of participant)

and in my opinion she/he understood the explanation.

Signature: __________________ Position: ________________________ Date:___________

2013_consent_form_for_ participation_non_medicalhealth_research_only.docx

Appendix 10. Consent Form (Vietnamese)

THE UNIVERSITY of ADELAIDE

Hội Đồng Đạo Đức nghiên cứu về con người (HREC)

PHIẾU CHẤP THUẬN

1. Tôi đã đọc bảng thông tin đáp viên và đồng ý tham gia vào dự án nghiên cứu sau đây:

Tên:	**Phân tích kinh tế về nhận thức của nông hộ, hành vi ứng phó và thái độ đối với rủi ro xâm nhập mặn ở đồng bằng sông Cửu Long (ĐBSCL)**
Mã số duyệt của Hội đồng	**H-2016-123**

2. Tôi đã được giải thích đầy đủ và hài lòng về các thông tin về dự án và các ảnh hưởng có thể có đến tôi, tôi chấp thuận tham gia dự án một cách tự nguyện.

3. Tôi đã được tạo điều kiện để có sự hiện diện của thành viên trong gia đình hoặc một người bạn tại thời điểm thông tin dự án được cung cấp.

4. Mặc dù tôi được giải thích mục đích của dự án, nhưng tôi cũng được thông báo rằng tham gia vào dự án có thể không mang lại cho tôi bất kỳ lợi ích gì.

5. Tôi đã được thông báo rằng, thông tin thu thập bởi nghiên cứu này có thể được xuất bản, nhưng thông tin cá nhân của tôi sẽ không được tiết lộ

6. Tôi hiểu rằng tôi có thể rút khỏi dự án bất kỳ lúc nào.

7. Tôi biết rằng tôi nên giữ một bản photo của phiếu chấp nhận này, sau khi hoàn thành và đính kèm vào bảng thông tin đáp viên.

Hoàn thành bởi đáp viên:

Tên: ______________________ Chữ ký: _________________________ Ngày: __________

Hoàn thành bởi Nghiên cứu viên/người chứng kiến:

Tôi đã mô tả bản chất của nghiên cứu này cho ______________________________________
(tên của đáp viên)

Và theo tôi, bà ấy/ông ấy đã hiểu rõ nội dung.

Ký tên: ____________________ Chức vụ: _________________________ Ngày: __________

2013_consent_form_for_ participation_non_medicalhealth_research_only.docx

Appendix 11. Respondent rate (n=146) of perceived salinity intrusion impacts on farm households and regional issues (percent)

	Dimensions	Scale (from 1-no effect to 7-extreme effect						
		1	2	3	4	5	6	7
Households issues	Income	0	4.79	10.96	19.86	26.03	15.75	22.60
	Housing value	62.33	11.64	6.85	9.59	4.79	4.79	0
	Farm land value	36.99	15.07	13.70	11.64	8.22	7.53	6.85
	Agriculture output and productivity	2.05	15.75	13.70	18.49	18.49	13.01	18.49
	Water supply for agricultural activities	7.59	8.97	11.03	22.07	19.31	13.10	17.39
	Water supply for daily lives	32.19	21.23	7.53	6.16	11.64	13.70	7.53
	Physical health	32.19	23.29	13.01	8.22	16.44	5.48	1.37
	Mental health (worrying)	8.22	13.01	11.64	23.97	15.75	10.27	17.12
	Households' habitation environment	30.99	11.97	21.83	18.31	5.63	7.04	4.23
Regional issues	Regional food security	23.29	16.44	15.75	21.23	11.64	8.90	2.74
	Regional economic	13.19	11.81	20.14	19.44	19.44	12.50	3.47
	Regional habitation environment	24.66	18.49	13.01	20.55	14.38	4.11	4.79

Appendix 12. Respondent rate (n=441) of expected salinity intrusion impacts on farm households' and regions over the next 3 years (percent)

	Dimensions	**Scale (from 1-no effect to 7-extreme effect)**						
		1	2	3	4	5	6	7
Households issues	Income	0.45	2.27	4.76	5.44	5.44	13.38	68.25
	Housing value	15.19	4.76	12.24	23.36	9.75	27.44	7.26
	Farm land value	6.80	4.08	3.85	11.79	9.52	12.93	51.02
	Agriculture output and productivity	0	2.04	2.72	4.99	7.71	25.17	57.37
	Water supply for agricultural activities	0	0.45	7.94	5.67	9.52	29.93	46.49
	Water supply for daily lives	6.36	6.36	3.64	17.50	13.86	32.27	20.00
	Physical health	7.26	8.39	9.98	28.80	19.73	19.73	6.12
	Mental health (worrying)	0.91	2.72	4.54	14.51	18.37	30.39	28.57
	Households' habitation environment	6.58	2.27	7.94	35.15	18.14	24.26	5.67
Regional issues	Regional food security	5.67	3.40	4.54	16.78	15.42	38.32	15.87
	Regional economic	3.40	3.17	7.94	14.51	13.83	29.48	27.66
	Regional habitation environment	6.80	4.31	8.62	20.18	19.27	31.07	9.75

Appendix 13. Respondent rate (n=441) of causes of salinity intrusion, as perceived by farm households (percent)

Causes of salinity intrusion	Scale (from 1-less important to 4-most important)			
	1	2	3	4
Sea level rises	11.79	20.18	34.01	34.01
River flow changes (upstream development)	26.08	26.53	29.48	17.91
Droughts	11.56	28.12	29.71	30.61
Increase in water demand in the MRD	50.79	24.26	7.03	17.91

Appendix 14. Respondent rate (n=146) of the effectiveness of salinity adaptation strategies adopted by farm households (per cent[48])

	Dimensions	Scale (from 1-very ineffective to 7-very effective)						
		1	2	3	4	5	6	7
Group 1. Non-engineering adaptation measures	Changing planting time	2.05	1.37	4.11	28.08	15.75	13.70	17.81
	Using short-term varieties	7.53	6.85	8.90	18.49	14.38	8.90	5.48
	Re-planting	5.48	4.79	12.33	11.64	11.64	0	4.11
	Changing to salt-tolerant varieties	1.37	3.42	6.16	10.96	2.74	19.18	10.96
	Changing the fertilizer schedule	6.85	3.42	11.64	17.12	4.11	14.38	4.11
	Changing fertilizer use	9.59	5.48	12.33	13.70	14.38	10.27	6.85
	Changing the chemical schedule	8.90	6.16	7.53	13.01	13.01	8.90	4.79
	Changing chemical use	8.22	13.01	7.53	21.23	10.27	10.27	6.85
	Changing the irrigation schedule	4.17	5.56	9.72	14.58	13.89	9.72	23.61
Group 2. Engineering adaptation measures	Heightening, maintaining individual dikes	0	2.84	3.55	7.80	12.06	14.18	11.35
	Dredging canals on farms	0	8.62	1.72	8.62	7.76	23.28	27.59
	Building/repairing wells	7.77	6.80	17.48	15.53	8.74	3.88	8.74
Group 3. Hydro management adaptation measures[49]	Increased water storage in dams, ponds	4.17	2.08	8.33	9.38	17.71	19.79	11.46
	Increased water filtering	9.41	0	14.12	10.59	15.29	12.94	5.88
	Appling water saving techniques	4.08	4.08	20.41	13.27	15.31	7.14	9.18
	Buying water from bordered areas	17.72	16.46	8.86	10.13	0	6.33	0
Group 4. Other	Getting information from local authorities	1.64	3.28	8.20	18.85	13.11	21.31	29.51

[48] The aggregate percentage in some is less than 100 per cent since several households have not applied adaptation measures/strategies
[49] Hydro management adaptation strategies may also relate to drought risk, however, based on farm households' experience and local government officials' knowledge, they can be treated as salinity intrusion adaptation measures in MRD

	Dimensions	Scale (from 1-very ineffective to 7-very effective)						
		1	2	3	4	5	6	7
adaptation measures	Getting information from TV, or radio about warning information	1.54	3.85	7.69	25.38	13.08	24.62	20.77
	Human insurance (for injury and illness)	2.63	22.37	13.16	7.89	13.16	7.89	5.26
	Agricultural insurance	0	0	0	0	0	0	0
	Changing from rice to aquaculture	30.56	16.67	6.94	8.33	2.78	2.78	0
	Changing from rice to livestock	10.34	17.24	11.49	9.20	5.75	14.94	9.20
	Participate in off-farm activities	22.35	23.53	11.76	9.41	2.35	5.88	2.35
	Migrate to other places	0	2.70	0	0	0	0	4.05

Appendix 15. Respondent rate (n=441) of intended future salinity adaptation strategies (percent)

	Dimensions	Scale (from 1-strongly disagree to 7-strongly agree)						
		1	2	3	4	5	6	7
Group 1. Non-engineering adaptation measures	Changing planting time	2.27	1.36	3.85	33.33	24.72	11.56	22.90
	Using short-term varieties	5.22	3.17	4.08	37.19	25.40	10.20	14.74
	Re-planting	15.42	6.58	7.71	52.15	12.24	3.17	2.72
	Changing to salt-tolerant varieties	2.72	1.81	2.27	14.74	11.34	13.83	53.29
	Changing the fertilizer schedule	7.03	3.85	6.12	20.41	25.85	26.76	9.98
	Changing fertilizer use	4.54	4.31	3.17	21.32	27.44	30.39	8.84
	Changing the chemical schedule	7.71	3.17	4.08	20.18	36.05	20.41	8.39
	Changing chemical use	3.85	4.08	3.40	24.04	31.29	22.90	10.43
	Changing the irrigation schedule	5.23	2.05	3.86	17.50	17.50	33.86	20.00
Group 2. Engineering adaptation measure	Heightening, maintaining the individual dikes	10.66	5.44	4.54	11.11	9.30	8.84	50.11
	Dredging canals on farms	8.84	4.76	4.54	11.56	7.48	12.47	50.34
	Building/repairing wells	12.70	9.30	6.58	22.68	9.98	20.18	18.59
Group 3. Hydro management adaptation measures	Increased water storage in dams, ponds	16.10	11.34	4.99	24.94	21.77	11.56	9.30
	Increased filtering of water	9.98	4.08	3.63	13.38	10.88	21.54	36.51
	Appling water saving techniques	7.94	3.17	4.76	9.30	8.62	38.55	27.66
	Buying water from bordered areas	37.50	8.18	5.23	36.59	6.59	2.27	3.64
Group 4. Other adaptation measures	Getting information from local authorities	3.40	1.81	4.08	12.47	9.98	31.75	36.51
	Getting information from TV, radio about warning information	1.59	1.81	3.17	11.79	11.79	29.48	40.36
	Human insurance (for injury and illness)	12.24	4.54	12.24	35.83	18.37	7.26	9.52
	Agricultural insurance	15.42	10.43	8.39	21.77	8.16	11.34	24.49
	Changing from rice to aquaculture	24.55	12.27	14.55	15.23	20.91	10.68	1.82

Dimensions	Scale (from 1-strongly disagree to 7-strongly agree)						
	1	2	3	4	5	6	7
Changing from rice to livestock	14.97	8.84	11.56	18.37	13.61	27.44	5.22
Participating in off-farm activities	14.74	13.61	12.70	44.44	5.90	2.95	5.67
Migrate to other places	53.06	6.58	4.99	29.25	1.81	1.59	2.72

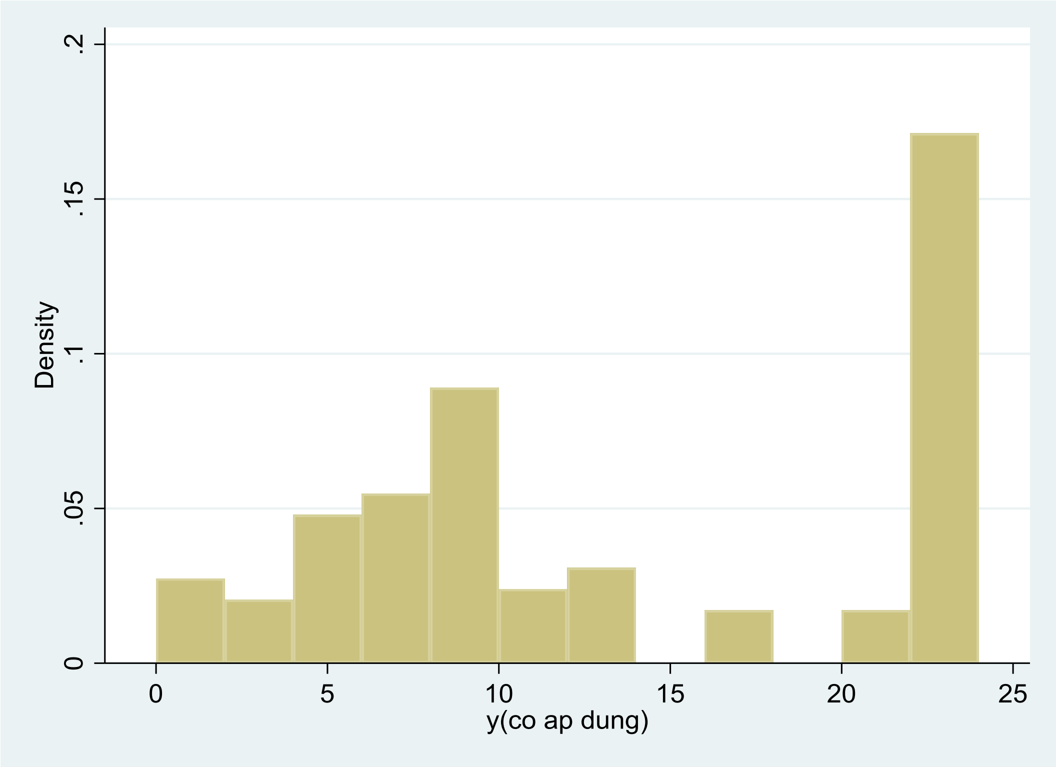
Appendix 16. Respondent rate (n=146) of the effectiveness of adaptation measures implemented by local authorities to deal with salinity intrusion (per cent)

Dimensions	Scale (from 1-very ineffective to 7-very effective)						
	1	2	3	4	5	6	7
Training	2.74	3.42	7.53	12.33	17.81	9.59	6.85
Damage subsidy	0	1.37	1.37	12.33	10.27	7.53	4.11
Implementation of early warning systems	0	2.74	2.05	13.70	8.22	10.96	13.70
Propaganda programs on TV, radio and newspapers	1.37	1.37	4.79	21.92	27.40	5.48	19.18

Appendix 17. Respondent rate (n=441) of farm households' preferences for future public strategies (per cent)

Dimensions	Scale (from 1-strongly disagree to 7-strongly agree)						
	1	2	3	4	5	6	7
Implementation and heightening of the current sea dike system	2.49	1.81	3.40	11.34	11.79	8.84	60.32
Converting to concrete sea dikes	1.81	4.08	3.85	14.51	15.42	31.75	28.57
Implementation and heightening of sluice/river mouth gates	0.45	2.27	3.85	12.47	16.55	32.43	31.97
Mangrove forest reforestation	4.08	2.72	5.67	12.93	12.93	29.25	32.43
Implementation and upgrading fresh water supply systems	0.68	1.13	5.44	7.48	15.19	16.10	53.97
Supporting short-term varieties of crops	1.81	4.76	3.85	20.41	27.66	17.69	23.81
Supporting salt-tolerant varieties of crops	0.45	2.95	0.45	7.94	5.44	19.73	63.04
Supporting changing crops	11.56	6.35	5.90	15.65	19.95	25.17	15.42
Supporting water storage tanks/containers	1.13	5.44	4.31	15.65	15.42	26.76	31.29
Training	0.91	2.04	1.81	9.52	12.47	26.53	46.71
Damage subsidies	0.45	3.40	4.31	9.75	9.07	23.81	49.21
Implementation of early warning systems	0.68	1.13	4.31	9.75	7.71	25.17	51.25
Propaganda programs on TV, radio and newspapers	0	1.36	4.08	14.06	8.16	24.49	47.85

Appendix 18. Histogram of adaptation strategies choices (y(co ap dung) indicates the number of adaptation strategies has been applied by farm households)



Appendix 19. Correlation matrix of determinants of WTP for salinity intrusion

	bid1	gender~1	hocvan	kinhng~m	hhmem	income~m	location
bid1	1.0000						
gendernam0~1	-0.0114	1.0000					
hocvan	-0.0277	-0.1126	1.0000				
kinhnghiem	0.0114	-0.1990	-0.2435	1.0000			
hhmem	0.0805	-0.0789	-0.0218	0.0251	1.0000		
incomenam	-0.0593	-0.1612	0.0674	0.1271	0.1355	1.0000	
location	0.0057	0.0490	-0.0834	-0.0014	0.0124	-0.0071	1.0000

Appendix 20. Mean WTP (US$) estimates of the different Groups by non-parametric method

	Own WTP	*Neighbour* WTP	*Reflected-Self* WTP
Group 1	2.58	2.02	2.2
	(VND 58,561)	(VND 45,890)	(VND 50,000)
(95% confidence intervals)	(US$2.07-3.08)	(US$1.51-2.52)	(US$1.70-2.69)
Group 2	1.99	1.59	1.59
	(VND 45,172)	(VND 36,206)	(VND 36,207)
(95% confidence intervals)	(US$1.48-2.49)	(US$1.08-2.09)	(US$1.08-2.09)
Group 3	1.32	0.91	0.79
	(VND 30,000)	(VND 20,667)	(VND 18,000)
(95% confidence intervals)	(US$0.81-1.82)	(US$0.40-1.41)	(US$0.29-1.29)

Appendix 21. Mean WTP (US$) estimates by parametric method

	Own WTP	*Neighbour* WTP	*Reflected-Self* WTP
Mean WTP	5.44	4.42	4.55
	(VND 123,591)	(VND 100,309)	(VND 103,284)
(95% confidence intervals)	(US$5.15-5.73)	(US$4.13-4.71)	(US$4.26-4.84)

Appendix 22. Tests for Sample Unit Nonresponse Bias (n=441)

Variable	Respondents (Yes)		Respondents (No and Do not know)		Test Statistic
	Mean	std	Mean	std	
Age	47.50	0.58	47.27	0.79	t=0.2404[ns]
Education	2.19	0.074	2.18	0.078	t=0.1405[ns]
Household members	4.29	0.076	4.27	0.099	t=0.1517[ns]
Gender	0.177	0.023	0.16	0.027	t=0.3489[ns]
Experience	24.21	0.670	22.24	0.816	t=0.1.8629[*]

Notes: *: statistically significant at 10% levels; ns: not statistically signigicant

Appendix 23. Coefficients and Marginal effects (dy/dx) of MRD farm household WTP for salinity intrusion programs, Protest "3 and 4" removed

Dependent variable: WTP (1=Yes, 0=No/Do not know)	Model 1 *Own*	
Independent Variables	Coefficient	ME (dy/dx)
Bid value	-0.0192*** (0.0023)	-0.0045*** (0.00054)
Household head's gender	-0.3327 (0.3792)	-0.0797 (0.0309)
Household head's education	-0.0299 (0.1319)	-0.0070 (0.0309)
Household head's farming experience	-0.0386*** (0.0141)	-0.0091*** (0.0033)
Farm household size	0.0523 (0.1127)	0.0122 (0.0264)
Farm household income	6.17e-06*** (1.67e-06)	1.45e-06*** (0.0000)
Farm location	0.2895 (0.2902)	0.0673*** (0.06688)
Constant	3.1487*** (0.7846)	-
Log-Likelihood	-152.22266	
Pseudo R-square	0.2787	
Prob>chi2	0.0000	
N (sample size)	311	

Notes: ***, **, and * is statistically significant at 1%, 5% and 10% levels, respectively. The standard deviation in parentheses. Marginal effects of Logit model are not available for the constant term.

Appendix 24. Khong, T.D., Young, M.D., Loch, A., Thennakoon, J., 2018. Mekong River Delta farm-household willingness to pay for salinity intrusion risk reduction. Agricultural Water Management 200, 80-89.