Multidimensional Indicators of Adaptive Capacity of Rice Farming Households to Address Saltwater Intrusion in the Philippines and Vietnam

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The vast majority of research on natural hazards in the Philippines and Vietnam tends to focus on risk estimation and modelling rather than adaptive capacity, especially the case of saltwater intrusion. This study aimed to analyze adaptive capacity of rice-farming households. This research was conducted to determine more comprehensively the multidimensional indicators of adaptive capacity of rural farming households to address saltwater intrusion in the two countries. The main objective of this study is to employ mixed method design to develop measure-based index to account for adaptation processes and define household-level variables that will potentially explain adaptive capacity by means of an explanatory factor analysis and a regression model. The results of the research show that the developed index captures the complexity of adaptation processes that address a number of shortcomings of previous studies. The results of the determinants of adaptive capacity were consistent with existing literature but more importantly models were developed specific to rural rice-farming households in the two countries and in the context of saltwater intrusion.

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INTRODUCTION

Background of the Study

There are very few evidence-based and empirically derived information to support the adaptation to climate change under local conditions. It is necessary to carry out research in the field to understand not only who may be more or less vulnerable, but also what factors influence adaptive capacity (Cutter, Boruff, & Shirley, 2003; Kriegler et al., 2012). Climate change adaptation and responses depend not only on changes in climate parameters but also on interaction between these parameters and changes over the same periods under certain socio-economic conditions (Arbuckle, Morton, & Hobbs, 2015a; Below, Mutabazi, Kirschke, Franke, & Sieber, 2012; Eakin & Bojórquez-Tapia, 2008; Fothergill & Peek, 2004).

Assessments of adaptive capacity to climate change hazards are not new and more research is needed, particularly regarding slow-onset hazards. Slow-onset hazards tend to receive less attention due to their gradual development which often goes unnoticed in the early phases (N. Adger, Agrawala, Monirul, & Mirza, 2007; Agrawal & Lemos, 2015; Kirchhoff, Lemos, & Dessai, 2013; Mohammed Nasir Uddin, Bokelmann, & Entsminger, 2014a). Most discussion of slow-onset hazards focuses on drought but these hazards can also include saltwater intrusion (Safi, Smith, & Liu, 2012; Samoilys et al., 2007; Smit & Wandel, 2006). It is considered a slow-onset hazard and appropriate actions in the early phases are needed in order to avoid damage to livelihoods before they reach an acute phase (Binh, 2015a; Khanom, 2016; UNFCCC, 2012). Hence, this research will be conducted to determine more comprehensively the multidimensional indicators of adaptive capacity of rural rice farming households to saltwater intrusion in the

Philippines and Vietnam. It is well-known that rice is a staple food in these two countries, thereby climatic factors affecting production could impact food security. In certain stage, a combination of stresses may exceed the coping capacity of vulnerable socio-ecological systems, raising the risk that could adversely affect food security goals and eventually outcomes of community development due to the lack of a timely response (Arbuckle et al., 2015a; Byrne, 2014; De Bruin et al., 2009). The losses from creeping hazards may be even more substantial than in the case of sudden-onset hazards (Bryan et al., 2013).

Clearly, slow-onset hazards such as salt-water intrusion require appropriate responses in its earlier stage in order to avoid damages to people's livelihoods in certain situation before they reach an acute phase (Arbuckle et al., 2015a). According to the International Rice Research Institute (IRRI) in 2010, flooding of rice fields periodically occurs in about 15 million to 20 million hectares of Asia's rice fields. The Food and Agriculture Organization (2010), on the other hand, estimated that about 6.5% or 831 million hectares of the world's total area is affected by salt-water intrusion.

Vietnam and Philippines present an opportunity for investigation of these issues as these two countries are some of the most threatened by sea level rise and saltwater intrusion, with global ranking at number four and seven, respectively (Khang, Kotera, Sakamoto, & Yokozawa, 2008). Saltwater intrusion in rice farms in Vietnam are already well-studied because the increasing frequency and scale. Several adaptation measures were already implemented such as suitable salt tolerant rice varieties, as well as climate smart land and crop management measures that are suitable to future climate scenarios and extreme weather events (CGIAR Research Centers in Southeast Asia, 2016; Danh & Khai, 2014; Thuy & Anh, 2015). On the other hand, in the Philippines, saltwater intrusion in rice farms remains largely undocumented, especially in Northern Mindanao but field reports from farmers is suggestive of the incidence becoming an increasing concern. More so, the acknowledgement of slow onset impacts of climate change in the country is a recent phenomenon and the literature on adaptive indicators and measures to combat saltwater intrusion is very limited (ICSC, 2015).

This study analyzed adaptive capacity of rural farming households to the saltwater intrusion hazard considered as slow onset event. The primary reason in pursuing this study is the limited multidimensional studies and approaches to analyzing adaptive capacity of rural farming households to saltwater intrusion in the two countries. To date the vast majority of research on natural hazards tends to focus on risk estimation and modelling rather than adaptive capacity, especially the case of saltwater intrusion (Karila, Nevalainen, Krooks, Karjalainen, & Kaasalainen, 2014; Khang et al., 2008; Thuy & Anh, 2015). Indeed, it is important to investigate the risks and vulnerabilities of changing bio-physical conditions on the rural farming households' livelihoods but equally important is to analyze how rural farming households are affected and react to the impacts. Hence, this research will be conducted to determine more comprehensively the multidimensional indicators of adaptive capacity of rural farming households to saltwater intrusion especially the most important indicators to specific adaptation measures to prepare for a future certain to be full of surprise and for devising better intervention policies to coastal zones in the two countries.

Vast literature suggested human adaptations to changing needs and socio-economic conditions and the concept of innovation draws attention to the broader, collective dimensions of adaptive practices. There is a need for a more retrospective analysis to understand the factors influencing the rural famers to adapt different measures to address saltwater intrusion in specific locations in the two countries. The investigation of local adaptation practices with a focus on historical experience, social and institutional conditions may guide in understanding social dynamics and uncover important loci of innovation. This will have strong implications on enabling policies and actions to support the implementation of various adaptive strategies much needed in offsetting the negative impacts of saltwater intrusion and climate change. Philippines can learn from Vietnam in its experience in terms of implementing technical practices at the farm level and consider how they can be implemented more strategically and more effectively. In the same token, there may be new information that Vietnam can learn from the Philippine experience. Both countries may integrate these insights into the existing agricultural management practices and the improvement of technical skills and capital investment to address constraints especially of the small-scale subsistence agriculture rice farmers.

Review of Literature

Rice farmers work in a system of great unreliability. A complicated interaction exists between the many parameters of production which depends on factors that are more or less out of the control of the individual farmer. Nevertheless, farmers in Southeast Asia have developed practices and strategies to cope with uncertainties and continuously create more resistant and resilient production systems to address saltwater intrusion. There are a range of options. One of these is selection of appropriate planting date. The planting date can have a dramatic effect on the development and yield of the crop (FAO, 2007). Another is the use of traditional varieties with high resilience and breeding of new varieties with higher resistance to salinity. A report conducted by the Australian Centre for International Agricultural Research has demonstrated that the average annual value is equivalent to USD127/ha (in 2009 values) across the average rice area in southern Vietnam of over 4.2 million ha/year since 1985. This is significantly higher than the average value per hectare for the Philippines (USD52/ha) and Indonesia (USD76/ha) (Brown, Dayal, & Rumbaitis Del Rio, 2012). In addition, appropriate infrastructure were built and research based rice-aquaculture practices were undertaken (Ahmed, Allison, & Muir, 2010).

Adaptive capacity is often viewed in terms of income, basic needs, security of person and property, sustainability, and empowerment/inclusion (Byrne, 2014; Ostrom, 2010). However, farmers' adaptation strategies are also largely influenced by social factors (Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009; Hinkel, 2011). On the other hand, Barnett and Adger (2007) cited that different social-ecological systems within a geographical area are impacted differently by climate change due to variations in socio-economic and biophysical features. In general, the poor and marginalized are the hardest hit due to their weak adaptive capacity and higher dependence on climate-sensitive natural resources for their livelihoods.

In most of the recent adaptation literature consistent with the concept of climate-related decisions, economic indicators predominantly constitute the multidimensional factors identified (Ahsan & Warner, 2014; Huber, 2005; Tesfahunegn, Mekonen, & Tekle, 2016; Mohammed Nassrasur Uddin, Bokelmann, & Dunn, 2017; Vaughan & Dessai, 2014). Some resource management agencies now stress climate change adaptation as a function of these economic indicators influenced by the demand for resources, environmental constraints, infrastructure, and technological change that, particularly in combination, could require changes in investment plans and business models (Bahinipati & Venkatachalam, 2015; Shikuku et al., 2017; Tompkins et al., 2010). In many less-developed regions which have limited success in reducing overall vulnerability, adaptive capacity, and exposure are critically influenced by existing structural deficits (low income and high inequality, lack of access to health and education, lack of security and political access, etc.). Most studies highlight that greater economic resources increase adaptive capacity, while a lack of financial resources limits adaptation options (W. N. N. Adger et al., 2014; Bergqvist, Holmgren, & Rylander, 2012; Campos, McCall, & González-Puente, 2014; Peria et al., 2016; Smit & Pilifosova, 2003; Truelove, Carrico, & Thabrew, 2015; Yohe & Tol, 2001). In terms of enhancing adaptive capacity Yohe and Tol (2001) made the point that getting markets to work properly may be an important part of adaptive capacity because they provide the incentives and flexibility which government policy may lack. Markets are also important as a device for learning.

In many instances, farmers are unaware of climate change and are less likely to apply agricultural measures that are effective in adapting to climate change. Thus, successful adaptation of farmers to climate change involves a two-stage process in which it is first necessary to perceive that climate change has occurred before deciding whether or not to apply an adaptive measure (Füssel, 2010). Adaptations to climate change often are not applied if the farmers are aware of climate change or recognize the problem and thus the necessity to adapt. Unawareness of climate change or its impact can occur if social habits and normative standards prohibit an understanding of the climatic stimulus (Smit & Wandel, 2006; Tompkins et al., 2010).

Summarily, the current literatures on multidimensional indicators are varied as indicated in Table 1.

Table 1. Indicators of Adaptive Capacity of Farming Households

Factors	Example
Biophysical	Favorable environment for integrated farming Great biodiversity of rice field flora and fauna Ecological relationship among biotic and abiotic components Low-lying rice fields with available water sources Sustainability of integrated farming Diversified cropping through integration Maintaining water quality and soil fertility
Economic	Income of farmers and associated groups Local marketing Diversified economies at household and community level Simple production technology Locally available inputs and fertilizer Post-harvest facilities
Social	Socially acceptable with receptive and supportive farming conditions Wider community involvement Social resilience including livelihood opportunity and food supply Social linkages and knowledge transfer
Institutional	Regulations and legal frameworks Cooperation among key stakeholders Institutional and organizational support Government support
Knowledge	Indigenous practices Past observations
Perceptions	Exposure to climatic conditions Predictions

However, studies applied to slow onset hazards such as saltwater intrusion in rice farms is quite limited as it is an emerging field in many parts of Asia (UNFCCC, 2012).

This resulted in little progress towards analytical or policy frameworks upon which interventions could be based. More studies are needed employing holistic approaches in analyzing the phenomenon. In view of the knowledge gaps, this research aims to conceptualize adaptive capacity and develop an analytical framework based on which effective assessment can be conducted. It will attempt to apply approach-based analysis of adaptation measures specific to slow onset events such salt-water intrusion to rice farms. Many of the studies recognize the fact that rice farmers have varied ways in adapting to saltwater intrusion influenced by multiple factors. Studying these factors are fundamental in the formulation of well-designed interventions for the adverse effects of such hazard targeted at the rice sector to ensure food security in the country.

Objectives

This research aimed to determine the indicators of adaptive capacity of rice farming households to salt-water intrusion in the Philippines and Vietnam. Specifically, it aimed to:

1. Describe the selected farms in terms of
    - 1.1 biophysical characteristics
    - 1.2 rice farming practices
    - 1.3 local institutions influencing farming practices
    - 1.4 market conditions
2. Describe the rice-farming households in terms of
    - 2.1 social characteristics
    - 2.2 economic characteristics

2.3 institutional affiliations

3. Discuss the existing knowledge and perceptions rice-farming households have on salt-water intrusion;
4. Formulate an index of household adaptation measures to combat salt-water intrusion based on

    4.1 ecosystem-based adaptation

    4.2 technology-based adaptation

    4.3 farm-based crop management

    4.4 off-farm diversification

5. Determine the relationship between index of adaptation measures and adaptive capacity of the rice farming households in terms of

    5.1 social characteristics

    5.2 economic characteristic

    5.3 institutional affiliations

    5.4 knowledge and perceptions on salt-water intrusion

6. Come up with recommendations to address adaptation of rice-farming households to salt-water intrusion.

Methodology

Given the multidimensional nature of adaptation to climate change, the mixed-methods approach to research was employed in this research. This involved gathering of both numeric data as well as text data so that the final database represents both quantitative and qualitative data. It is suggested that a mixed approach provides a better understanding of the phenomenon (Creswell and Plano Clark, 2011).

Data Collection

Quantitative Data

Secondary data regarding the physical, natural and rice production conditions in the study site were gathered from different sources and organizations. Annual report on rice production were sourced from the Department of Agriculture (DA) Region 10 and the Municipal Agriculture Office of Plaridel, Misamis Occidental in the Philippines as well as the Ministry of Agriculture and Rural Development (MARD), provincial Department of Agriculture and Rural Development (DARDs) and local authorities in Vietnam. Data and information related to agriculture and crop damages due to coastal flooding were also collected from the same agencies. The data and information on weather and coastal flooding susceptibility were sourced from the Mines and Geosciences Bureau in the Philippines and the Vietnam Center Archive. Secondary data related to population, income and poverty rate were mainly obtained from the Philippine Statistical Authority (PSA) and Vietnam General Statistics Office (GSO).

The researchers sought formal endorsement and permission from the various heads of government units to collect secondary data and conduct the field survey, focus group discussions (FGDs), Key Informant Interviews (KIIs).

The researcher conducted a pre-test last August 5-6, 2017 which helped in the improvement of the survey questionnaires used for the farmers in Plaridel, Misamis Occidental, Philippines. The inputs gathered from the pre-test of the questionnaires were used as basis for the final and revised survey questionnaires encoded on the data collection app called Kobo Tool Collect.

Rapid rural appraisal (RRA) by Beck et. Al. (1997) was used to gain the first insights to understand the main characteristics of the communities, identify the most affected coastal barangays and verify the various information included in the survey instrument especially on the various saltwater adaptation measures implemented in the municipality (Appendix A). The rapid rural appraisal was conducted last August-September, 2017 through visits in the rice fields most susceptible to coastal flooding. A focus group discussion with these officials was also conducted to have an initial scoping on the conditions commonly experienced and to verify certain information included in the survey questionnaires. The researcher together with local officials did a transect walk and observation around the village to confirm the situation and the challenges discussed as well as to see the levels of vulnerability of various coastal rice farms to saltwater intrusion and the common adaptation strategies implemented in different social-ecological settings.

A survey questionnaire (Appendix B) was developed considering the four major objectives of the research pertaining to the demographic and socio-economic characterization of the rice-farming households and their institutional affiliations. It also included questions on rice production, their knowledge, awareness and perceptions on climate change and saltwater intrusion and measures for adaptation.

The surveyed data were automatically tabulated by the KoboTool Software which is downloadable into various formats such as Excel spread-sheet dataset and the exportable SPSS format. The preliminary data cleaning was done in Excel. Frequency counts and other descriptive statistics were employed to detect any errors that may have appeared during data entry. The copies of the original Excel and SPSS data files were kept untouched.

The researcher officially hired twelve research enumerators who have undergone series of trainings in the conduct of the field survey data gathering, starting from the pre-testing of the questionnaires up to the implementation of the survey using the Kobo Tool software. Each enumerator was required to sign the Enumerators' Term of Reference and was given the Enumerators' Manual for the strict adherence to the protocols of conducting the field survey activities.

The field surveys, FGDs and KIIS were conducted last September-November 2017. The survey was implemented through the Kobo Toolbox Software using mobile android devices, such as smartphones and tablets. The software is an open-source, fully transparent and flexible enabling the remote administration of the questionnaire. It also has the ability to synchronize and aggregate tabulated results. The generated results were downloadable in various formats.

Twelve enumerators were grouped into three (3) with four (4) enumerators. Each group had a local guide, who is knowledgeable on rice production and rice farmers and helped arranged for the interviewers. The local guides helped the enumerators identify the targeted farmers and rice-farming households. These arrangements were appropriate and useful. A field supervisor was also hired, who was responsible for supervising all the members of the group, checking questionnaires daily, and making reports to the researcher.

Participation of research respondents in the survey, FGDs and KIIs were based on the freely given informed consent and their participation did not expose them to any harm. Respondents were given information on the research objectives using terms that are understandable and meaningful to them. They were told what their participation in the research involved, who is funding the research and the likely use of the research findings when they are initially approached to take part in the research. They were given clear information and assurance about how the data will be reported, who will have access to it and on what terms, and about the confidentiality of information they provided in the course of the research. They were informed of the approximate duration of the data gathering (survey, FGD, KII), that they are free to withdraw from the interview or withhold information at any point and ask for further information about the study at any time. The questions asked and information given were communicated to the respondents in the local vernacular.

One interview is completed in forty-five minutes to one hour depending on the skill of the enumerator as well as the responding ability of the interviewee. On the average, each interviewer did seven questionnaires per day. The search for the right respondent was at times a challenge since most farmers are in the field during the day time.

Qualitative Data

The farming systems framework was used to collect, organize and analyze primary data on how farming systems in the study areas have evolved over time. The approach recognizes the biophysical production system, made up of crops, climate, soils *etc.*, the management system, including people, values, goals, knowledge, resources and decision making and the social, economic and institutional context in which they are situated (Keating and McBrown, 2001). Using such a framework enabled the analysis of the interconnectedness and interdependence of components simultaneously influencing farming systems, yet operating across a range of spatial scales.

The results from the FGDs and the KIIs were both used in the development of the survey questionnaire especially on the section which capture farmers' observations, experiences and perceptions on climate related events. The farmers' perceptions were sought by means of rating scales to evaluate the climate-related events in terms of frequency of occurrence, intensity and ability to manage the changes. The scales guided the farmers and community members on their evaluation of the stress levels posed by the different changes identified which included flooding, storms, droughts, erratic rainfall, hotter temperature and saltwater intrusion. The farmers were asked to assess the climatic events based on a given gradation where they were allowed to answer no change noted, or admit to having no knowledge. They were asked additional questions on the manner in which changes occurred and their perceptions of these changes.

The assessment of frequency of the event taking place in the municipality is based on the number of times the event occur yearly during the last ten years. That is, if it happens more than two times a year in the last five years, then it can be considered frequent. To understand the differences between farmers' perceptions of their exposure to climate variability and changes and the actual meteorological observations, rainfall and temperature data were obtained from existing reports. Rainfall and temperature are routinely measured at various stations distributed across Northern Mindanao, although not all municipalities have weather stations. Trends were analyzed to determine how scientific observations and farmers' experiences interrelate and to understand the factors influencing community experiences.

Ethno-history method was also employed in collecting information on the history of the rice production and farming practices in selected farms as well as drawing the experiences and perceptions of the farmers regarding saltwater intrusion.

Two FGDs were conducted simultaneously with the field surveys, one for a group of rice farmers and the other for Barangay officials from the various field survey sites. The FGDs included questions on existing conditions of the research locale and the rice farms, access to markets and infrastructure, institutional conditions and factors affecting rice farming such as local climate conditions, main agro-ecological zone, temperature, precipitation, number of rainy seasons and soil conditions; saltwater intrusion issues and concerns and adaptation measures.

FGDs with farmers from a set of representative barangay were also conducted with the aim of triangulating the information obtained from household survey, confirming the various potential response options to climatic change, including listing of climate events that may have influenced local strategies, and sketching out the main trends and changes in land use to understand to which extent changes can be explained by the adaptive strategies. The FGDs consisted of 8-14 participants with a group of women and a group of men in each barangay in order to ensure that views were as representative as much as possible of the population.

Key Informant Interviews (KIIs) were conducted to support the information on characterization of farms in terms of biophysical factors, rice farming practices and production system, strategies technologies based on opinions of experts and farmers. Interviews with key-informants (Municipal Agriculturists, Presidents of the irrigators Associations and Community Groups) were conducted with the aim of identifying main agricultural and natural resource management strategies, significant change patterns in the last 20 years and major socio-economic and biophysical drivers of land use change. Separate KIIs for agricultural experts and administrative entities were conducted to validate the iterative classification of adaptation measures and triangulation of empirical results from the survey. The FGDs and KIIs enabled the researcher to collect qualitative data and verify some primary data (Appendix G).

Sampling Procedure and Sample Size

The primary data used for the study was obtained from the survey of rice-farming households susceptible to saltwater intrusion and coastal flooding. A simple random sampling was used to obtain the effective sample size of 312 households from the official list of farmers in the selected barangays as documented by the Plaridel Municipal Office and 241 households for the two districts in Ben Tre and Tra Vinh in Vietnam. This is computed based on a total population of rice farming households, confidence level of 95% and margin of error at 0.05. The formula is based on the Raosoft Sample Size Calculator given below and the assumption of Normal distribution. The sample size *n* and margin of error *E* are given by:

$$n = {}^{Nx}/_{((N\text{-}1)E^2 + x)}$$
$$x = Z({}^{c}/_{100})^2\, r(100\text{-}r)$$
$$E = \text{Sqrt}\ [{}^{(N-n)x}/_{n(N\text{-}1)}]$$

where
N is the population size
r is the fraction of responses
Z(*c*/100) is the critical value for the confidence level.

After determining the sample size, cluster sampling was conducted for all the sites covered in this study to be able to choose a limited number of smaller geographic areas in which simple random sampling can be conducted. The official data on the size of the rice farming household population for each community was used.

The legitimate respondent is somebody who is knowledgeable in rice farming which means that the respondent should be actively involved throughout the various stages in the production of rice. The research team conducted the survey through personal interviews. The team completed 326 questionnaires were used for the Philippines with and 258 questionnaires were covered in Vietnam, wherein 134 for Tra Vinh and 124 for Ben Tre provinces.

Data Analysis

Mixed Method Approach

This research used multiple reference points where separate data sets are collected at the same time with the ultimate aim of merging the two data sets in a visual display using a matrix, transforming the qualitative data to quantify the adaptation measures and convert them to Measure-based Adaptation Index (MAI). In qualitative methods, adaptive capacity is analyzed by describable characteristics whereas under quantitative way it is measured using quantifiable characteristics. The literature review revealed that most publications have employed quantitative and qualitative approaches separately to measure adaptation to climate related hazards at different levels in different contexts whereas but there are limited studies combining both approaches (Cutter et al., 2003; Feleke, Berhe, Gebru, & Hoag, 2016).

Applying simultaneously different methodologies to assess adaptive capacity provided a broader understanding of the research. Considering the dynamic and multifaceted nature of adaptation, there is a need to enhance understanding through developing more comprehensive and holistic approaches (Singh & Hiremath, 2010). Therefore, an assessment of adaptive capacity to saltwater intrusion in this research was carried out by a mixed approach, a combination of both qualitative and quantitative tools for a better understanding of the potential adaptation measures and indicators of adaptive capacity.

Specifically, the concurrent mixed method design was employed in this research. Concurrent mixed method was employed through multiple reference points where separate data sets are collected at the same time with the ultimate aim of merging the two data sets. Qualitative data were gathered during the initial stages of the research and converted to coded responses for the research survey instrument. The survey instrument also incorporated open–ended questions. The results from the separate quantitative and qualitative components of the research was then confirmed, cross-validated, or corroborated on the findings within the study. This is a multi-strand design in which there are two relatively independent strands/phases: one with qualitative questions and data collection and analysis techniques and the other with quantitative questions and data collection and analysis techniques. The inferences made on the basis of the results of each strand are pulled together to form meta-inferences at the end of the study (Creswell and Plano Clark, 2011).

The simultaneous collection was done during the survey of both quantitative data indicating the socioeconomic characteristics of the farmers and their households and qualitative data in terms of the institutional affiliations, knowledge, awareness and perception levels regarding climate change related events and feasibility assessment of the various adaptation measures. The qualitative research questions involved uniform levels of familiarity and agreement through the use of structured responses. The structured response categories were identified in close consultation with farmers and agricultural specialists. Each set of structured questions in the survey instrument was followed by at least one open-ended and unlimited comment field, which was explicitly linked to the question set immediately preceding it.

Index Formulation

Several indices were formulated in this study. An index is a useful statistical measure which can depict changes in a representative group of individual data points.

In this research, the perception index for the various climate related events was formulated to indicate the varying levels of assessment in terms of frequency, intensity and manageability. To determine the perception index on the number of weather related changes perceived by the farmers within the last decade in relation to the indicators of change discussed above, an index adapted from the study of Below, Mutabazi, Kirschke, Franke, & Sieber (2012) was developed. The perception index is expressed as:

$$\mathrm{PI_j} = \sum_{i=1}^{1=m} C_{ij} \tag{1}$$

where:
$\mathrm{PI_j}$ = Number of perceived changes by the household
i: climatic event
j: individual farming household
Cij = Changes of the climate change related events indicators

To determine a unified level of awareness on saltwater intrusion, an index from the study of Below, Mutabazi, Kirschke, Franke, & Sieber (2012) was adapted. The index is expressed as:

$$ASWI = (S_1 + \cdots S_{10})/10 \tag{2}$$

The awareness index on saltwater intrusion (ASWI) is obtained by adding the total score of the farmers for the ten (10) items divided by ten.

This research also applied the multi-criteria analysis (MCA) in assessing the feasibility of adaptation measures to aid the development of the measure-based adaptation index (MAI). The MCA provides one systematic strategy for decision makers to make sense of the wide range of information that may be relevant to making adaptation choices (Eakin and Bojórquez-Tapia, 2008; Harrison and Qureshi, 2000; Rolland, 2013). Farmers were asked to assess different adaptation strategies by using five-point rating scale to rate the feasibility based on four criteria for each strategy applied. The weights were generated from the ranking of the farmers to determine the specific relevance of each measure related to saltwater intrusion. The weights were attributed with respect to the feasibility of the practices. A five point Likert scale was used for ranking, following the method of Wyatt and Meyers (1987).

To ensure all items were scored in the same direction, reverse recoding was undertaken for some of the answers of negatively framed questions based on the technique used by Zikmund & Babin (2010). All recoding, adding and calculating variables were processed using SPSS syntax command language. The use of syntax files helped to document changes that were made to the dataset.

A reliability test was performed using a licensed SPSS version 23 by determining the Cronbach's alpha, which is the most common measure of internal consistency. It is most applicable for this research in testing the farmers' level of awareness on climate change related events and saltwater intrusion phenomenon and their assessment of the feasibility of the various adaptation measures using the Likert scale.

This research applied quantizing process as in the case of transformation of adaptation measures to Measure-based Adaptation Index (MAI) adopted from Below et al. (2012). The construction of the index of the potential adaptation measures began with a step by step evaluation of the feasibility criteria that reflect their strength or weakness. The FGDs with farmers and the KIIs with the municipal agriculturists during the rapid rural appraisal contributed to the determination of the most important criteria for the choice of adaptation measures. These criteria were judged on the major considerations on the degree to which each measure would help or impede its adoption. The important criteria applied in this research are ability to implement the measure, the effectiveness, the cost of implementation and support from major stakeholders. To identify the adaptive strategies which held relative importance over others, farmers were asked during the survey to assess different measures by using a five-point rating scale to rate the ability to implement the measure, the effectiveness, the cost of implementation and support from major stakeholders for each measure to their rice production. The weights were generated from the average ranking of all the farmers to determine the feasibility of each measure related to saltwater intrusion. This approach prevents the arbitrariness of expert ranking and reduces the dependency of high computational skills and simple in operationalization.

The Adaptation Weight (AW) for each measure is obtained by dividing the average rating for each feasibility criterion of the ith respondent by most desirable score of each criterion and getting the sum for all criteria divided by the total number of criteria, thereby reducing the score to a scale of $0 \leq AS \leq 1$. This expressed as

$$AW_{ij} = \sum_{k=0}^{n} \{(A_j, E_j, C_j, S_j)/4\} \quad (3)$$

where:

AW_{ij}: represents the Adaptation Weight for the j^{th} household for a given measure i

i: the measure employed

j: individual farming household

k: Total measures employed

A: Ability of the farmer to implement the measure

E: Effectiveness of the measure

C: Cost of implementing the measure

S: Level of support from major stakeholders

T: the total number of criteria (T= 4)

To determine the Adaptation Score of the farmer for each measure the adaptation level is multiplied by the adaptation weight. The resulting Adaptation Score follows a scale $0 \leq AL \leq 1$.

$$AS_{ij} = AL_{ij} \ x \ AW_{ij} \tag{4}$$

where:

AS_{ij}: represents the Adaptation Score for the j^{th} farmer for a given measure *i*

i: the measure employed

j: individual rice-farming household

Individual scores for each measure were combined into a final score for the Measure-based Adaptation Index (MAI). The index was calculated as the sum of the weighted adaptation measures of the household. This is expressed as

$$MAI_{ij} = (AL_{ij} \ x \ AW_{ij} + \ldots AL_n \ x \ AW_n) \tag{5}$$

where:

MAIij = Measure-based adaptation index of rice-farming household *j* for all the *i* measures employed from 1- n

i: the measure employed

j: individual rice-farming household

n = the last *i* measure employed by the *jth* rice farming household

AL_{ij} = *jth* rice farming household's value for a given *i* measure employed ($0 \leq AL \leq 1$)

AW_{ij} = weighting factor for each adaptation measure *i* employed by the *jth* rice-farming household it is therefore necessary to standardize each as an index using the equation:

$$\text{Standardized Index} = \frac{MAI_{Actual} - MAI_{Minimum\ Value}}{MAI_{Maximum\ Value} - MAI_{Minimum\ Value}}$$

Standardization of variables resulted in MAI scores ranging from 0 to 1.

Statistical Analysis

The quantitative data from the household survey were analyzed by means of descriptive statistical methods, multiple linear regression techniques and explanatory factor analysis. Measures of the central tendency of key variables were computed to gain an initial overview of the socio-demographic, socio-economic, and farm characteristics, institutional affiliations, perceptions on climate change related events and level of awareness on saltwater intrusion and the current farming household measures for adaptation.

To determine the significant factors of farming households' adaptive capacity, a multiple linear regression analysis was conducted using a licensed SPSS version 23. The basic assumption is that adaptation measures depends linearly on rural households' farm, socio-demographic, economic, institutional affiliations and characteristics as well as their knowledge, awareness and perceptions on saltwater intrusion. The relevance of the explanatory variables attributed to the determinants of adaptive capacity is adopted from Chambers' (1989), as well as Yohe and Tol (2002) and the methodology of Below et.al. (2012). The resulting model was formulated using the following function:

MAI = f (farm characteristics, socio-demographic characteristics, socio-economic characteristics, institutional affiliations, knowledge, awareness and perceptions) + ε (6)

The relevance of the explanatory variables attributed to the determinants of adaptive capacity and the description of the explanatory variables and their expected relationship with MAI is provided in Table 2.

The main objective of this study was to come up with an empirical account of the adaptation processes and define household-level variables that potentially explain adaptive capacity. The entire process involved constructing and validating models and procedures, as well as establishing new techniques, and tools based on a methodical analysis of rural rice farmers adaptation to saltwater intrusion. It attempted to address the knowledge gaps and methodological constraints in terms of the formulation of more comprehensive indices and contextualization of the issue in various temporal scales under a place-based research in the assessment of rural rice farmers adaptive capacity to saltwater intrusion in order to provide reliable, usable information to development theorists, practitioners and policy planners.

Table 2 Explanatory Variables and Their Expected Relationship with Adaptation Measures

DIMENSIONS OF ADAPTIVE CAPACITY	INDICATORS	DESCRIPTION	EXPECTED RELATIONSHIP WITH ADAPTATION MEASURE
Social	Age	Age of Farmer (in years)	Positive
	Sex	Sex of Farmer	Positive
	Farming Experience	Number of years respondent worked as a Farmer	Positive
	Household size	Total number of household members	Positive
	Total Dependents	Total number of unproductive household members, i.e. younger than 15 years or household members challenged or/and older than 65 years	Negative
	Education	Number of years in school completed by farmer	Positive
Economic	Total Employed Members	Total Number of Employed Family members	Positive
	Household Income Level	Total household income from all sources as a ratio to the official standard of living for the province	Positive
	Housing Tenure	Status of ownership of house and lot	Positive
	Farm Size	Total lot area for rice production	Positive
	Farm tenure	Status of ownership of farm	Positive
	Valuable Assets	Total number of valuable assets	Positive
Institutional	Membership to organizations	Total number of membership of farmer to relevant organizations	Positive
	Sources of information	Total Sources of Information $INFO = (I_1 + \cdots I_8)/8$ INFO = Total number of information sources	Positive
	Trainings on adaptation measures	Total number of trainings for Saltwater adaptation measures	Positive

Table 2 continued…

Knowledge	Level of awareness on saltwater intrusion	Total score on facts about saltwater intrusion $ASWI = (S_1 + \cdots S_{10})/10$ ASWI= Awareness on Saltwater Intrusion $S_1 \ldots S_{10}$ = Empirical statements on saltwater intrusion	Positive Positive
Perception	Perception of climate change related problems	Number of weather related changes perceived by a farmer within the last decade $PI_j = \Sigma_{i=1}^{i=m} C_{ij}$ with: PI_j = Perceived changes by j^{th} farmer Cij = Changes of weather parameters	Positive

Spatial Analysis

Basic spatial analysis through geographical information system (GIS) was also employed through mapping of specific attributes of the barangays covered in the study. Spatial analysis is a type of geographical information analysis which seeks to explain patterns of human behavior and its spatial expression in terms of mathematics and geometry, that is, locational analysis (Lieske, 2015). The spatial analysis in this study is intended to present the spatial patterns characterizing the various barangays in terms of the physical environment, socio-economics conditions and adaptation levels. The generation of analytical maps accompanying the tables and figures improved the examination and characterization of the rice farming population directly affected by saltwater intrusion. The data and the maps may be integrated into saltwater adaptation planning as it can potentially improve the analysis of a wide range of issues, letting policymakers, planners and those who are not familiar with spatial analysis interact directly with relevant information (Zomer, Trabucco, Bossio, & Verchot, 2008).

RICE PRODUCTION IN AREAS PRONE TO SALTWATER INTRUSION IN THE PHILIPPINES AND VIETNAM

This section discusses the biophysical factors, rice farming practices, technical efficiency in rice production, local institutions influencing farming practices and market conditions that affect the rice production threatened by saltwater intrusion in the selected study sites in the Philippines and Vietnam. The farming systems framework was used to analyze how farming systems in the study areas have evolved over time based on the secondary data and primary data collected from the rapid rural appraisal (RRA), FGDs, KIIs and socio-economic survey. Understanding farmer-specific characteristics as well as the environment where rural rice farmers operate is an essential requirement in the analysis of adaptation to saltwater intrusion.

An agricultural system is defined as the complex of resources that are arranged and managed according to the totality of production and consumption decisions taken by a farm household, including the choice of crops, livestock, on-farm and other enterprises (Zavalloni, Raggi, Targetti, & Viaggi, 2015). The production structures, drivers and constraints of these systems are shaped by constant interaction with the local social and biophysical context (Ghimire, Dhungana, & Teufel, 2012). The result is farming system diversity in space, resource endowment, variability through time and multidimensionality in terms of production techniques and consumption decisions (Giller, 2013). As rice production faces similar context, efforts to understand the rice production system needs to start with an acknowledgement of this heterogeneity.

Moreover, practical way of dealing with the rice farming system is to stratify its components into subsets or groups that are homogenous according to specific criteria, production factors, enterprise patterns, livelihoods and constraints (Chandra, Dargusch, McNamara, Caspe, & Dalabajan, 2017). Results can then be used to support the development, implementation, targeting and scaling-out of interventions and monitoring of development projects (Li, Liu, & Deng, 2010). In addition to being a practical framework on the basis of which more differentiated approaches to addressing rural challenges may be designed (van Aalst, Cannon, & Burton, 2008), descriptions might also inform the academic study of rice farming system conditions. For example, they can be applied to assist in-depth farming system analyses or inform further exploratory studies through the selection of representative farms for detailed characterization. Characterization of the conditions of surrounding rice production may also be used in modelling and simulation studies to evaluate potential effects of specific interventions on rice farming systems (Ghimire et al., 2012). Given this, literature supporting locally oriented case studies of this nature has increased in number (Diep, 2013; Khai & Yabe, 2011; Koirala, Mishra, & Mohanty, 2013; Parichatnon, Maichum, & Peng, 2017).

The success of any intervention depends on understanding of how the biophysical and socioeconomic conditions shape land use for rice production (Ghimire et al., 2012). Concern about biophysical and socioeconomic factors is not limited to agricultural scientists, natural resource managers, and policymakers, but also farmers have a vested interest in these factors which influence their production (Rodríguez, 2010). A growing number of studies on local knowledge on rice production have been published over the last three decades, demonstrating an increased recognition of farmers' knowledge on the biophysical and socioeconomic factors offering insight which can guide future research to develop sustainable rice production (Eulito & Evelyn, 2008; Ghimire et al., 2012; Korres, Norsworthy, Burgos, & Oosterhuis, 2017; Li et al., 2010). In general, such studies provide good information for particular physical conditions, land management practices and market conditions.

Biophysical characteristics refer to the sensitivity of physical and ecological systems, which defines the natural limits to adaptation (Diedrich, Balaguer Huguet, & Tintoré Subirana, 2011; Lee, 2014; Tesfahunegn et al., 2016). In the climate change literature, these natural limitations are often viewed as thresholds beyond which change becomes irreversible and limits the ability to adapt (Alemayehu & Bewket, 2017; Asante, Boakye, Egyir, & Jatoe, 2012; Jat et al., 2016; Mwongera et al., 2017; Tesfahunegn et al., 2016).

Most of the factors affecting the rice farmers practices are also influenced by favorable environment which includes support institutions and market conditions (Agarwal, McSweeney, & Perrin, 2008; Ampaire et al., 2017; Smucker et al., 2015; Termeer, Biesbroek, & van den Brink, 2012; Tesfahunegn et al., 2016). The availability of support services such as water sources are also found to be one of the most important factors for more sustainable and integrated rice farming (Rehr et al., 2012; Schipper, Liu, Krawanchid, & Chanthy, 2010; Vaughan & Dessai, 2014). Aside from these, changes in socioeconomic conditions have profound effects on the individual farmers and communities (Li et al., 2010; Palis et al., 2015; Mohammed Nasir Uddin, Bokelmann, & Entsminger, 2014b).

Biophysical Characteristics

Geography and Climate

a. Philippines

The study site in the Philippines in Northern Mindanao is in the Municipality of Plaridel, one of the original towns of the Province of Misamis Occidental. Situated at the northern portion of the Province of Misamis Occidental, the Municipality of Plaridel is located in between the two cities of Ozamis (67 km) and Dipolog (68 km). It is bounded by three municipalities: Baliangao to the north, Lopez Jaena to the south and Calamba to the west while the Mindanao Sea cradles the municipality to the east. Plaridel has thirty-three (33) barangays with a total area of 8,000 hectares.

It has an average elevation of 23 meters (75 feet) above sea level with undulating terrain. The municipality's coastline average ground level is at 4 meters with some areas going as low as one meter above the sea level and as high as nine meters, with most coastal areas at 3 meters above sea level. The Geographic Information System (GIS) map in Figure 1 shows that six out of the ten barangays covered in the study have elevation between two (2) to four (4) meters above sea level. Inland, some barangay near the river channels and creeks are only one meter above sea level, making them highly susceptible to coastal flooding (Municipal Disaster Risk Reduction Management Office Report, 2016).

A major river system traverses through the cultivated vast lands in the various parts of the municipality. The municipality was originally named after this river called Langaran River, from the word "Langanan", the local term for "delay". The river was named as such because of its circuitous, winding route that traverses many kilometers. This was where the original settlers, the "Subanen" indigenous peoples, travelled to reach the different settlements located along the riverbanks. The Subanen delved into farming, fishing and hunting and were able to open tracts of land for agricultural purposes with their slash and burn ("*kaingin*") way of farming. These tracts were later on bartered for axe heads and salt with the migrants (Municipality of Plaridel Historical Records). A creek is also located on the western side of the area that flows to Lobog River.

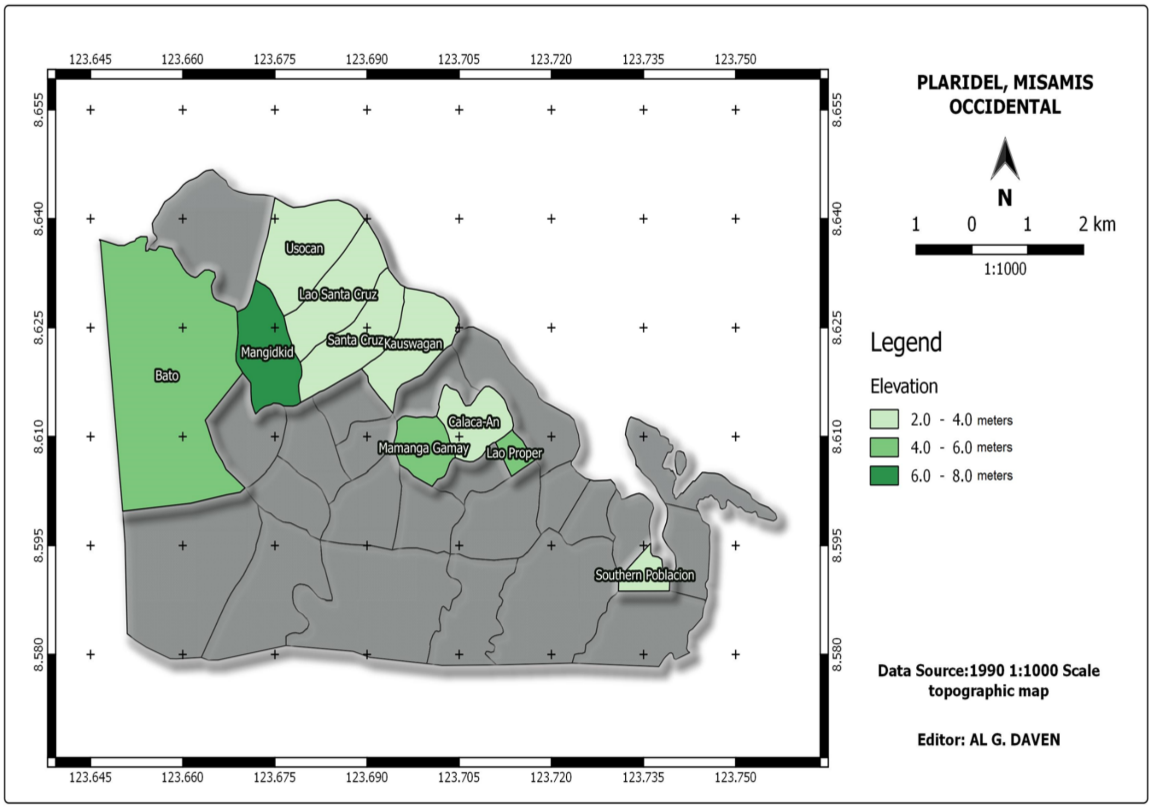


Figure 1 Elevation of Selected Barangays, Plaridel, Misamis Occidental, Philippines

Ten (10) barangays in Plaridel, Misamis Occidental were chosen as the study sites since they were identified by the Municipal Agriculture Office and the Municipal Disaster Risk Reduction Management Office as the major rice producers in the Municipality with very high susceptibility to coastal flooding and saltwater intrusion which causes saltwater intrusion in rice fields. This can be attributed to the proximity of the barangays to the coast (Figure 2). These are Barangays: Bato, Calaca-an, Kauswagan, Lao Proper, Lao Sta. Cruz, Mamanga Daku, Mamanga Gamay, Sta. Cruz, Usocan and Mangidkid.

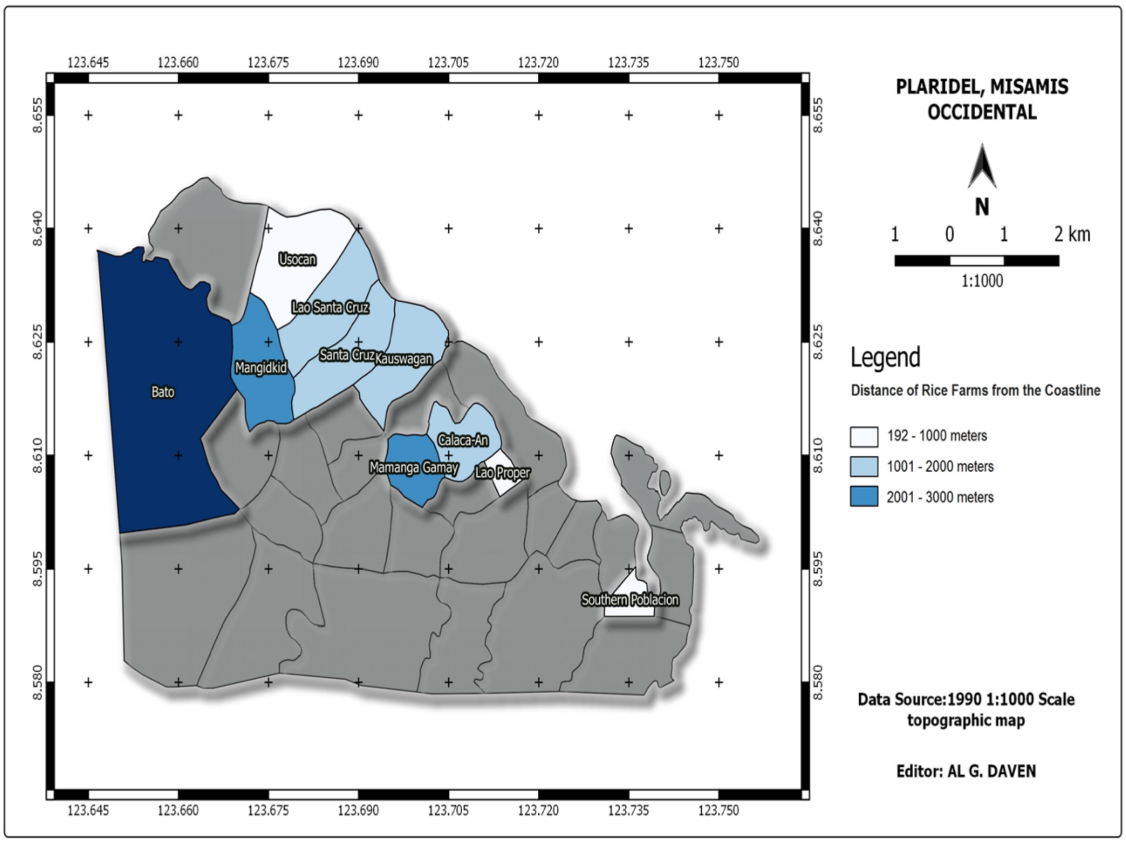


Figure 2 Distance from the Coastline of Selected Barangays, Plaridel, Misamis Occidental, Philippines

Plaridel has a tropical climate. There is a great deal of rainfall in Plaridel even in the driest month. This climate is considered to be following the Type IV of the modified Corona Climatic Classification characterized by evenly distributed rainfall throughout the year. There is no dry season with a very pronounced maximum rain period from November to February. The minimum monthly rainfall occurs during the period from March to May. The greatest amount of precipitation occurs in November, with an average of 365 mm while the driest month is in April, with 89 mm of rainfall. The variation in temperatures throughout the year is 1.7 °C and the average annual temperature is at 27.4 °C. The warmest month of the year is May, with an average temperature of 28.3 °C while the lowest average temperatures in the year occur in January, when it is around 26.6 °C.

Plaridel is suited for intensive agriculture since 51% of the land area is level to gently sloping. Rolling hills are found at the southern portion extending to the boundaries of the Municipalities of Calamba and Lopez Jaena. The existing general land use of Plaridel are classified into: built-up, agricultural, timber land, nipa land, special uses and other uses such as riparian zone, cemeteries, roads and streets, and water bodies. Of the total land area of the municipality, agricultural area got the biggest chunk; it has 7,385 hectares or about 92% of the municipal land area. Built up in most barangays are concentrated on six (6) central barangays or "*Poblacion* namely Northern Poblacion, Southern Poblacion, Southern Looc, Looc Proper, Eastern Looc and Lao Proper. Along major roads and thoroughfares, the total built-up area of the 33 barangays comprises about 4%. Timberland or mangrove areas are concentrated at the southern and northern boundaries of the municipality.

b. Vietnam

The study sites in Vietnam are in Bai Tri District, Ben Tre Province and Cang Long District, Tra Vinh Province, both located in the Mekong Delta region in the

Southern part of Vietnam. Ben Tre is geographically wedged between the Tien Giang River, one of the two main branches of the Mekong. The province's northern boundary is formed by the Tien Giang's main course, while the province's southern boundary is formed by the Tien Giang's largest branch. The entire province is bypassed by a network of smaller rivers and canals. The extensive irrigation that this provides makes Ben Tre a major producer of rice but is also prone to flooding. The Climate Change Research Institute at Can Thơ University in 2014 has predicted that 51% of Ben Tre province can be expected to be flooded more often if sea levels rise by 1 meter. Both provinces are on the average, only 1.5 meters above sea level and are located very near the coastline (Figure 3).

Tra Vinh Province borders Ben Tre, Vinh Long provinces on the north, Soc Trang Province on the west, and East Sea on the east with the 65km seaside. Its topography includes coastal plain, alluvial deposits, hundreds of mounds and sand caves, a complex network of rivers and canals.

Ben Tre and Tra Vinh are both found on the tropical monsoon region. The weather is hot around the year. Annual average temperature is 26^{o}C. The dry season lasts from December to April. The rainy season is between May and November. The distribution of rainfall is unequal increasing from south-west to north-east (*Mekong delta water resources assesment studies*, 2011).

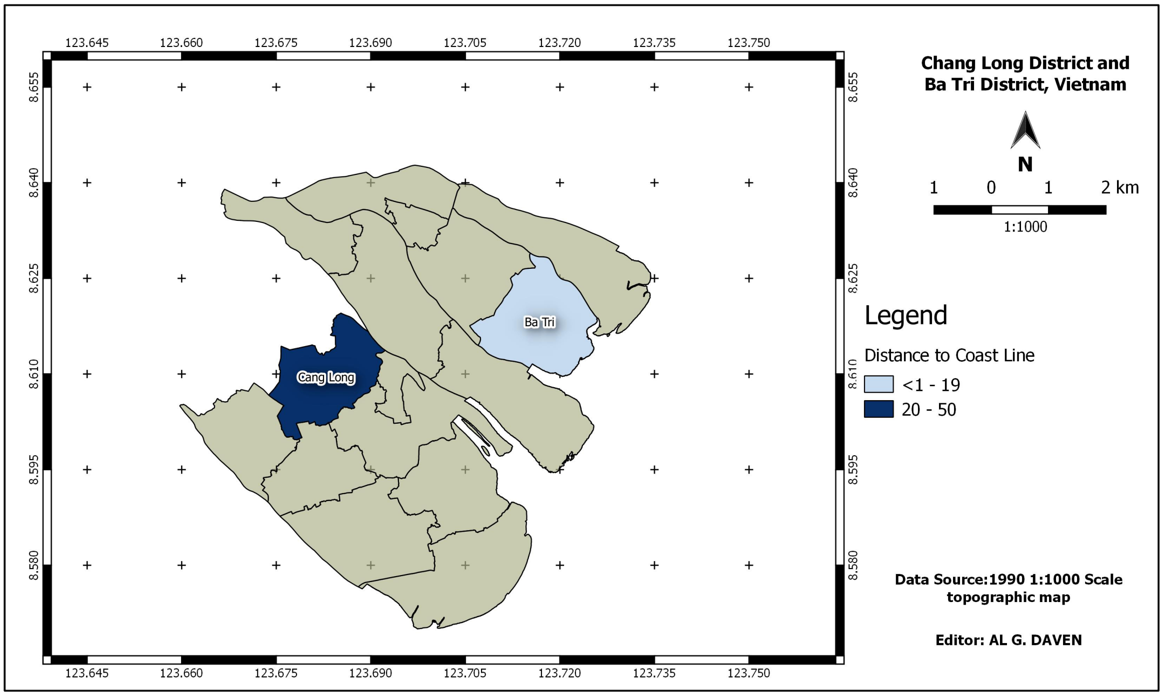


Figure 3 Distance from the Coastline of Selected Districts in Ben Tre and Tra Vinh Provinces, Vietnam

Saltwater Intrusion and Weather Disturbances

a. Philippines

The spatial distribution of the coastal flood risk zones of the municipality of Plaridel has shown that the barangay covered in the study are highly susceptible to flooding as shown in Figure 4. This is mainly due to the areas' elevation and proximity to the coast.

The coastal low-lying barangays are not only susceptible to flooding but have become highly vulnerability to saltwater intrusion. Many farmers shared during the various FGDs and filed surveys that saltwater intrusion in the coastal barangays has been a problem since the 1990s and has become a severe problem adversely affecting their agricultural production. Several agricultural plots throughout the municipality have been degraded due to saltwater intrusion.

On February 2017, the Sanguniang Panlalawigan issued a resolution requesting the Department of Agriculture, PhilRice and the International Rice Research Institute for technical assistance and funding for saline tolerant and drought tolerant rice varieties (Appendix I) given that all coastal municipalities in the province face the problem of saltwater intrusion in rice farms.

Coastal flooding and flooding through the Langaran River System and its tributaries have also been one of the biggest challenges faced by farmers in all the barangays covered in this research. The unpredictability and intensification of tropical storms passing through Northern Mindanao could increase the occurrence of storm surge and coastal flooding. It will deepen the flood waters and potentially impact the greater land areas along the coast. This has been the case of the most recent coastal flooding in January 16, 2017.

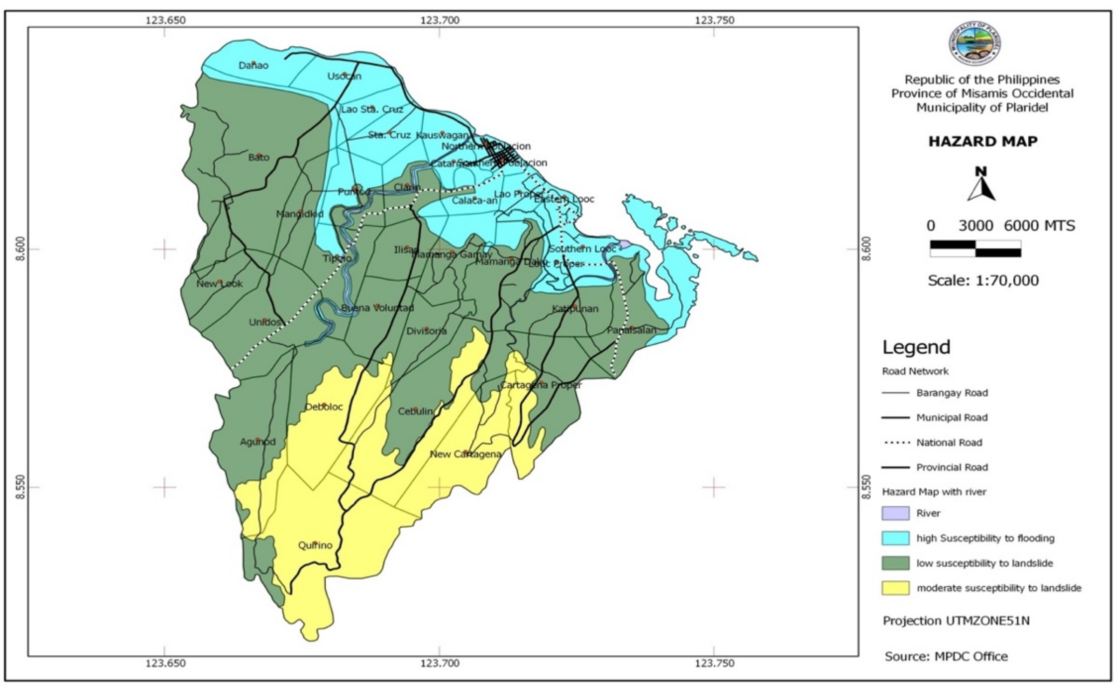


Figure 4 Coastal Flooding Susceptibility Map Plaridel, Misamis Occidental, Philippines

All of these barangays as shown in Figure 5 have been adversely affected by the most recent flooding in January 16, 2017 which led to the declaration of a state of calamity in the entire Municipality (Appendix J). The coastal flooding simultaneously taking place with the flooding over the areas along the river banks caused significant damage to lives and properties. It displaced hundreds of people, destroyed livelihood, polluted water resources and increased the risk of sickness and diseases in the area.

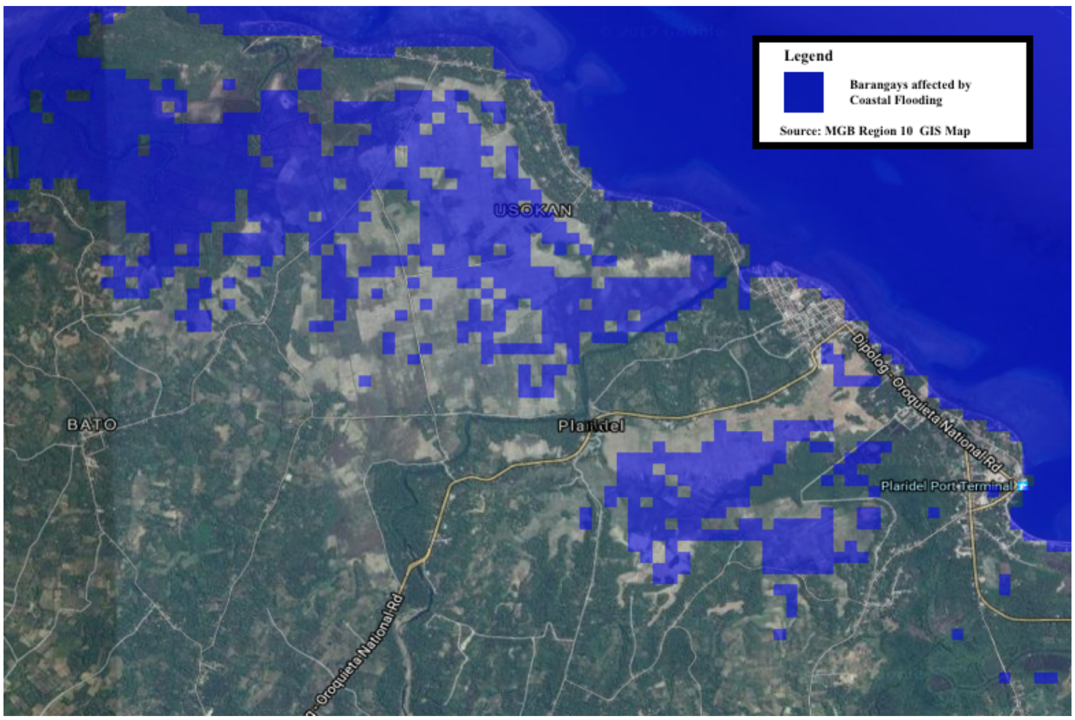


Figure 5 Coastal Flooding Map of Plaridel, Misamis Occidental, Philippines
January 16, 2017

Around ninety percent (90%) of all the newly planted and tilled rice fields were declared damaged with only ten percent (10%) chance of recovery in the ten barangays covered in the study. Various parts of the municipality were submerged due to the massive flooding (Appendix K). Four days after the flooding, the rice fields were also attacked by rodents causing more damage to the affected farms.

Plaridel also suffered from massive damages due to the long spell of drought. A widespread damage in its various standing crops in Southern Looc, Plaridel, Misamis Occidental prompted the local government to raise a state of calamity due to the onslaught of severe drought as declared by the Municipal Agriculture Office (MAO). As reported, the dry spell started in October of 2015 up to May 2016 due to the El Niño phenomenon.

b. Vietnam

The two provinces in the Mekong Delta region are constantly affected by salinity intrusion given their location near ocean coastal areas, where saline water moves into freshwater aquifers. The salinity intrusion happens naturally to some extent, however, climate change and changes in rainfall are causing more severe salinity intrusion. In addition to the salinity intrusion, drought and rising temperatures cause problems to agriculture and aquaculture. During the dry season salinity becomes a problem in the coastal areas (Konishi, 2011).

Even though surface water is very abundant, over three quarters of the Ben Tre surface water areas (water in rivers, canals, lowland areas) are affected by salinity from two or three months to the whole year. The salinity intrusion is constrained to some extent using dykes, sluices and sand dunes along the coast (Ratering Arntz, 2018).

In most instances, farmers rely on wet season rainfall which results to more frequent salinity intrusion in rice farms allowing only one rice crop per year. Farmers may also use fresh water from network of canals to provide supplementary irrigation where required, although in years when saline water intrusion occurs early, this is not possible. Over the past 30–40 years, many rice farmers in the saline affected areas have adapted to the natural conditions by growing rice in the wet season, then using the rice fields for growing shrimp (aquaculture) in the dry season.

Salinity level in the Mekong River System normally start to rise by the end of December, reach its peak in March or April and decline afterwards. However, in February 2016, the salinity intrusion reached beyond the dykes for the first time. Despite warnings, both local officials and farmers underestimated the risks. This is because the profit to be obtained encouraged farmers to keep planting even in high risk areas with increased threats of drought and salinity-related problems. Leakage problems and sluice gate malfunctions also contributed to increased salinity in the canal systems (CGIAR Research Centers in Southeast Asia, 2016).

Rice Production

a. Philippines

Just like other municipalities in the province, Plaridel's economy depends on agriculture with coconut having the biggest area of more than 6,000 hectares. Rice ranked as 2nd in the municipality in terms of area planted and 2nd also in the entire province of Misamis Occidental. Rice is harvested 5 times in 2 years with a yield of 6-6.5MT/ha. The Philippine rice yield on the average vary from 6-8 MT/ha across various regions in the country (PSA Country Stat, 2017). Other crops are also planted under coconut trees such as banana, corn, fruit trees such as mango, pomelo and lanzones as well as root crops such as sweet potato, cassava among others (Country Statistics PSA, 2017).

Rice farmers in Plaridel have five (5) cropping cycles for two years or on the average, 2.5 cropping cycles in a year. The length of one cropping cycle ranges from 110 to 150 days. The cropping calendar followed by the majority of the sixty two percent (62%) of the farmers is dependent on the community irrigation system called the Nazareno Gamutan Agricultural Development Irrigation Association (NGADIA). The first cropping usually takes place between May to July while second cropping is between October to end of November. Harvest period takes place for the first cropping at the beginning of August to end of September while for the second cropping, harvest is between beginning of January to end of February. According to the President of NGADIA, very few farmers fallow their rice fields or practice crop rotation.

Among the 326 farmers covered in the survey of this study, around fifty five percent (55%) have successfully completed two cropping cycles (Table 3). Unfortunately, a significant proportion of forty two percent of the farmers had only one successful cropping cycle for the same period. This may be attributed to the devastating impact of the flooding that occurred in January of 2017. A minority of farmers (3%) are on their third cropping cycle for the year.

Table 3 Total Number of Rice Cropping Cycles in a Year
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

NUMBER OF CROPPING CYCLES	FREQUENCY (n=326)	PERCENTAGE
2	179	54.91
1	138	42.33
3	9	2.76
total	326	100.00

Irrigation is the major water supply for rice farmers in Plaridel. There are three irrigation systems in the municipality: NGADIA the largest community irrigation sytem covering 800 hectares of rice farms, National Irrigation Administration (NIA) which cover around 400 hectares of rice farms and the Mamanga Daku, Mamanga Gamay, Baliangao Community Irrigation System which cover around 120 hectares of rice farms.

Established in 1876, the NGADIA community irrigation has operated for 140 years and was declared the first-ever Cooperative in the entire Philippines and awarded in 2016 by the Department of Agriculture and the National Irrigation Administration (NIA) as one of the best community managed irrigations in the country. Construction of this irrigation was headed by Nazareno Gamutan, a Boholano who migrated in Plaridel at that time. It irrigates 800 hectares total rice area or around 62% of all rice farms in the municipality with about 5000 farmers served. The irrigation water supply is sourced mainly from the Langaran River, a major river system in the municipality connected to the Mt Malindang watershed. The same river system supplies water for the NIA irrigation canal in the eastern parts of the municipality.

Tree planting and mangrove Reforestation are two of the major environmental projects to maintain the watershed of the Langaran River and coastal management to arrest flooding and saltwater intrusion in the irrigation system were implemented in collaboration with DENR and DA. Efforts were also made through monthly *"pahina"* (participation in maintenance activity) in the irrigation system is required for all farmers to maintain access to irrigation.

Table 4 shows that thirty-two (32%) of the farmers surveyed till their own the lands which are usually less than one hectare while thirty one percent (31%) are renting the rice farms. Several owners mentioned during the field surveys that they acquired the land through land reform and others by direct purchase. Customarily, farmers use "*bulos*" as the means of measuring the size of the rice field. One "*bulos*" is approximately one third of a hectare. Another term used is "*himabaw*" which is approximately three fourths of one "*bulos*" or one fourth of a hectare. There are, however, few sizable landholdings ranging from two (2) to five (5) hectares.

Table 4 Agricultural Land Tenure
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

TENURE	FREQUENCY	PERCENTAGE
Free Use	31	9.51
Sharecropped	86	26.38
Rented	103	31.60
Owned	106	32.52
Total	326	100.00

The land tenure system per barangay can also be gleaned from the GIS map in Figure 6. The map shows that the concentration of land ownership is dominated by sharecropping in seven barangays.

Local labor pattern for rice cultivation follows the "*dumdoman*" system of labor exchange where whoever plants the crops could automatically help in the harvest and receive a share. This system does not entail payment of wages for work extended. "*Hunglos*" or labor exchange is another system commonly practiced in various barangays and those who help in planting are given first priority to help in harvesting (*dumdom*). Those who can afford to pay normally hire farm workers. Family labor is the last resort in performing farming activities.

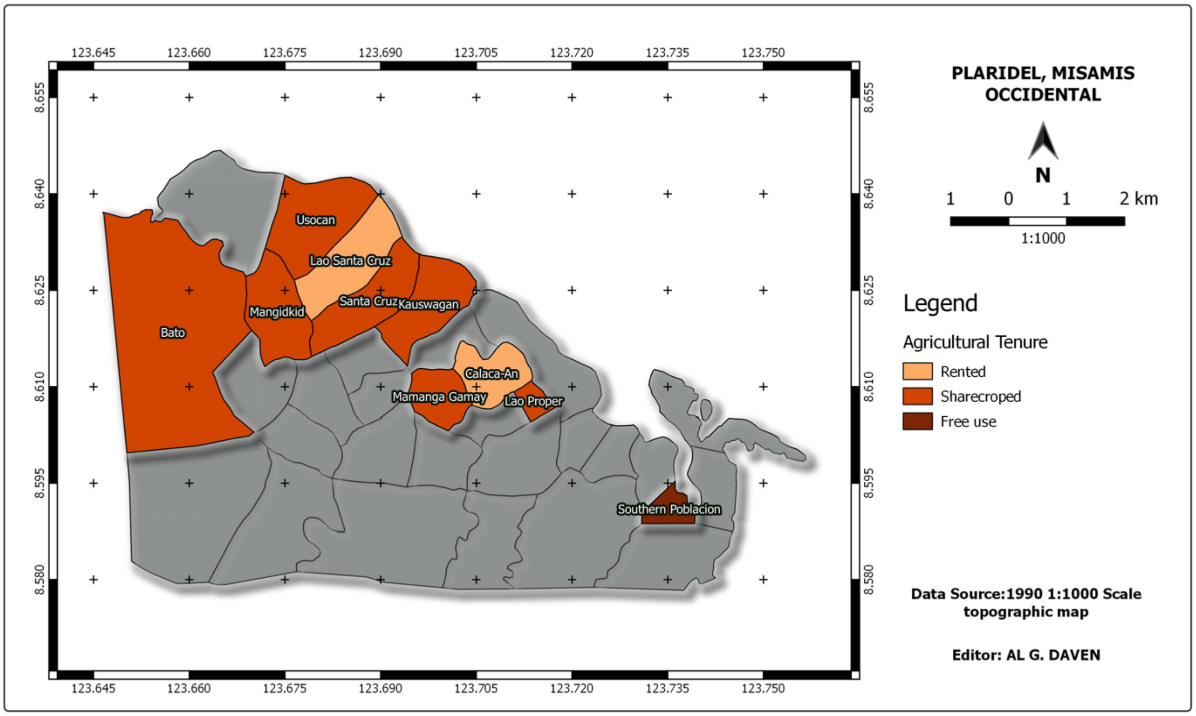


Figure 6 Agricultural Land tenure in Selected Barangays, Plaridel, Misamis Occidental, Philippines

Rice seeds in the municipality are commonly distributed by the Municipal Agriculture Office, therefore, farmers, usually use available rice variety during the planting season. Rice is usually a monocrop for most farmers in which sowing rate of dry seeds normally ranges from 30-40 kilograms per hectare (DA Report, 2016). In the barangays covered in the study, sowing rate is so much higher at 45-120 kilograms per hectare or 15-40 kilograms for every "*bulos*". Most farmers allocate allowances for seedlings that commonly die due to "*asgad*" or saltwater in the rice fields. Majority of the farmers use more that 50% of the seed requirement for a given parcel of land as shown in Table 5.

Table 5 Farmers' Sowing Rate/Bulos
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

SOWING RATE	FREQUENCY	PERCENTAGE
less than 50%	42	12.88
less than 80%	19	5.83
`1 - 50 %	86	26.38
51% - 100%	107	32.82
101%-150%	46	14.11
151%-200%	14	4.29
201%-300%	12	3.68
Total	326	100.00

Note: 1 *bulos* = 1/3 hectare

Majority of farmers use various combinations of chemical inputs such as inorganic fertilizer and pesticides classified as insecticides, herbicides, fungicides and molluscicides. Around forty three percent (43%) use three types of chemicals and only four percent (4%) of the farmers reported that they do not use chemicals at all.

During the FGDs, the farmers revealed that they continue to use a lot of inorganic fertilizers and apply various chemicals in rice production. They are still reluctant to use organic inputs because of fear that it won't be as effective as the pesticides, herbicides, fungicides and even molluscicides for "kuhol" or snails. However, the municipality being the lone member of LOAM in Misamis Occidental, has produced some supporters of the use of organic fertilizers, one of which is the Barangay Captain of Mamanga Gamay who is also the President of the Agricultural Training Institute-Regional Training Center. During the field survey, some farmers cited his influence in raising consciousness among rice farmers to use not only inorganic but also organic fertilizers and practice integrated pest management. This motivated the researcher to conduct a KII with the said Barangay Captain. It was held in the Organic Fertilizer Facility of the Municipality. The organic fertilizer is commonly processed using animal manure, vegetables and fruit byproducts, “madre de cacao” leaves and saw dusts from lumber yards. According to the Barangay Captain, the juice coming from the facility during the processing of the organic fertilizer is being utilized as organic spray effective for killing certain types of rice pest such as “*tungro*” or green leafhoppers.

The Plaridel Municipal Agriculturist reported that the expected yield per “*bulos*” is around 1200-1600 kilos. Based on the results in Table 6, eighty five percent (85%) of the farmers only harvested around twenty six percent (26%) to fifty percent (50%) of the expected yield per *“bulos”*. This implies that most of the farmers do not attain the expected technical efficiency of rice production.

Table 6 Percentage of Actual Yield to Total Expected Yield
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

PERCENTAGE OF ACTUAL TO EXPECTED YIELD/BULOS	FREQUENCY	PERCENTAGE
1 to - 25	32	11
26 to - 50	276	85
51 to - 75	12	4
76 to - 100	6	2
Total	326	100

Note: bulos = 1/3 hectare

The average yield at the barangay level showed that coastal rice farmers in Plaridel are technically inefficient in using the productive resources. Eight out of the ten barangays have attained only one to twenty percent of the expected yield per area. This is extremely low given that more than fifty percent (50%) of the farmers go beyond the required sowing rate and use at least three chemicals. This also pales in comparison to the eighty two percent (82%) Philippine average of 6-8 MT/ha (Koirala & Hall, 2014).

This may be associated with the adverse impacts of sea water intrusion especially that all barangays are highly susceptible to the slow onset event. This may be further explained by the small land holdings and the tenure of the rice farms. To wit, several studies have demonstrated the importance of land tenure in the attainment of technical efficiency (Giller, 2013; Kea, Li, & Pich, 2016; Koirala & Hall, 2014; Mariano, Villano, & Fleming, 2011; Rola & Quintana-Alejandrino, 1993).

Rice production is commonly aimed at subsistence consumption. According to farmers during the FGDs and field surveys, around 60% of their harvest is appropriated for household consumption while the rest is distributed in nearby municipalities and cities. The produce is normally sold in Oroquieta and Dipolog and the rest shipped to the Visayas in Siquijor, Cebu, Bohol and Dumaguete, given the availability of a port within the municipality servicing some shipping companies that travel to these destinations.

Farm gate prices of dried “palay” (rice grains) has increased through the years based on regional data from 2010 to 2015 (Philippine Statistics Authority Report, 2016). Plaridel farm gate price of dried “palay” (rice grains) is between PhP17 to PhP19 per kilogram. This is relatively lower to the farm gate price in Bukidnon, the major rice producer in Northern Mindanao which is at PhP18 to PhP21 per kilogram or approximately US$ 0.39 (exchange rate of PhP 54 = US$1).

b. Vietnam

The total area of agricultural land for Ben Tre and Tra Vinh provinces is 323,000 hectares which account for thirteen percent (13%) of the total agricultural lands of the Mekong Delta in Vietnam. The main agricultural products are rice, fruits, fish and shrimp. They contribute thirty percent (30%) of the agricultural production value, twenty-two percent (22%) of total rice production and thirty-one percent (31%) of aquaculture production of the whole Mekong Delta Region in Vietnam (GSO, 2016). About 136,000 ha of agricultural land are dedicated to rice production. Ben Tre province, which has a relatively flat terrain, has a total of 97,710 ha of paddy fields, while Tra Vinh has 38,120 ha. There are only 170,000 ha of cash crops (vegetables, soybean, maize, sugar cane, etc.) and perennial crops (durian, coconut, mango, longan, etc.).

The environment zones along the two provinces favor the expansion of fishing and aquaculture. Ben Tre contributes a large share to the fishing and aquaculture production of the region's fishery production. In 2012, Ben Tre province produced 226,928 tons of aquaculture products (GSO, 2013).

The two provinces benefited from the construction of dikes and sluices for rice intensification which was significant to their economic development. Before 1975, the irrigation systems were not yet developed, and rice cultivation was strongly affected by salinity intrusion. The only traditional rice crop per year during the rainy season (June to late November) had an average yield of about 2 tons/ha. Between 1975 and 1980, primary canals and some dams were built. Consequently, areas affected by saltwater intrusion were reduced and farmers started to cultivate a second rice crop using high-yielding varieties (CGIAR Research Centers in Southeast Asia, 2016).

From 1980 to the present, the irrigation infrastructure was further developed through dyke developments, as the government aimed for food security and livelihood improvement. The improved system provided freshwater to a larger agricultural area, and increased the area of double rice cropping. These interventions have created suitable conditions for intensifying and diversifying agricultural production. Improvement of water management led to significant increase of rice production, from 6.3 million in 1985 to 22 million tons in 2015 (CGIAR Research Centers in Southeast Asia, 2016). In the recent years in Ben Tre, the ratio of fruit trees output value has grown sharply while in Tra Vinh, rice is still the most important crop (Karila et al., 2014).

Among the 258 farmers covered in the survey of this study, ninety percent of the rice-farmers owned the lands for rice production of which forty five percent (45%) are more than 1 hectare and forty percent (40%) between 0.6 to 1 ha (Table 7). The average landholdings in the two provinces are larger than in other parts of the country where agriculture is still largely based on small scale production by a large number of smallholders (Smith, 2013).

Table 7 Total Land Ownership, Ben Tre and Tra Vinh Provinces, Vietnam

Total area planted (in hectares)	Frequency	Percentage
0.1-0.5	36	14.69
0.6-1.0	100	40.82
1.1-1.5	57	23.27
1.6-2.0	32	13.06
2.1-2.5	13	5.31
Over 2.5	7	2.86
	245	100

Three rice crops per year is common in the two provinces. Around seventy five percent (75%) have successfully completed three cropping cycles (Table 8).

Table 8 Total Number of Rice Cropping Cycles in a Year, Ben Tre and Tra Vinh Provinces, Vietnam (2017)

Number of Cropping Cycles	Frequency (n=258)	Percentage
2	64	24.81
3	194	75.19
total	258	100.00

Approximately ninety percent of the farmers rely on personal resources in financing rice production activities (Table 9).

Table 9 Financial Resources to Support Rice Production, Ben Tre and Tra Vinh Provinces, Vietnam

Sources of Financing	Frequency	Percentage
Personal	232	89.92
Formal Loan	43	16.67
Informal Loan	10	3.88

Rice yields are very high, reaching an average of 6.33 tonnes of paddy per hectare per crop. The winter-spring crop is the best, with yields exceeding an average of 7.2 tonnes/hectare the two provinces (Smith, 2013). The data in Table 10 on the average rice yield of the showed that rice farmers in the two provinces are technically efficient, wherein fifty seven percent attain at least seventy six percent (76%) of the expected yield per hectare.

Table 10 Percentage of Actual Yield to Total Expected Yield, Vietnam

Percentage of Actual to Expected Yield/Ha	Frequency	Percentage
1 to - 25	39	15.12
26 to - 50	21	08.14
51 to - 75	52	20.16
76 to - 100	146	56.59
Total	258	100

A study estimated that ninety three percent (93%) of rice production was sold to small traders who then sold on to other intermediaries, rice mills and trading companies. Only four percent (4%) was sold direct to rice trading companies. Seventy percent (70%) was destined for export and thirty (30%) for the domestic market (OXFAM, 2013). Vietnam's total rice exports are primarily through government to government contracts with Indonesia, Philippines and Malaysia. Government intervention in the export market has been issued through export bans in order to stabilize domestic rice prices. Export tariff policies have also been implemented with similar intent. Due to rising input costs, the government also instituted measures to try to protect farmers from these costs by setting a floor farm gate purchase price for export rice. Farm gate price ranges from US$0.24-US$0.36 per kilo (Smith, 2013).

CHARACTERISTICS OF THE RICE FARMERS AND THEIR HOUSEHOLDS

This section provides detailed information on rice farmers' profile in the two countries in terms of their demographic, social, economic and institutional characteristics. The data from the household survey were analyzed by means of descriptive statistical methods, applying measures of the central tendency of key variables. These were computed to gain an overview of the socio-demographic, socio-economic, farm characteristics and institutional affiliations of the farmers and their households.

Achieving sustainable agricultural production necessitates understanding the people who are involved in the activity, including their needs, capacities, and motivations (Alderman et al., 1994; Chenoune, Belhouchette, Paloma, & Capillon, 2016). The condition of any agricultural system is inter-related to the farmers' socio-demographic characteristics, economic and financial status and the level of social capital in a community (Ong, Storey, & Minnery, 2011).

Researchers have recognized that many similarities underlie the development and application of characterization of farmers for the purposes of farming systems research. Farmers can be grouped together to provide insight into their diversity and the relationships between influencing factors and identify rural regional development opportunities and constraints (Eakin & Bojórquez-Tapia, 2008; Kriegler et al., 2012). Surveys of farmers' socioeconomic characteristics and land-management behavior could enhance understanding of the adoption of sustainable farming practices and improve public policies and programs (Giller, 2013).

Moreover, considerable research effort has been undertaken to integrate the role of demographic and socio-economic factors as indicators of capacity to adopt to climate change (Binh, 2015; Huang, Wang, & Wang, 2015; Kim, Elisha, Lawrence, & Moses, 2017; Limantol, Keith, Azabre, & Lennartz, 2016; Menapace, Colson, & Raffaelli, 2014; Yohe & Tol, 2002). These research studies have generated insights into the relations between socioeconomic characteristics of farmers and adaptation behavior and decisions. Specifically, they highlighted the influence of age, farming experience, education and economic conditions of the household to adaptive capacity.

To fully understand the relationship between adaptive capacity and adaptation behavior, a researcher must fully grasp the profiles of various types of farmers. This may be achieved by representing the characteristics of each group using set of typologies. In other words, typologies summate the characteristics of farmers (Ghimire et al., 2012).

Most researches about farmers' adaptation to climate change always include patterns of similarities and differences in farmers' socio-economic profiles. The socioeconomic profiles of farmers has been used to assist in the analysis of variations in productivity, environmental management, and effects of government policies and extension strategies in the adaptation of climate change (W. N. Adger et al., 2009; Agarwal, Perrin, Chhatre, Benson, & Kononen, 2012; Ahmed et al., 2010; Ahmed & Garnett, 2010; Elum, Modise, & Marr, 2017; Meulen & Rose, 2012; Morton, 2007; Parry, Canziani, Palutikof, Van Der Linden, & Hanson, 2007; Smit & Pilifosova, 2003).

The adaptive capacity and vulnerability among developing countries' rural households heavily dependent on agriculture is influenced by socioeconomic, technological and institutional factors (Asante et al., 2012). These factors include age, gender, education of the farmer and household characteristics such as household size, income and land size accessible to the household (Smit & Pilifosova, 2003; Smit & Wandel, 2006). Other variables include availability of technology, and the level of awareness of the available technology and adaptation options as well as social network or groups that enhance ability to adapt and access to financial services (Ludena & Yoon, 2015).

Socio-economic Characteristics of Rice Farming Households

Social characteristics in this study comprise of socio-demographic factors that influence the level of knowledge, ability to decide and the basis of pursuing different adaptation strategies (Smit & Wandel, 2006). These are indicated by role, age, sex, household size and the dependency ratio of the household and educational attainment. Economic characteristics include: household livelihood (the complete details are found in the Appendices V-AA), income from all sources, housing tenure, farm tenure, farm size, total and number of valuable assets. These indicators are very important to achieve household livelihood objectives and significantly influence the household adaptation (Yohe and Tol, 2002).

a. Philippines

The household head/breadwinner in this study refers to the resident member of the household acknowledged by the other members as the household head. This person may be acknowledged as the head on the basis of age (older), sex (generally, but not necessarily, male), economic status (main provider), or some other reason. The respondents decide who heads the household.

The identification of other roles is based on the relationship of each person to the household head, not the relationship to the respondent, for example, if the respondent is the wife of the head of the household. The respondents interviewed were predominantly the heads of the household which usually is the father of the family. They comprise around sixty eight percent (68%) of the total number of respondents (Table 11). This was followed by spouses at around twenty eight percent (28%).

Majority of the respondents were male comprising around sixty percent (60%) of the total number of respondents. This is expected given the fact that farming in the Philippines is dominated by men (Harman Parks, Christie, & Bagares, 2014; Lu, 2007; Valientes, 2015).

Approximately sixty three percent (63%) are over 50 years old, with the youngest being is 23 years old while the oldest, 81 years old. More than half (63.80%) of the rice farmers had rice farming experience of greater than twenty-one (21) years. Based on the interviews during the field surveys, most farmers shared that they were accustomed to farming at a very young age. During the FGD, some cited that during the early stages of their adult life, they were previously engaged in non-farming activities and it was only later in their life after they got married that they returned to farming and assume the responsibility of tilling the lands owned by their parents.

The household in this study is defined as the person or group of persons who usually live and eat together. The members live together in the same dwelling unit, may be related or unrelated but share the same living arrangements. Around eighty percent (80%) of the respondent are married, which is very common in many rural farming communities. Sixty percent (60%) belong to a household with four to six members. This may be explained by the fact that majority of the interviewed farmers have big family size but their children who are of working age are no longer living with the family.

The dependency ratio is determined based on the proportion of family members in each household who are 15 years old and 65 years old and not actively working or engaged in any productive work. Around 64.11% have one to three dependents while twenty six percent (26%) have no dependents. As mentioned above, majority of the interviewed farmers have children who are of working age and are no longer living with the family.

Table 11 Social Characteristics of the Respondents (n = 326)
Plaridel, Misamis Occidental, Philippines, 2017

Social Characteristics	Frequency	Percentage	Average
Head of the family	220	67.48	-
Sex (male)	195	59.80	-
Age (over 50)	206	63.19	52
Rice-farming Experience (21-30 years)	208	63.80	28
Legally Married	259	79.45	-
Total Household Members (4-6)	194	59.51	4.52
Total Number of Dependents (1-3)	209	64.11	2
Highest Educational Attainment (HS Level)	182	55.83	5 (HS level)
Household Income below Poverty Threshold	176	53.99	
Own House with Land Title	206	63.19	
Farm size is less than 1 hectare	218	66.87	0.38 hectare
Membership in Organizations	297	91.10	

The educational attainment covered primary, secondary and post-secondary schooling, as well as any other intermediate levels of schooling in the formal school system. It also included technical or vocational training, such as long-term courses in mechanics or secretarial work. The highest level attained is based on the respondent’s last level attended before leaving the education system. For someone still at school, the highest level is the one he/she is currently attending. More than half (56%) of the farmers reached high school level, twenty two percent (22%) finished elementary and eleven percent (11%) were college graduates.

Eighty percent (80%) of the respondents are full-time farmer who are actively engaged in the various phases of rice production, i.e., land preparation to harvest. Forty five percent (45%) of the households earn additional income either from pensions, government subsidy and/or income by other members of the household.

Twenty five percent (25%) of the respondents shared that their households are actively engaged in some entrepreneurial activities through selling, vending or peddling. Coastal communities depend on available natural resources for augmenting their families' diets and income. Women are responsible for local fish processing and distribution and also forage in water, rivers, swamps and lagoons for shells, shrimps, crabs and shellfish for food or for sale in local markets. The abundance of certain species in the various coastal barangays have been very helpful in fostering the entrepreneurial activities of the households. The most common activities include peddling of sea shells locally known as "*kinhason"* or small shells sold at PhP 30 pesos per "*tapok*" which is approximately one kilo and "*saang*" or big tiger shells sold at PhP 50 pesos per "*tapok*" or PhP500 per pail.

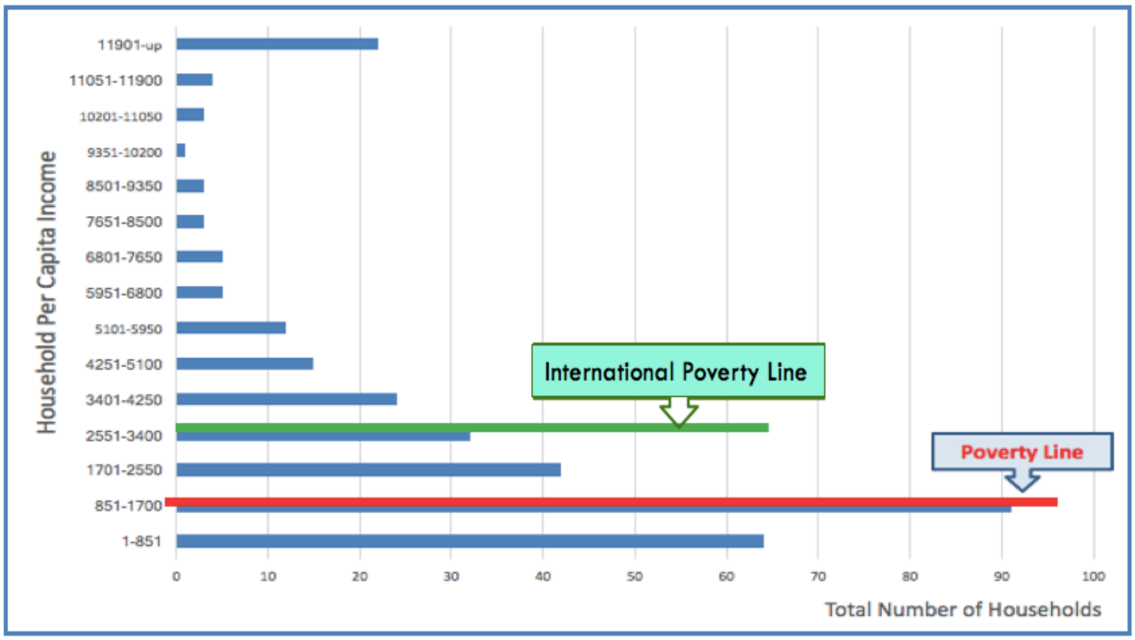
In Barangay Calacaan and Barangay Bato, a number of women are engaged in the production and trading of *"nipa*" roofing materials. Men do the harvesting of mature nipa leaves while the women are assigned to the weaving of the leaves. One bundle of nipa leaves is sold at PhP40 and the finished product is sold by the hundreds at PhP400-500 pesos.

Other income-generating activities of the rice-farming households involved growing crops such as vegetables and root crops. Only a minority of farmers at around twenty one percent (21%) are engaged in growing other crops since according to most farmers, they have relatively small parcels of lands and most of them focus on rice production. Most farmers were also engaged in other agricultural activities with approximately fifty four (54%) of them are engaged in livestock production. Fishponds are common around different parts of the municipality; however, only a handful of farmers engage in aquaculture which could be attributed to the high capitalization cost of aquaculture.

The total income of the household is computed based on the combined earnings of all members of the household from their own production activities or employment and all other sources. The total income is estimated in this study to assess the standard of living of the households. Household income is regarded as one of the clearest indicators of socioeconomic status and wellbeing and is highly correlated with a wide range of outcomes (Hansen and Kneale, 2013). The standard of living in this study is measured in terms of the of the attainment of the required income from the predetermined poverty line for the province as indicated by the official standard set by the government through the Philippine Statistical Authority (PSA). The reference used in the study is the 2015 Family Income and Expenditure Survey (FIES) annual per capita poverty threshold for the province of Misamis Occidental which is pegged at PhP20,376/year or PhP1,698/month.

There are 176 households whose monthly incomes are within the poverty threshold for Misamis Occidental, pegged at PhP8490 for a family of 5 (Figure 7). The PSA 2015 Report for the Municipality of Plaridel has documented that poverty incidence is at thirty seven percent (37%). However, for the selected study sites, poverty incidence is approximately fifty four percent (54%).

In October 2015, the World Bank updated the International Poverty Line (IPL) to \$1.90 a day. The new figure of \$1.90 is based on purchasing power parity (PPP) calculations and represents the international equivalent of what \$1.90 could buy in the US dollar in 2011. Two hundred fifty-one (251) or seventy-seven percent (77%) of the farmers in the Philippines are below the IPL.



Note: Per Capital Poverty Threshold: Misamis Occidental:PhP20,376/year or PhP1,698/month (PSA, 2015)
International Poverty Line (IPL) to \$1.90/day (World Bank, 2015)

Figure 7 Monthly Income Per Capita Poverty Threshold in Selected Barangays Plaridel, Misamis Occidental, Philippines

On the average, five barangays are bordering around the poverty line (Figure 8). Though these five barangays are the largest rice producers among the areas covered in the study, they also have the lowest technical efficiency, attaining around only one to twenty percent of the expected yield (1% -20%). The information generated from the GIS Maps may be used as basis for targeted interventions aimed at specific barangays. Mapping can be used in not only in targeting development interventions but also for in-depth assessments and setting of priorities for programs aimed at reducing vulnerability to saltwater intrusion, food insecurity and poverty alleviation.

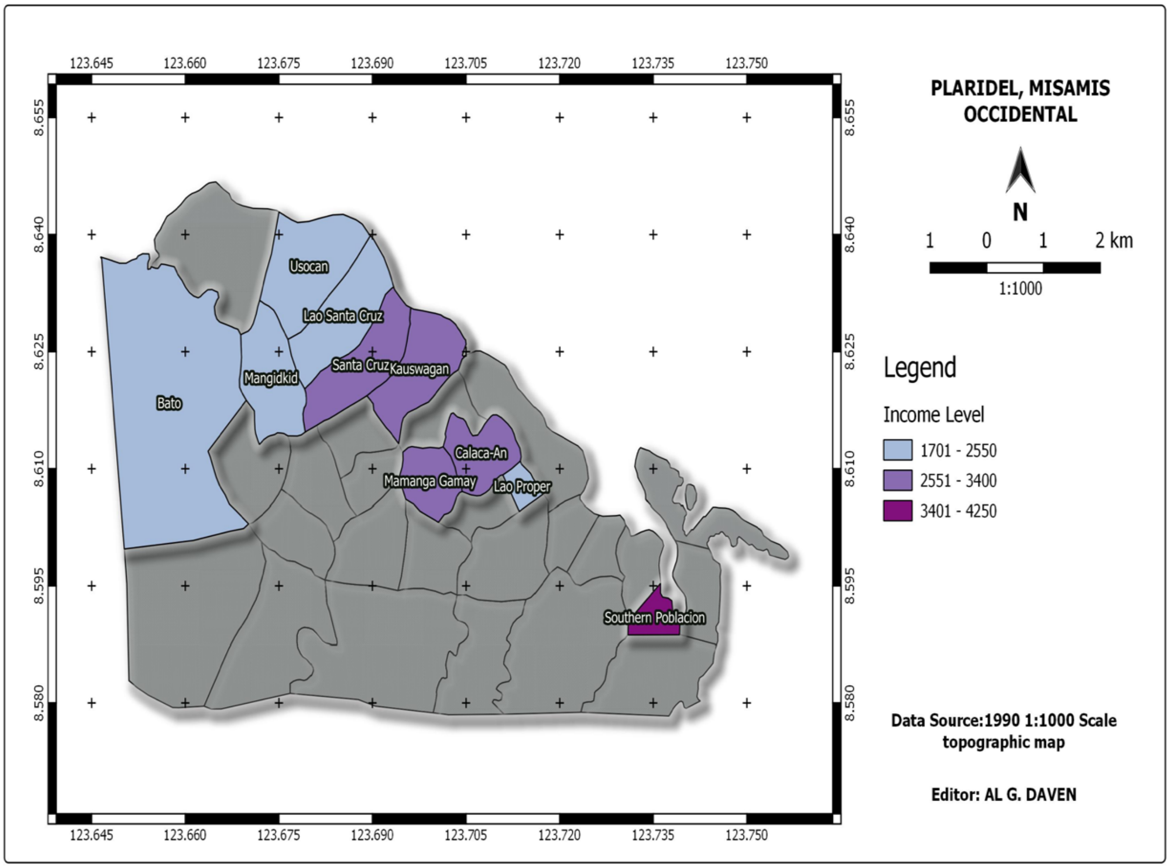


Figure 8 Average Income Level in Selected Barangays, Plaridel, Misamis Occidental, Philippines

Housing tenure is another indicator of household economic security. Housing tenure refers to the financial and legal arrangements under which someone has the right to live in a house. The tenure status of housing released by the former National Statistics Office (now PSA) is based on the 2010 Census of Population and Housing (2010 CPH).

In this study, five classifications were used to distinguish tenurial arrangement, namely: owner, owner like possession of house and lot; rent house or room including lot; own house & rent lot; own house and rent-free lot with consent of owner; and own house and rent-free lot without consent of owner. Among the 326 households, approximately sixty three percent (63%) owned their house and lot while approximately eighteen percent (18%) own the house in a rent free lot with consent of owners. This arrangement is very common in many rural areas. These are usually the households of farm tenants or lessees who occupy rent-free houses belonging to the owner of the land they farm; or farmers who till lands under sharecropping conditions; or those employees given free housing as part of fringe benefits but must vacate the housing unit upon separation from work.

The valuable assets owned by the households are commonly indicated by furniture, appliances and tangible assets that can be liquidated by households for emergencies or when they have insolvency situations. Around eighty percent (80%) of households own at least one cellphone (Table 12). Seventy three percent (73%) owned television and around forty seven percent (47%) own a motorcycle. A minority of farmers, around five percent (5%) own a car. They are mostly large-scale farmers who own agricultural lands over three (3) hectares and are involved in multiple sources of income.

Table 12 Valuable Items Owned by Households (Multiple Responses)
Selected Barangays Plaridel, Misamis Occidental, Philippines, 2017

VALUABLE ITEMS	FREQUENCY	PERCENTAGE
Mobile Phone	264	80.98
Television	238	73.01
Musical Appliances	194	59,51
Motorcycle	176	46.93
Refrigerator/Freezer	131	40.18
Cooking Appliances	73	22.39
Washing Machine	60	18.41
Jewelry	52	15.95
Personal Computer/Laptop	26	7.98
Vehicles	24	7.67
Air-conditioner	23	7.06
Sewing machine	22	6.75

b. Vietnam

The households surveyed in Ben Tre and Tra Vinh provinces live in communes in rural areas and mainly obtain their livelihood from agricultural, and fishing activities. Table 13 shows that the rice-farming household are dominated by male household heads. More than sixty three percent (53%) of these farmers are over fifty (50) years old. They have rice farming experience ranging from twenty-one (21) to thirty (30) years.

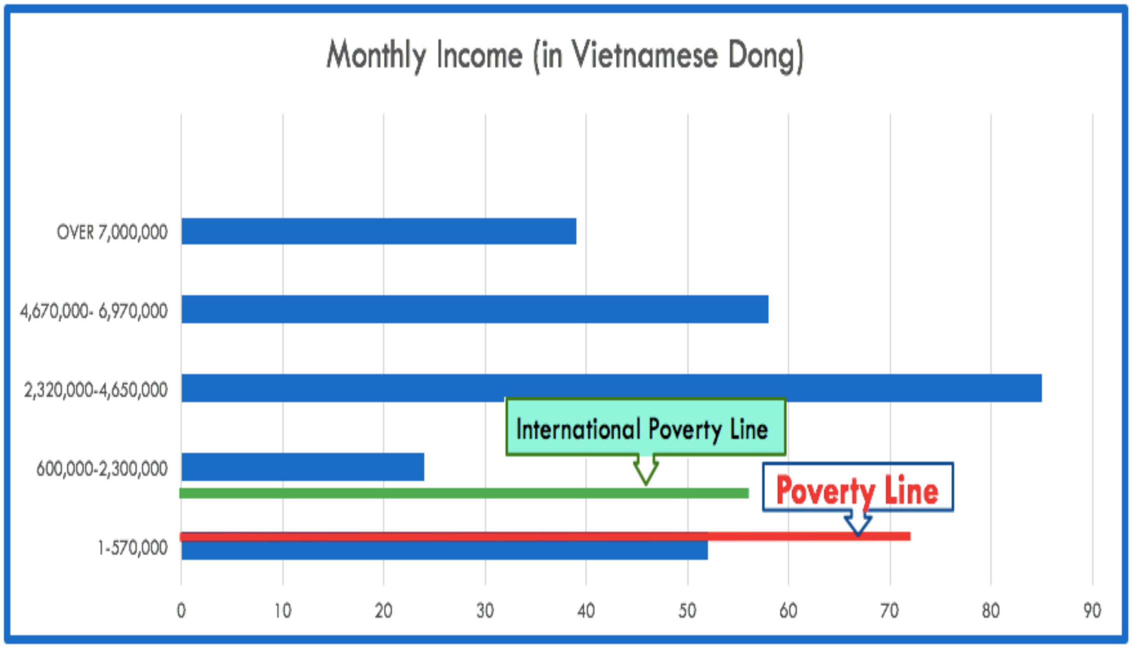
Sixty three percent (63%) of the households vary from four to six members which are mostly composed of members within the productive working age. Fifty-five percent (55%) of the farmers have attended elementary level of basic education.

Table 13 Socio-economic Characteristics of the Respondents (n = 258)
Ben Tre and Tra Vinh Provinces, Vietnam, 2017

Social Characteristics	Frequency	Percentage	Mean
Head of the family	161	62.42	-
Sex (male)	157	61	-
Age (over 50)	206	63.19	49
Rice-farming Experience (21-30 years)	120	46.51	28
Legally Married	234	90.70	-
Total Household Members (4-6)	164	63.57	4.25
Total Number of Dependents (0)	118	46.74	0.78
Highest Educational Attainment (Elementary level)	141	55.43	
Household Income below Poverty Threshold	52	20.16	
Own House with Land Title	256	99.22	
Farm size is less than 1 hectare	177	68.60	1.23 ha
Membership in Organizations	93	36.05	1

The World Bank's updated the International Poverty Line (IPL) in October 2015 is at $1.90 a day. The new figure of $1.90 is based on purchasing power parity (PPP) calculations and represents the international equivalent of what $1.90 could buy in the US dollar in 2011. Sixty-eight (68) farmers or twenty-six percent (26%) in Vietnam are below the IPL (Figure 9).

Official per capita poverty threshold for rural areas in Vietnam is pegged at VND 570,000 per capita per month or US$ 24.52 (General Statistics Office (GSO), 2015). Using these as the yardstick, fifty-two (52) farmers or twenty percent (20%) would fall under the poverty line.



Note: Per Capital Poverty Threshold: Rural Area, Vietnam: VND 570,000 per capita per month / US$ 24.52 (General Statistics Office (GSO), 2015)
International Poverty Line (IPL) to $1.90/day (World Bank, 2015)

Figure 9 Monthly Income Per Capita Poverty Threshold in Selected Communes Ben Tre and Tra Vinh Provinces, Vietnam

On the average, the households in the communes in Ben Tre are below the country's official poverty line (Figure 10). The information generated from the GIS Maps may be used as basis for targeted interventions aimed at poverty alleviation in the communes, especially in targeting interventions and in-depth assessments and setting of priorities for programs aimed at reducing poverty.

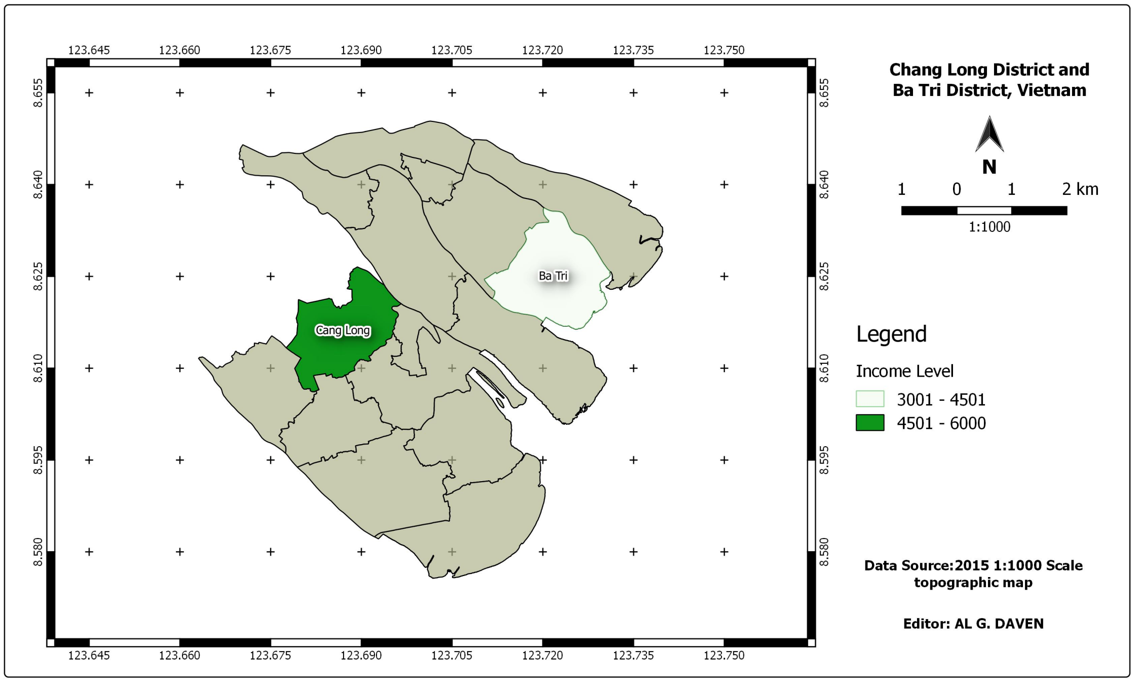


Figure 10 Average Income Level in Selected Communes, Ben Tre and Tra Vinh Provinces, Viet Nam

Growing rice is the major source of livelihood in the two provinces because it is considered more sustainable practice compared to aquaculture, which may be profitable but entails higher risk. Income from aquaculture is on average seven times higher for extensive shrimp farming (Black Tiger Shrimp, 5 shrimps/m2) and thirty times higher for intensive shrimp farming (White Leg Shrimp, 25 shrimps/m2) per hectare as compared to income from rice production. However, investment costs are high and shrimp can catch diseases quickly which often results in total production failure (Ratering Arntz, 2018).

In rice-shrimp rotational areas, farmers grow shrimps on their fields in the dry season when there is a shortage of fresh water. Rice yields are usually lower but farmers have on average due to the profitability of aquaculture (DARD, 2017).

Farmers often grow vegetables on the banks of their fields to make more income. Other additional sources of income include livestock production such as pigs and ducks and selling goods from small house shops. Surface water from the canal system is the main source of irrigation water for farmers, who use pumps to supply their fields.

Table 14 shows the most valuable assets owned by rice-farming households. The four most common valuable assets owned by the households are television (98%); cellphone (94%); electric fan (85%) and LPG tank (84%). A minority of farmers, around five percent (6%) own a motorcycle. They are mostly large-scale farmers who own agricultural lands over two (2) hectares.

Table 14 Valuable Items Owned by Households (Multiple Responses)
Ben Tre and Tra Vinh Provinces, Vietnam, 2017

Valuable Items	Frequency	Percentage
Television	254	98.45
Mobile Phone	244	94.57
Electric Fan	220	85.27
LPG Gas	217	84.11
DVD Player	123	47.67
Electric Iron	121	46.90
Jewelry	118	45.74
Refrigerator/Freezer	97	37.60
Stereo	62	24.03
Karaoke	48	18.60
Sewing machine	20	7.75
Motorcycle	16	6.20
Washing Machine	10	3.88
Others	53	20.54

Institutional Affiliations

The institutional affiliations of the farmers and its household is a form of social capital. It can be both a capital stock and a mobilizing force (Beckley et al. 2002). The institutional affiliations may include informal social networks and the associational life in a community, which influence the ability and willingness of residents to work together for community goals, and the norms and networks that facilitate collective action. Additionally, the farmer's affiliations may be means to which they draw strategies in pursuit of their adaptation. These are developed through civic or community engagements that increase trust and ability to work together and expand their access to wider institutions through networks and connectedness between individuals with common interests. Affiliations promote adherence to mutually agreed norms, rules and sanctions that often entails membership of more formalized groups. Mutual trust and reciprocity reduces transaction costs of working together and provide the basis for informal safety nets amongst the poor (Glaeser and Redlick, 2008).

Institutional affiliation indicators used in this research include households with formal or informal membership in various organizations or associations in the community and sources of primary and secondary information. The Philippines' results show that ninety one percent (91%) have membership in formal or informal organizations (Table 15). Most of them are also active in the irrigators association either in the two community irrigation systems called the Nazareno Gamutan Agricultural Development Irrigation Association (NGADIA) and the Mamanga Daku, Mamanga Gamay, Baliangao Community Irrigation System or the National Irrigation Administration (NIA). The irrigators' association is one of the institutions they consider important in growing rice. In most of the barangays surveyed, farmers are informally organized by "*cabicilla*" or groups of parcels of land in a given area with around thirty "*cabicilla*" groupings in the various barangays. This arrangement is very convenient in terms of communicating and organizing the farmers, such as calling for meetings and conducting trainings. Each barangay has also their own farmers' association which is not only limited to rice farmers but to all types of agricultural farmers. These organizations are able to help farmers gain access to most services and inputs for their production.

Table 15 Farmers' Membership in Organization (Multiple Responses)
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

Membership in Organization	Frequency	Percentage
Irrigators' Association	202	61.96
Farmer's organization	95	29.14
Other Types of organizations	107	32.82

In the two provinces in Vietnam, only ninety-three (93) or thirty six percent (36%) are members of organizations.

Table 16 Farmers' Membership in Organization (Multiple Responses)
Selected Communes, Ben Tre and Tra Vinh Provinces, 2017

Membership in Organization	Frequency	Percentage
Members	93	36.05
Not Members	165	63.95
Total	326	100.00

As cited in most literature, the organizations and community networks of farmers assist them in taking appropriate production and marketing decisions for their crops. It enhances farmers' local production by making available timely information on various stages of crop development that guide them specifically on decisions pertaining to input usage. They also serve as a reference for emergency planning and the rehabilitation of farming systems after disasters (Below et al., 2012; UNDP, UNCDF, & UNEP, 2013).

FARMERS' AWARENESS, PERCEPTIONS AND EXPERIENCE ON CLIMATE RELATED EVENTS AND SALTWATER INTRUSION

This section analyzes farmers' perceptions and awareness on saltwater intrusion and other climate related events. The data were collected through the socio-economic survey.

There are varied perceptions on saltwater intrusion risks based on the farmers' evaluation of long-term risk, including the identification of thresholds, or points at which adaptive behavior begins (Grothmann & Reusswig, 2006).

These perceptions are usually based on actual experience as major source of well-established information assimilation, which may motivate action. Individuals' interpretation of information is mediated by personal and societal values and priorities, personal experience and other contextual factors (Mahmuduzzaman, Ahmed, Nuruzzaman, & Ahmed, 2014; Nhan, Phap, Phuc, & Trung, 2010, Binh, 2015).

Over the past decade, a number of changes in climate have been observed worldwide, especially atmospheric warming, increasing variability in precipitation and sea level rise as documented in the Fifth Assessment Report (AR 5) of the Inter-governmental Panel on Climate Change (IPCC) in 2014. The report highlighted that the projected average annual temperatures could rise by more than 2°C by the mid-21st century and exceed 3°C, and up to 6°C over high latitudes, by the late 21st century under a high-emissions scenario. Under a low-emissions scenario, average temperatures could rise by less than 2°C in the 21st century, except at higher latitudes, which could be up to 3°C warmer. The report also indicated that the magnitude of sea level rise by the century's end implies significantly increased risks for coastal settlements in Asia, as well as for coastal economies, cultures and ecosystems. On a global level, IPPC warned that climate change could affect food security by the mid-21st century.

Most studies of climate change in agriculture have focused on empirically estimating the effects of climate change on crop yields. While these provide evidence of historical and projected climate trends, as well as the likely effects of climate change on agricultural productivity, they incorporate very limited qualitative analysis (Deressa et al., 2009; Mertz, Mbow, Reenberg, & Diouf, 2009; Tschakert, 2007). The integration of meteorological records with observations of local people is also indispensable to arrive at a more relevant analysis of the nature of climate change (Mulenga, Wineman, & Sitko, 2017).

A qualitative approach involving the observations of local people is necessary to construct a more thorough and relevant analysis of the nature of climate change (Mulenga et al., 2017). Local knowledge may illuminate important elements of change at localized geographic scales which impact local livelihoods (Mohammed Nassrasur Uddin et al., 2017). Local narratives on climate change is necessary as a prerequisite for adaptation strategies to be adopted (Arshad et al., 2017; Gandure, Walker, & Botha, 2013; Kibue, Liu, & Zheng, 2016; Valley, Li, Tang, Luo, & Di, 2013).

Climate changes will progressively threaten human security, the protection of the vital core of human lives and the freedom and capacity to live with dignity. Climate change threatens human security through undermining livelihoods; compromising culture and identity; increasing migration that people would rather have avoided and challenging the ability of states to provide the conditions necessary for human security. Thus, improving the capacity of states to conduct effective adaptation efforts becomes imperative (Adger et al., 2014).

In doing so, it is important to determine farmers' perception about causes and impacts of climate related events in relation to the choice of adaptation measures. It is expected that farmers who recognize climate change will take appropriate adaptation measures to cushion themselves against its adverse effects (Komba & Muchapondw, 2015).

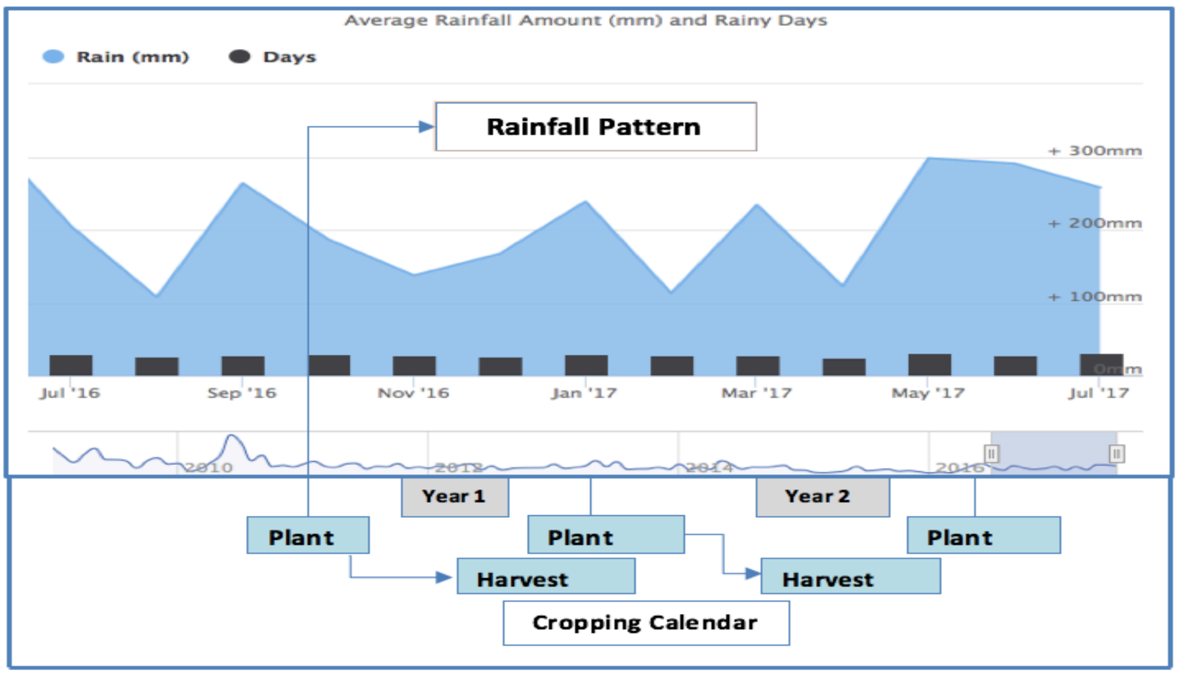
Simelton et al. (2013) contended that appreciating how changes are perceived at the local level is crucial in anticipating the impacts of climate variability and/ or change. The farmers who perceive a problem will implement strategies to adapt or respond to it. How farmers perceive climatic trends will influence the extent of farmers' adaptive capacity which can strengthen the design of contextually relevant adaptation plans (Arshad et al., 2017). Thus, one section in the survey questionnaire was devoted to asking the farmers certain climatic events that trigger coastal flooding and aggravate salinity in rice fields. These events include flooding, storms, erratic rains and droughts.

Farmer's Experience and Perceptions on Climate Related Events

The changing rainfall pattern has tremendous impacts on the cropping pattern of rice grown in the area. One section of the questionnaire collected information on farmer's experience in terms of changes in natural phenomena and climate affecting rice production in the last 10 years. A 10-year period rainfall pattern (2007-2017) was used to determine the associated impacts of change in rainfall on the rice cropping pattern of farmers. The selection of ten year period as a reference was based on the observation that farmers can best recall events that take place with that time frame (Ludena & Yoon, 2015). Farming activities are greatly affected by the amount of rains available especially during the planting season (Pulhin, 2016).

a. Philippines

In Plaridel planting season coincides with the rainy season which takes place between January to February, May to June and September to October as shown in Figure 11.



Source: Philippine Atmospheric Geophysical and Astronomical Services Administration
Rainfall Pattern Figure: World Weather Online
Cropping Calendar: Arranged by Researcher

Figure 11 Annual Rainfall (in millimeter) and Cropping Calendar, Dipolog, Zamboanga del Norte, Philippines

Unseasonal and erratic rainfall has long been experienced in the area. However, the variability has not been very frequent as claimed by sixty eight percent (68%) of the respondents (222 farmers) as shown in Figure 12. This coincides with the PAGASA report on the pattern of rainfall from 2009-2017 where significant variations were observed in 2009 and 2010. The figure is based on the PAGASA weather monitoring system installed in Dipolog City which is the closest city to Plaridel Misamis Oriental (distance of 60 kilometers). Some farmers nonetheless noted that the prolonged rains (changing climatic patterns) was the dominant climatic event experienced by the farmers more recently, specifically the devastating event that took place last January 2017.

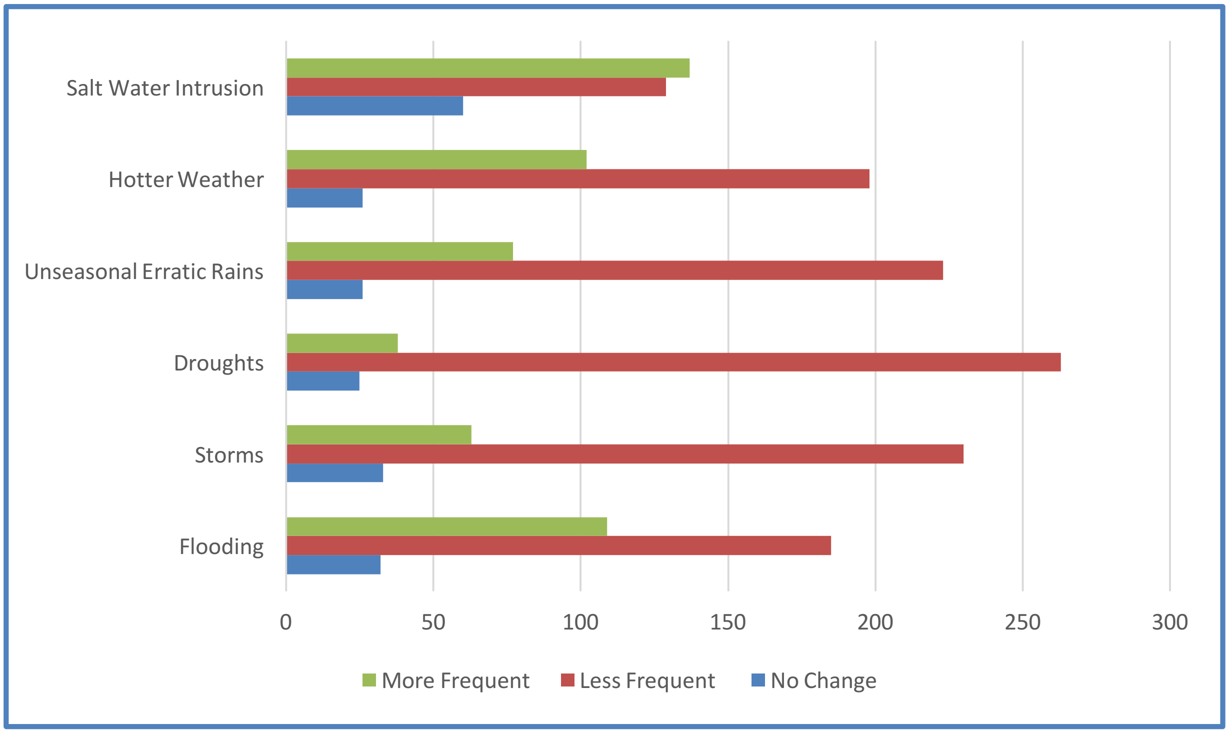
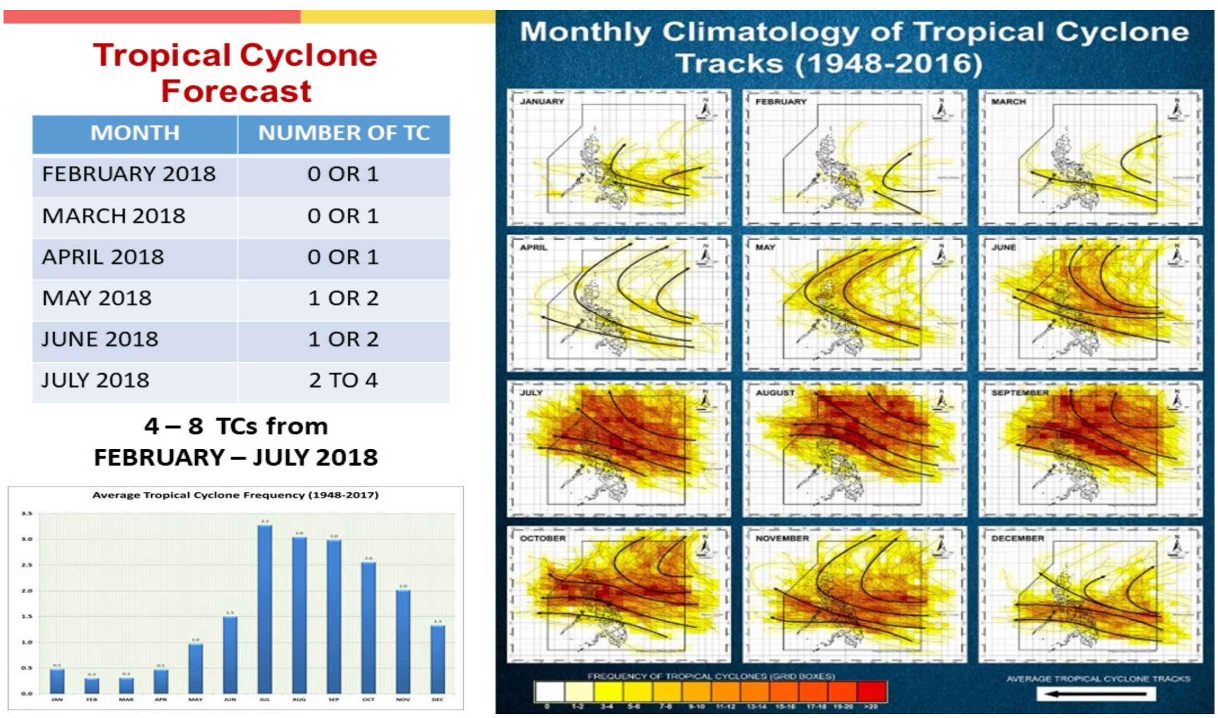


Figure 12 Farmers’ Perceived Frequency of Climate Related Events
Selected Barangays, Plaridel, Misamis Occidental, Philippines

According to farmers during the FGDs, the pattern was still regular from the 1990s where the amount of rains decreases in summer time usually during April and slowly increasing to its peak in May and then gradually decreases until December. In the past ten years (the time frame used in the study), the farmers expressed that most of them were expert in foretelling the onset of rainy season but with the changing climate, even the onset of rainy season becomes unpredictable to them. More recently, they noted that their expectations of the onset of the rainy seasons has become unpredictable as the rainy seasons have shifted through the years. This becomes problematic, especially when they are not abreast with latest weather reports from various media sources.

During the FGDs, a number of farmers expressed that they have to make adjustments in the right time of ploughing, seeding, weeding and harvesting. According to them, the changes in the onset of precipitation led to difficulty in choosing the right time for the different procedures. More importantly, choosing the right time of seeding and harvesting is crucial, which both mainly are determined by the start and end of the rainy season.

Typhoons and storms affect the municipality less frequently relative to other parts of the country according to more than seventy percent (70%) of the respondents (228 farmers). Their perception is consistent with the Manila Observatory (MO) and the data from the Joint Typhoon Warning Center (JTWC). Mindanao (including Northern Mindanao and Misamis Occidental) has the lowest number of typhoons in the country, given that only 35 tropical cyclones made landfall in the Mindanao region between 1948 and 2016 (Figure 6.3). This implied an average of one every two years as compared to other parts of the country that experience around twenty (20) typhoons on the average per year. The reports also noted that only six typhoons made landfall from 1996-2010 prior to Tropical Storm Sendong in 2011. Tropical Storm Sendong (International name: WASHI) hit the region, in particular, Cagayan de Oro City, Iligan City and other neighboring provinces such as Misamis Occidental. The Department of Public Works and Highways (DPWH) predicted that the return period for an event like TS Sendong is around 75 years, but the storm event that triggered it was categorized as having a 20-year return period for its volume of rain. A year later, TS Pablo hit Northern Mindanao including Misamis Occidental. This time, the effective utilization of early warning systems in the various provinces resulted to zero casualties. According to Fr. Pedro Walpole of the Environmental Science for Social Change (ESSC), the currently available research can only give an idea of when the TS Sendong can happen again. Understanding the different permutations and scenarios which could play out is imperative to be better prepared in the future. From 2012 to 2017 sixteen typhoons have been recorded to make landfall in Northern Mindanao (Figure 13) which is higher than the previous periods (Xavier University Engineering Resource Center Report, 2017).



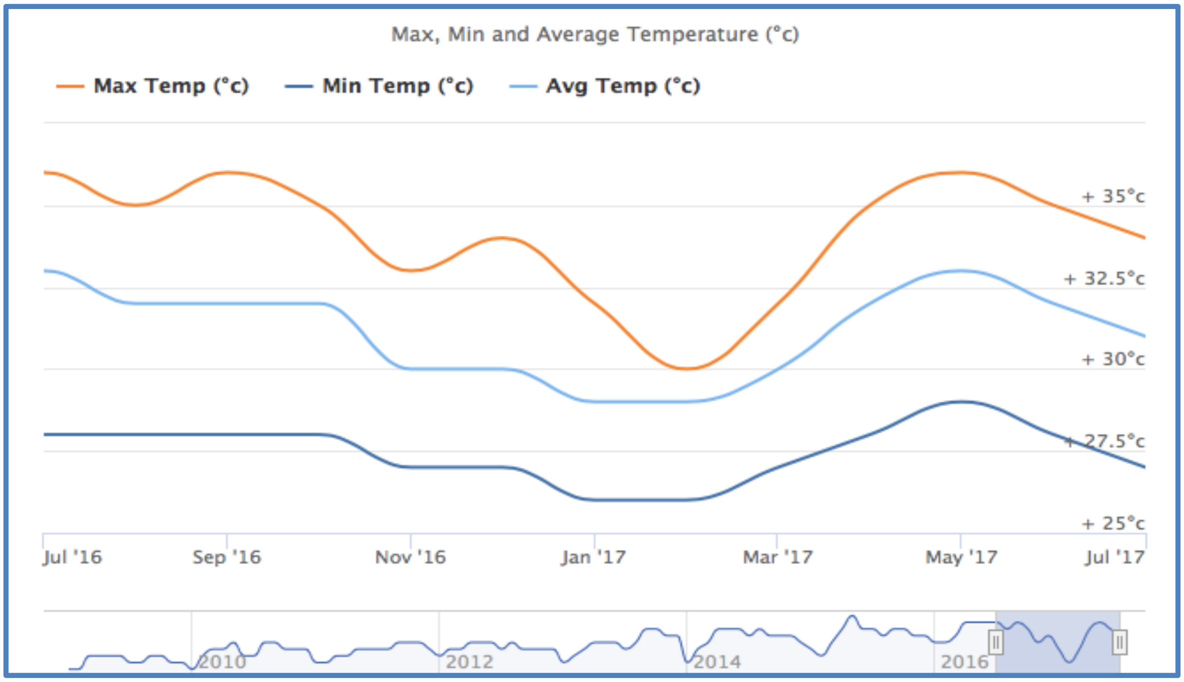
Source: Philippine Atmospheric Geophysical and Astronomical Services Administration (PAG-ASA)

Figure 13 Typhoon Tracks in the Philippines, 1948-2016

Flooding through the Langaran River System is not very frequent according to fifty seven percent (57%) of the respondents (186 farmers). However, this tended to have severe effects and has been one of the biggest challenges faced by farmers in most the barangays. All of these barangays have been adversely affected by the most recent flooding in January 16 2017 which led to the declaration of state of calamity in the entire Municipality. Although a devastating flood of that scale does not happen more than twice a year, many farmers noted that it has been happening on a yearly basis in the last three years. Flooding when coupled with high tide increases the susceptibility of the rice farms to saltwater intrusion.

Similarly, increase in temperature or hotter weather is not as taking place frequently as indicated by the sixty percent (60%) of the respondents (196 farmers). Nonetheless, the respondents cited that it has become warmer in the last ten years. This is supported by the temperature data from PAGASA shown in Figure 14. Despite having eighty percent (80%) of the respondents say that the occurrence of drought is not frequent, El Niño which brought severe drought in 2016 not only in Misamis Occidental and also in the different parts of Mindanao was frequently mentioned.

Among all the climate related events, saltwater intrusion was the only one considered to take place more frequently according to forty two percent (42%) of the respondents (137 farmers). According to the farmers, coastal flooding has become more frequent and this is exacerbated by heavy rains that simultaneously occur with the high tide. Every month, high tide is expected to take place which increases the susceptibility of their rice farms to saltwater intrusion.



Source: Philippine Atmospheric Geophysical and Astronomical Services Administration (PAG-ASA)
Map: World Weather Online

Figure 14 Average Temperature, Misamis Occidental, Philippines

The farmers during the FGDs noted that previously, they only focused their attention on the start and end of the rainy season. However, the more frequent incidence of coastal flooding compels them to be more observant of timing the cropping season with the schedule of the high tide. Furthermore, the farmers often mentioned that the coastal flooding add more stress in the early and latter stages of the rice plant.

The farmers were also asked to assess the various climatic events in terms of intensity which was interpreted as the impact in terms of harm and damages to their rice production activities (i.e., 0: no effect; 1: at least 10%; 2: 11-20%; 3: 30-40%; 4: 41-50%; 5: more than 50%).

Erratic, unseasonal rain and hotter weather were both perceived to have slightly severe intensity as shown in Figure 15. This means that they affect rice production activities but the impact is relatively tolerable in most instances. According to most farmers, erratic heavy rains become a major problem when it coincides with high tide which causes the Langaran River to overflow and increases the probability of coastal flooding. On the other hand, prolonged hot weather is a threat as it causes the "*asgad*" or saltwater to dry up causing damage to the plant.

Flooding and drought occur less frequently but the impact to the rice crops was perceived by majority of farmers to be severe. The severity implied major damages to the crop resulting to less than fifty percent (50%) recovery.

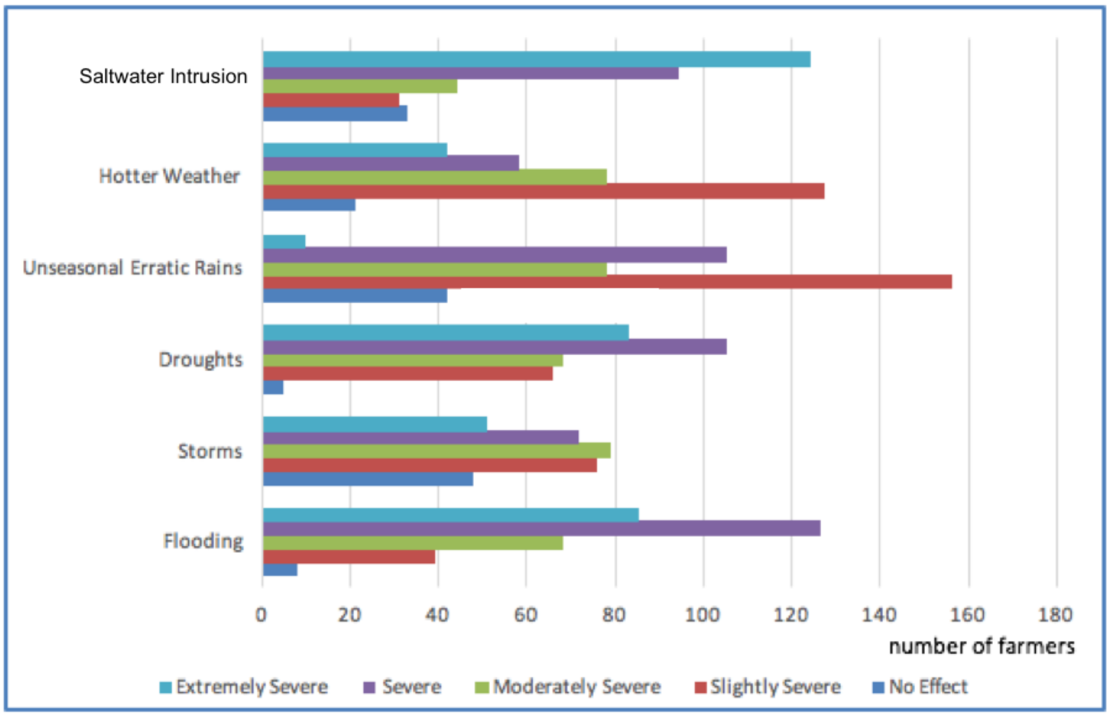


Figure 15 Farmer's Perceived Level of Intensity of Climate Related Events Selected Barangays, Plaridel, Misamis Occidental, Philippines

Saltwater intrusion which has become more frequent in the recent years was perceived to have extremely severe impact. The damages farmers incur take place at the various stages of production. During the planting season, this could mean replanting of seedlings more often than necessary. As a result, farmers would often allocate extra seedlings as replacement for dead plants. This is validated by the data on the seed ratios per *"bulos"* or plot that farmers use. The practice is very common and has also become the major adaptation measure farmers implement.

The major areas often suffering from this incidence manifest in uneven growth of plants, the physical indicators of the impact of "*asgad*" which local farmers would describe "*pula-pula*" or yellowing of the tip of the leaves resulting to the abandonment of plots were saltwater were trapped. The researcher saw all these during the field reconnaissance with the Mayor and some LGU Officials and during the field surveys where farmers showed the actual impact. If the saltwater intrusion take place at the mature stage of the rice plant, the farmers have no other recourse, which often lead to a reduced yield, often less than half of the potential harvest. Again, this can be shown by the data on farmers' rice yield during the reference year for the survey.

Finally, farmers were also asked about their capability to manage impacts of climate related events. For example, sixty percent (60%) of the farmers were not threatened by the rising temperatures and claimed that the farmers in Plaridel can adapt to the changes because of the relative abundance of water supply sourced from the Langaran River system. This confidence in the capacity to "manage" climate impacts at the individual and community level may reduce the perception of climate risks.

Among the farmers surveyed, approximately fifty percent (50%) claimed that erratic rains and hotter weather are the most manageable implying that the risks brought about by these events may be controlled. Though intense storms, flooding, droughts do not occur yearly, the risks and the impacts of such events were perceived unmanageable because they have limited capacity to combat the risks and reduce the potential damage they bring. Saltwater intrusion which occur more frequently was also perceived to have a similar impact. This can be partly explained by the above average level of intensity of these climate related events as perceived by fifty eight percent of the respondents (Figure 16).

Indeed, there are different levels of impact and costs and limitations to managing these climatic events. Furthermore, different socioeconomic groups will have differing capacity to truly manage these impacts (Agarwal et al., 2008; Burton, Huq, Lim, Pilifosova, & Schipper, 2002; Jat et al., 2016; Pulhin, 2016; van Aalst et al., 2008).

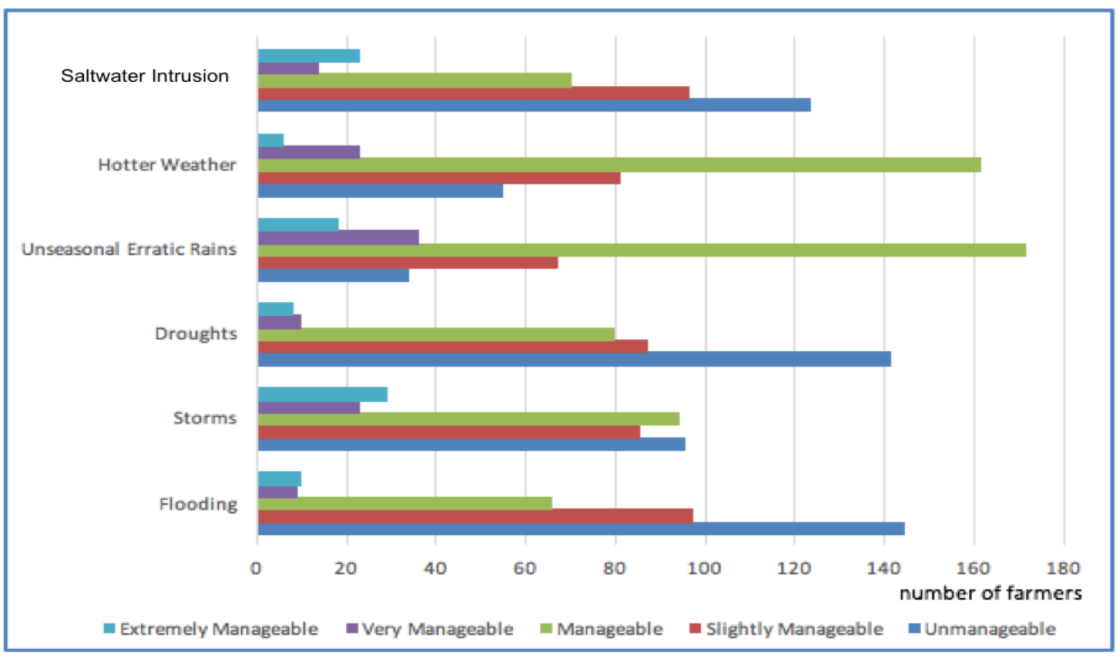


Figure 16 Farmers' Perceived Manageability of Climate Related Events
Selected Barangays, Plaridel, Misamis Occidental, Philippines

A GIS generated map was created to represent a barangay's shared perceptions about climate-related events. It is helpful in understanding the common or diverging perceptions of farmers from within the same barangay. The map can lead to a process that generates a deeper understanding of the perceptions that guide decision making of the farmers that affect their rice production system.

Nine out of ten barangays in Plaridel, Philippines have almost the same perception on the frequency, intensity and manageability of the various climate related events (Figure 17). The map indicates that the respondents from these barangays agree with the general assessment of the climatic events. By and large, there are strong similarities in how these events are perceived by the farmers. It is obvious from this study that though farmers' perceptions of climate related events were based on local climatic events identified by farmers. These farmers are particularly vulnerable to climate change since the majority of them do not have enough resources to cope with change in climate.

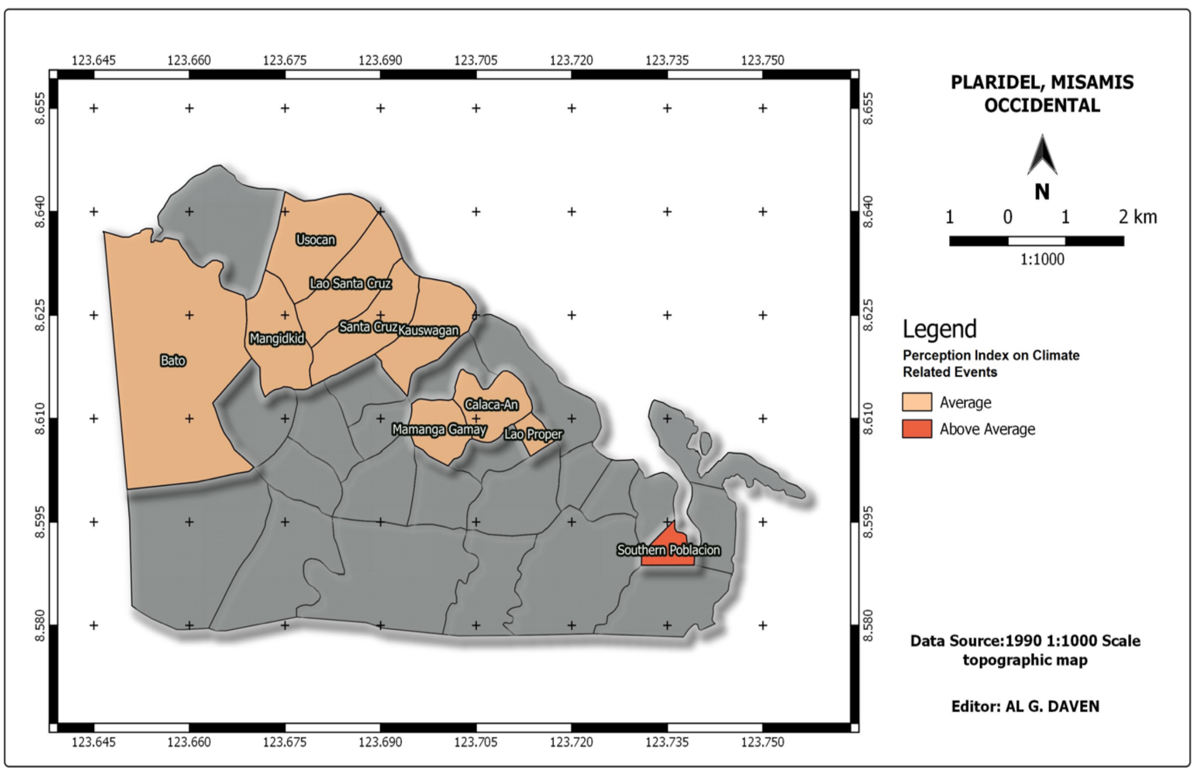


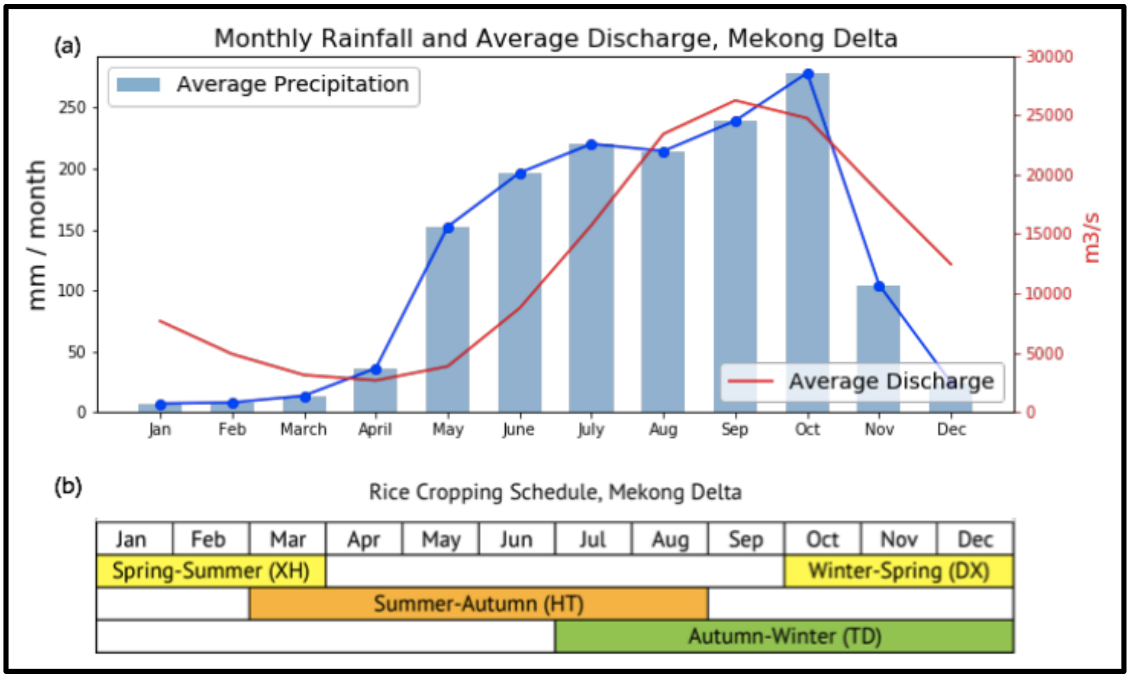
Figure 17 Barangay Level Perception Index on Climate Related Events Selected Barangays, Plaridel, Misamis Occidental, Philippines

b. Vietnam

Ben Tre and Tra Vinh, being located in the Mekong Delta, a tropical monsoon region, are hot year-round and seasonal distribution of dry-wet months depending on the operation of the monsoon. Figure 18 (a) shows that the dry season usually coincides with the period of control of the Northeast monsoon that lasts from November to April, and the weather is characterized by dry heat and little rain. The wet season coincides with the period of control of the South-West monsoon that lasts from May to October, and the climate is characterized by hot, humid, and (high) rainfall. When compared with winter, the summers have much more rainfall (*Mekong delta water resources assesment studies*, 2011). The average annual temperature is 27.3 °C, average rainfall is 1441 mm., monthly average temperature does not drop below 25 degrees Celsius during the year and the average annual precipitation lies around 1660mm (Köppen and Geiger, 2018).

The south-west monsoon causes heavy rainfall from May to November and the decrease in precipitation in December marks the beginning of the dry season, which lasts through April (Figure 18 (b)). The availability of water and location of the two provinces allow different farming to have triple rice-cropping cycles, rice-shrimp rotational farming, orchards, vegetables, and brackish aquaculture.

The income of farmers in the two provinces depends significantly on the weather conditions. For rice farmers, winter-spring is the most profitable crop of the year as the weather is usually favorable. The high number of sunshine hours and relatively dry period prevents pest and disease outbreaks. In triple rice crop areas, the third rice crop (Spring-Summer) generally has the lowest output (Ratering Arntz, 2018).



Source: Arntz, 2018

Figure 18 (a) Precipitation and Discharge Mekong Delta, Vietnam (Chau Doc and Tan Chau Stations); (b) Rice Cropping Schedule Mekong Delta, Vietnam

Majority of the famers in the two provinces consider saltwater intrusion occur most frequent among all the climate related events Figure 18. This has affected the water quality in the canal systems. The process of mixing sea water and fresh water is influenced by topography, river discharge, and tidal propagation.

In most recent years, the saltwater intrusion has reached a maximum length of 35-40 km. In the dry period, saltwater ingresses through drains, creeks, and rivers in the delta. The construction of water management control measures such as dikes and sluices are built to keep the saline water out of irrigation areas. However, many canals have not yet been equipped with sluices to prevent saltwater intrusion. In addition to management issues, several other factors influence the severity of the salinity intrusion (DARD, 2017). Upstream of the Mekong Delta, forests are rapidly being converted into intensive agricultural land and dams are constructed along the entire stretch of the Mekong River, decreasing downstream discharges (CGIAR Research Centers in Southeast Asia, 2016; Danh & Khai, 2014; Karila et al., 2014; Khang et al., 2008; *Mekong delta water resources assesment studies*, 2011; Smith, 2013; Thuy & Anh, 2015).

Increased groundwater extraction has led to severe subsidence issues in the Mekong Delta which outpaces the risk of saltwater intrusion caused by sea level rise (Konishi, 2011; Ratering Arntz, 2018). In addition, dam construction reduces the supply of fertile sediment to the delta (Danh & Khai, 2014). Consequently, saline water infiltrates groundwater aquifers, and salinity gradients increase in large parts of the Mekong Delta, in particular during the dry-season months. Moreover, the region is likely to experience a shift in wet and dry seasons and an increase in the duration of the dry season (Danh & Khai, 2014; *Mekong delta water resources assesment studies*, 2011).

The farmers also cited that unseasonal erratic rains caused lower discharges with respect to the normal dry and wet season discharges in the Mekong river. Erratic unseasonal rains cause saltwater to intrude further inland under tidal influence via the delta's main distributary branches.

The impact of saltwater intrusion in rice farms is perceived by majority of the farmers as severe to extremely severe (Figure 19). High level of rice productivity is dependent upon the abundance of fresh water from the Mekong River, which makes the production of a dry season crop with irrigation possible. However, saltwater intrusion is a major constraint to the irrigation planning initiatives for rice cultivation in the the two provinces especially in the coastal areas in Ben Tre.

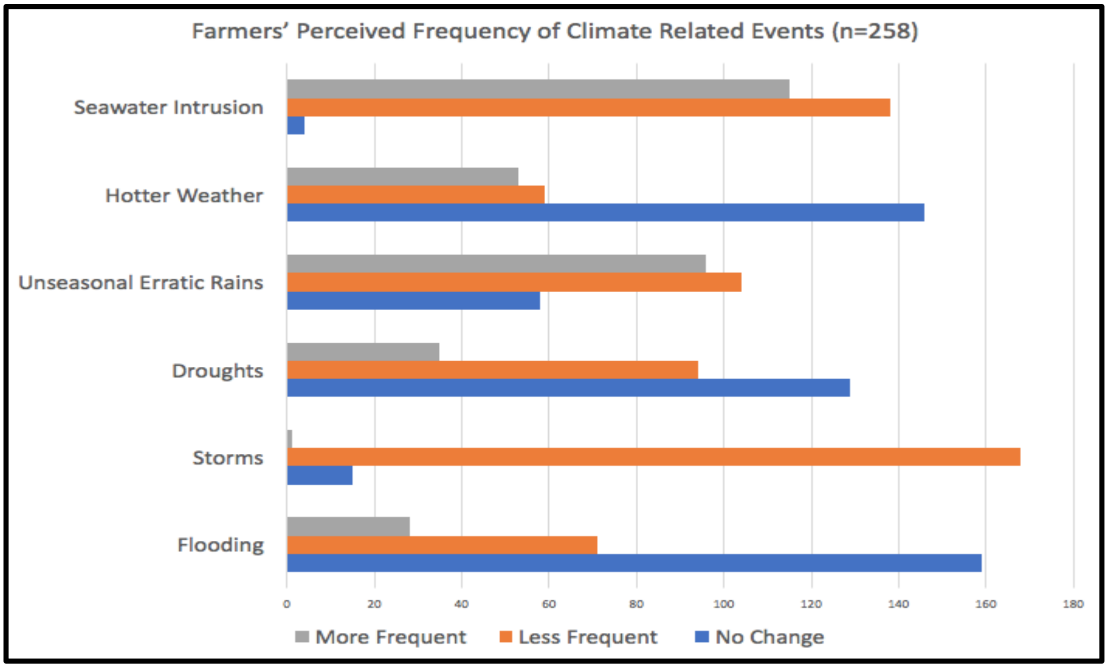


Figure 19 Farmers' Perceived Frequency of Climate Related Events
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

In 2016, saltwater intrusion expanded much earlier and more extensively because of drought. The drought and high evaporative demand, reduced substantially the source of fresh water for irrigation causing the farmers to struggle as their rice crops were massively damaged. According to the Ministry of Agriculture and Rural Development, 400,000 ha of cropland have been damaged by drought and saltwater intrusion, of which 25,900 ha were left fallow. Rice yields dropped by 6.3% due to spoiled crops in 11 of the 13 provinces in the Mekong Delta. The national water authorities declared that the drought has resulted in the decrease of groundwater levels and the most extensive salinity intrusion in last 90 years in the Vietnam Mekong Delta (Ratering Arntz, 2018).

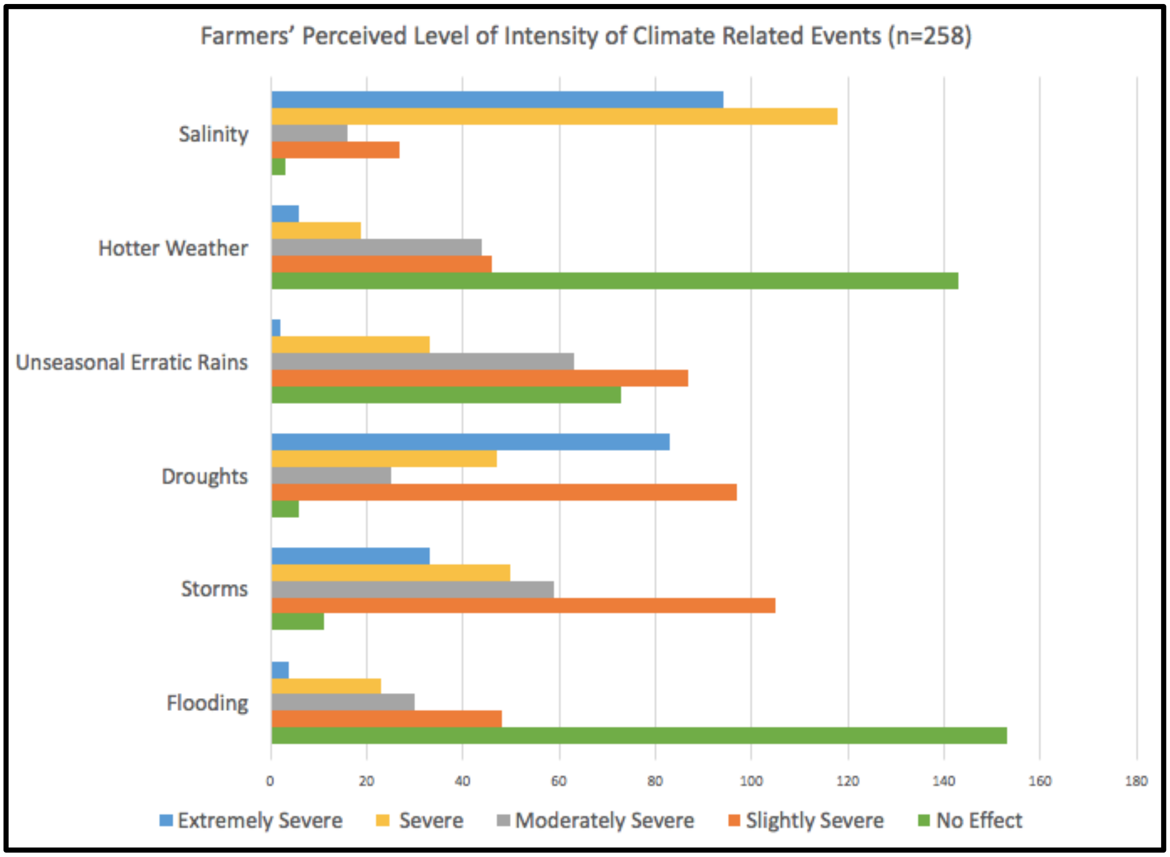


Figure 20 Farmers' Perceived Intensity of Climate Related Events
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

The farmers' perceived unmanageability of saltwater intrusion and all other events (Figure 21) may be among of the ascertained consequences of the global climate change. The change in the Mekong River flow and sea level rise were identified as being two of the most disruptive factors affecting agricultural production (DARD, 2017). The farmers' doubts in managing the impacts are understandable given that climatic predictions are variable causing difficulties in the decision-making process (Pulhin, 2016) which has serious implications regarding their adaptive capacity.

The study of Khang et al. (2008) has shown that approximately 0.6 million ha of potential rice cropping area in the eastern central region of the Vietnam Mekong Delta will be significantly affected by two of the most ascertained consequences of global climate change due to sea level rise and the reduction of the Mekong River flow in the dry season. In addition, climate change will not only alter hydrological conditions but also increase the risk of extreme floods and droughts, affecting the rice production adversely in the coming decades. Flooding of fields due to intense rainfall is expected to cause greater damages to rice production in the rainy season.

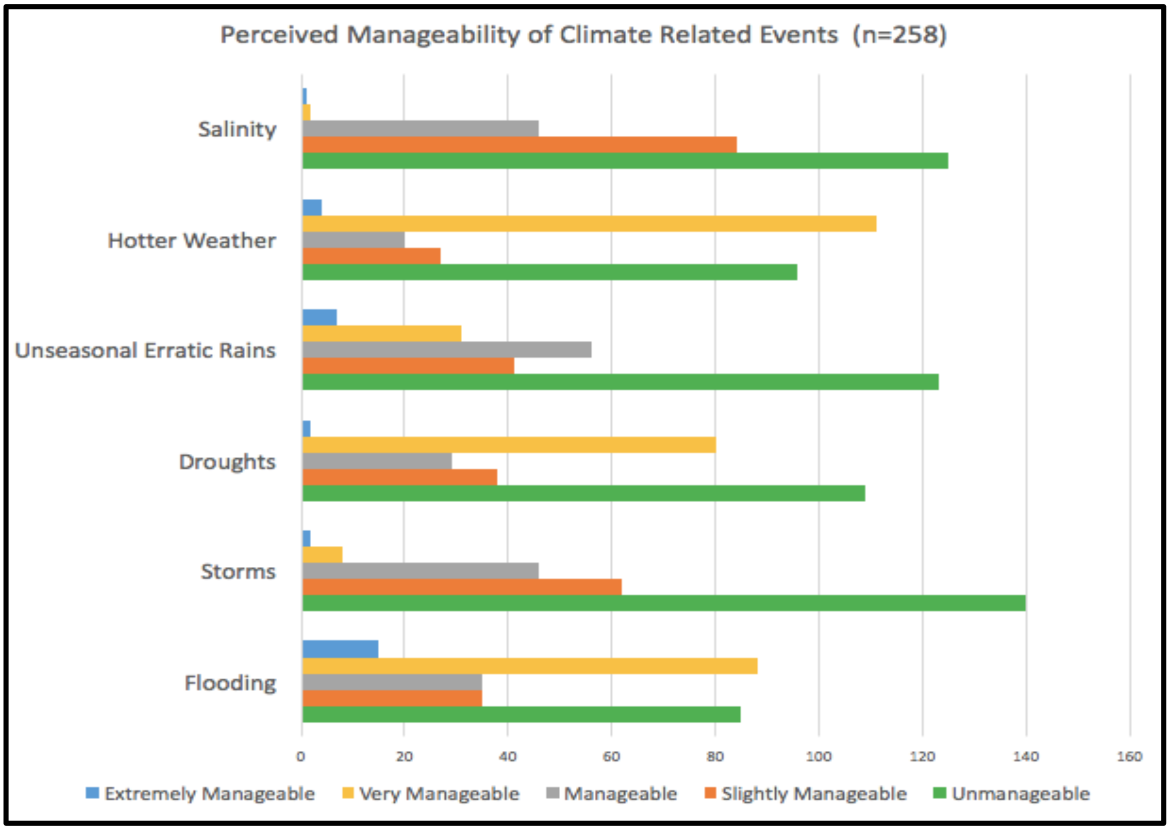


Figure 21 Farmers' Perceived Manageability of Climate Related Events
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

The GIS map created to represent the farmers' overall perception on climate related events show that the they have similar levels of perception on the frequency, intensity and manageability of the various climate related events (Figure 22). The map indicates that the respondents from these communes in Ben Tre and Tra Vinh agree with the general assessment of the climatic events.

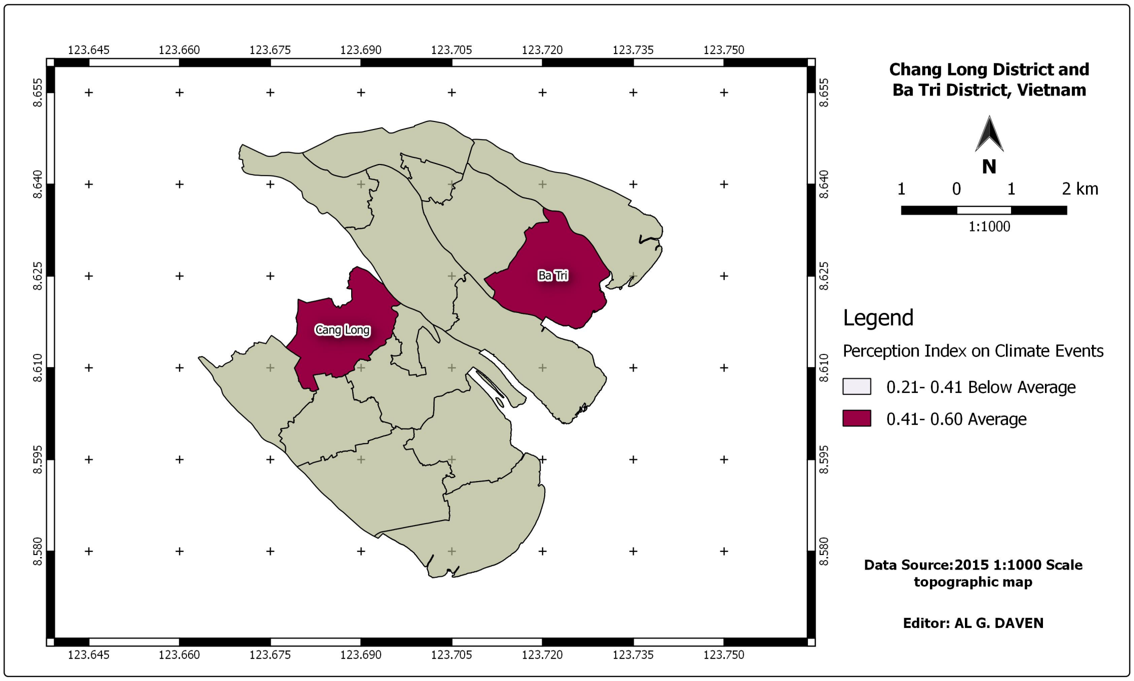


Figure 22 Commune Level Perception Index on Climate Related Events
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

Farmers' Level of Awareness on Saltwater Intrusion

As discussed in the preceding section, awareness is an indication of the consciousness and knowledge of climate related events and its effects (Smit & Wandel, 2006). In particular, awareness of fundamental facts about saltwater intrusion is a precondition for the farmers' decision for adaptation measures. One section in the questionnaire was intended to capture the farmers' level of awareness of crucial information regarding saltwater intrusion based on their experience in the last ten (10) years. Ten major statements were included in the questionnaire to assess farmers' level of awareness.

a. Philippines

The results showed that forty percent (40%) to fifty-five percent (55%) of the farmers were extremely aware of the six major conditions related to saltwater intrusion in terms of: incidence in coastal areas; the occurrence in the rice farms; frequency of occurrence; physical manifestation to the rice plant which the farmers described as "pula-pula" or yellowing of the tip of the leaf; reduction of soil fertility; and the negative effects to rice productivity (Figure 23). During the FGDs, farmers often mentioned that saltwater intrusion has been a common phenomenon in the municipality has been taking place since the last three decades according to the farmers during the FGDs. There are no existing official data as to the extent of saltwater intrusion in the municipality but the existing coastal flooding maps of the municipality would attest to their claims.

In four of the statements, thirty six percent (36%) of the farmers answered moderately aware. These were on the likelihood that extreme rain events will increase the flooding and saturated soils; there are ways of coping with saltwater intrusion; that it is an outcome of climate change and bad natural resource management.

These four facts regarding the saltwater intrusion require some technical knowhow. In terms of natural resource management, many farmers during the survey and the FGDSs mentioned that the presence of nipa plants are indicative of the presence of saltwater as these species only thrive in brackish water. This particular hydrological condition enhances the development of nipa assemblages from the sea shore toward inland areas. The farmers also mentioned that while the presence of these plants can be a potential source of income, at times, they are a problem because they limit the passageways and they trap the flow of saltwater back to the seas, thereby increasing the susceptibility of their farms to salinity. The combination of rainfall amounts, high tide and congestion of the passage way due to thick growth of nipa gives way to more salinity problem.

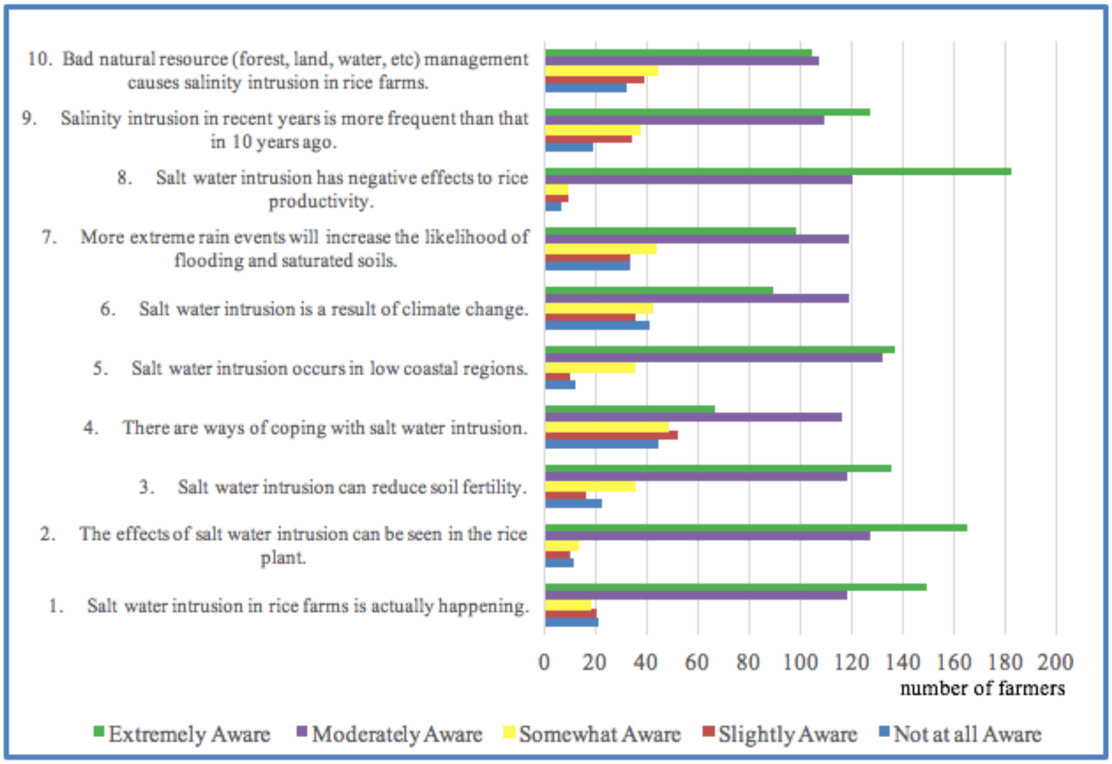


Figure 23 Farmers' Level of Awareness on Saltwater Intrusion
Selected Barangays, Plaridel, Misamis Occidental, Philippines

The heightened level of awareness on saltwater intrusion based on certain indicators, the spatial characteristics, the proximity of the barangays to the coast and the surrounding ecology and the environmental factors are also visually evident in the GIS map (Figure 24), wherein farmers in eight barangays demonstrate above average level of awareness.

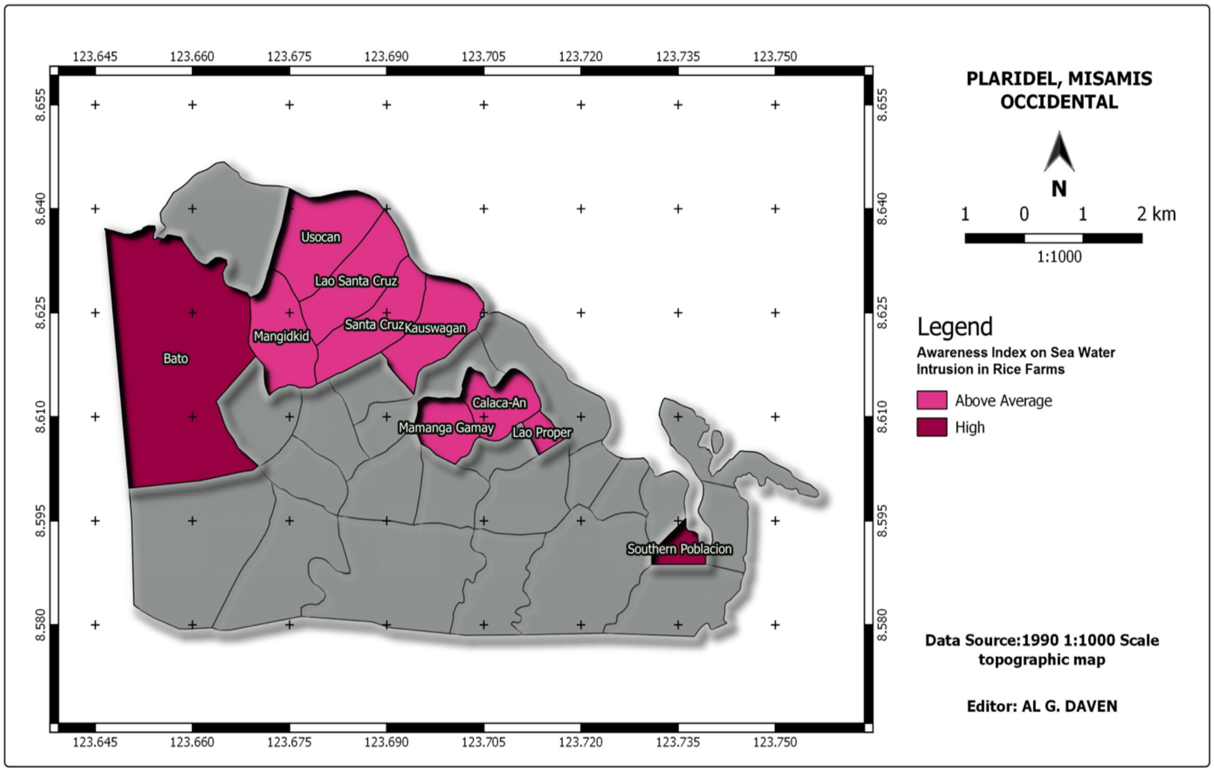


Figure 24 Barangay Level Awareness Index on Saltwater Intrusion Selected Barangays,Plaridel, Misamis Occidental, Philippines

The high level of awareness in Barangays Bato and Southern Poblacion is expected given that these two areas suffered from the most devastating impacts of the past and most recent calamities brought about by coastal flooding. The results indicate that across the entire coastal barangays, farmers have strong sensing of the physical changes due to saltwater intrusion in the rice fields.

b. Vietnam

The results showed that farmers in Ben Tre and Tra Vinh were extremely aware of the four major conditions related to saltwater intrusion incidence in the rice farms. These are: negative effects to rice productivity; physical manifestation of the effects to the rice plant; frequency of occurrence and the occurrence in the rice farms (Figure 23).

A number of farmers mentioned that saltwater intrusion has been a major problem in the communes has been taking place since the last three decades. Existing official data and various studies have shown the extent of saltwater intrusion in the various provinces in Mekong Delta in Vietnam and the existing coastal flooding and salinity maps would attest to the claims of the farmers (DARD, 2017; Karila et al., 2014; Khang et al., 2008; Smith, 2013; Thuy & Anh, 2015).

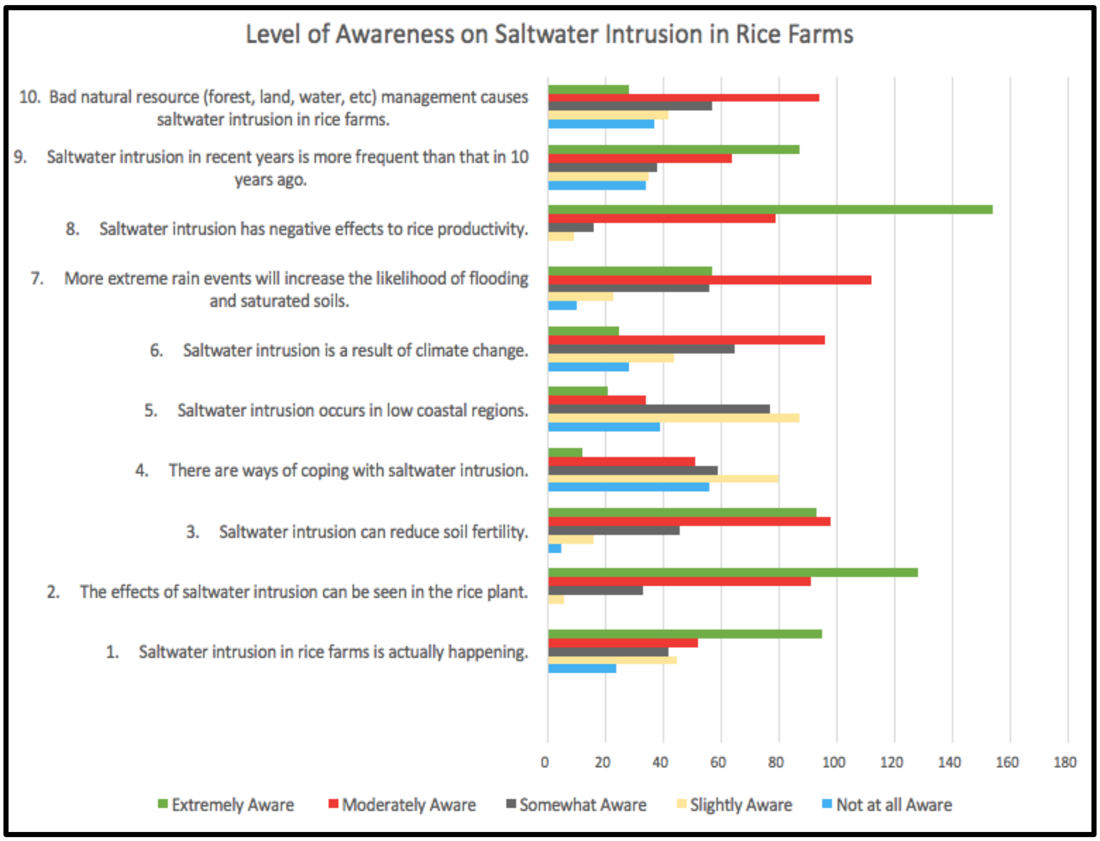


Figure 25 Farmers' Level of Awareness on Saltwater Intrusion
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

Farmers are beginning to perceive that changing weather patterns as the dominant cause of salinity intrusion. The farmers also think that saltwater intrusion is caused by bad natural resource management, especially in water management system. Farmers' opinions on the wrongful operational management of water infrastructure primarily on the decision to operate (open/close) sluice gates are not always made in consultation with the farmers. On the average, less than half of the farmers in the two provinces are able to associate the major indicators, causes and effects of saltwater intrusion in rice farms (Figure 26). These results reflect that the rice farmers in the two provinces are currently faced by the challenging and uncertain conditions brought about by saltwater intrusion.

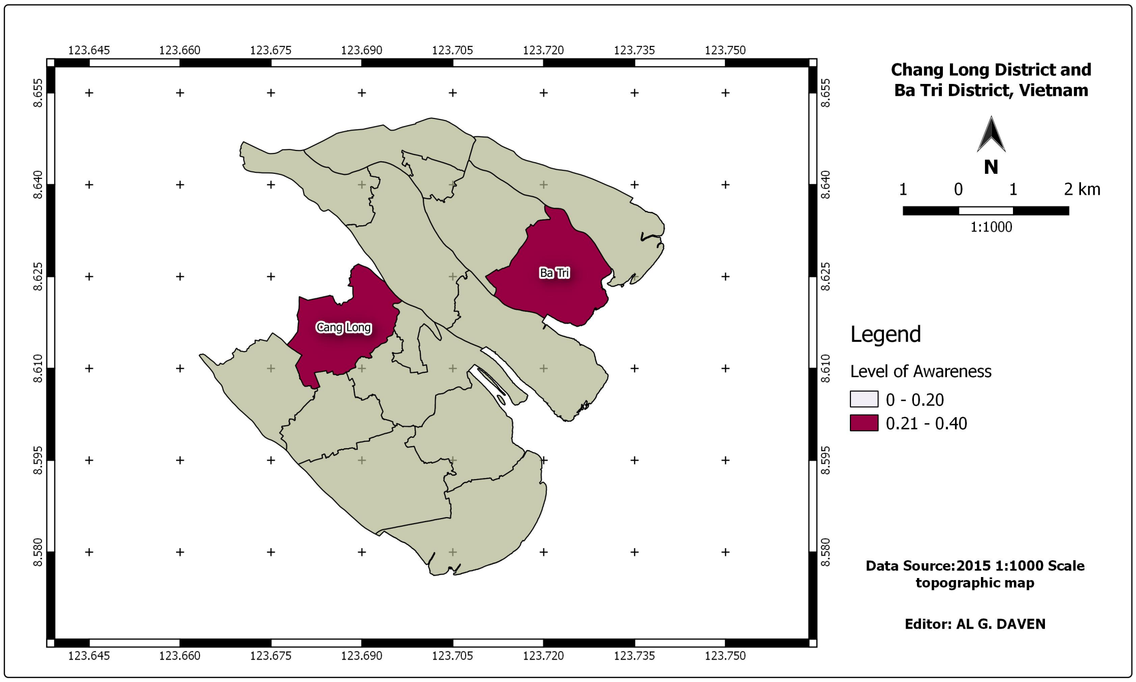


Figure 26 Barangay Level Awareness Index on Saltwater Intrusion
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam

FORMULATION OF THE MEASURE-BASED ADAPTATION INDEX TO ADDRESS SALTWATER INTRUSION

This section discusses the farmer's personal assessment of the feasibility of the adaptation measures implemented. There were two levels of analyses for the assessment of the feasibility of the adaptation measures implemented by the farmers. The first level of analysis involved the identification of adaptation measures implemented in various periods. The reference periods were the last cropping, present cropping and next cropping cycle.

Identifying climate-specific farmers' adaptation behavior is vital in order to facilitate a societal response to the changes in climate. Tailoring adaptation measures to specific climate change events may make it possible to offset its adverse impacts (Artner, 2010). Several comprehensive studies of farmers' adaptation to climate change focus on adaptation measures and the factors influencing their choices (Bécault, Koenig, & Marx, 2016; Bohunovsky, Jäger, & Omann, 2011; Hubert; meuret, 2007; Kirchhoff et al., 2013; Morton, 2007; Shongwe, 2014). Another type of study compares adaptation practices in a comparative manner using different criteria (Kriegler et al., 2012; Saito, 2013; Soriano, Diwa, & Herath, 2017; Torres-Delgado & Palomeque, 2014; Tripathi & Mishra, 2016).

Given the multifaceted features of adaptation and the difficulty to compare the very different adaptation measures cited in various studies, this study sought to aggregate adaptation responses into household measures that would contribute to the goal of adaptation to saltwater intrusion. Research on emerging scholarship in adaptation to saltwater intrusion provides an opportunity in developing new approaches by which adaptation can be tracked. One of the intentions of this research is not to identify which approach is best but rather identify the different measures that can be grouped for specific purposes. The main aim in coming up with a typology of measures is for comparative purpose and to identify and prioritize broad-level intervention needs (Noble et al., 2014). In this context, the typology is intended to systematically track adaptation across households to be able to draw upon the general data that can be used to provide information to policy makers and various stakeholders.

The second level of analysis was the farmers' assessment of the feasibility of implementing the measure based on the most important criteria. This research applied the multi-criteria analysis (MCA) in assessing the feasibility of adaptation measure. The MCA provides one systematic strategy for decision makers to make sense of the wide range of information that may be relevant to making adaptation choices (Eakin & Bojórquez-Tapia, 2008; Harrison & Qureshi, 2000; Rolland, 2013). There are multiple methods for conducting an MCA to which around more than forty (40) methods have been identified in various literature reviews. Some methods rely on a rapid stakeholder engagement process to identify and then place values on particular criteria, which are then used to make decisions through a discursive and deliberative process. Other processes integrate numerical weighting of the importance of each criterion to produce a list of prioritized policy alternatives or options (Dixit & McGRay, 2013).

Adaptation can be motivated by many factors, including the goals of the individual farmer such as protection or reduction of risks. It can be evaluated through extension of social networks or through actions of individuals and organizations to meet their own individual or collective goals (Barnett & Adger, 2007; Kumar et al., 2012; Vaughan & Dessai, 2014). To understand the motivation of farmers in their choice of adaptation measures, it is important to examine how farmers appraise the feasibility of their adaptation measures. However, investigation of the appraisal adaptive measures in climate change research has been discussed in only a few studies (Asante et al., 2012; Below et al., 2012; Grothmann & Reusswig, 2006). Hence, this research is an attempt to contribute to the knowledge base by exploring farmers' appraisals of feasibility of measures to address saltwater intrusion. It explores the major feasibility criteria farmers prioritize in their choice of adaptation measures, taking into account explicitly the effect of temporal scale.

Defining success simply in terms of the effectiveness of meeting objectives, however, is not sufficient. Thus, a survey of literature in developing countries in Southeast Asia was conducted to determine the most important criteria. In these studies, the choice of adaptation measures depended on the availability of financial support; limited barriers to implementation; effectiveness of adaptation (influenced by geographic factors, knowledge on climate variability, organizational membership); accessibility and affordability of particular adaptation procedures; effectiveness in reducing vulnerability and increasing resilience; stakeholder participation, engagement and support; and social acceptability (Nguyen, Takagi and Estebar, 2014; Noble et al., 2014; Pulhin et al., 2016). These criteria were later on validated through the FGDs during the pre-testing of the questionnaires and the rapid rural appraisal. The final criteria chosen were: farmer's ability to adapt, effectiveness, cost of implementation and the level of support by major stakeholders.

Four major criteria were chosen to assess the feasibility of the adaptation measures under varying conditions of saltwater intrusion. These criteria coincide with the coping appraisal under the protection motivation theory (PMT) (Floyd, Prentice-Dunn, & Rogers, 2000). The adaptation appraisal is also consistent with the economic Utility Maximization Theory which aims to minimize costs and maximize the individual utilities over the time horizon, geographical space and range of states of nature. The three criteria are indicators of the efficiency of the measures often judged through the self- efficacy or the ability to implement the measures, effectiveness, and perceived cost of implementing the measures (Grothmann & Reusswig, 2006).

The fourth criterion on support from major stakeholders is important because adaptation to climate change is local. It is crucial to understand better the role of local institutions in shaping adaptation and improving capacities of the most vulnerable social groups. More recently, the role of local institutions have been recognized as an important factor for adaptation especially in poor communities. There are four types of local institutions relevant to adaptation namely civic, public, and private and informal forms. They shape the choice on adaptation measures through a range of indispensable functions they perform in rural contexts such as information gathering and dissemination, resource mobilization and allocation, skills development and capacity building, providing leadership, and networking with other decision makers and institutions. These local public institutions constitute the major stakeholders coming from local governments, civil society institutions, farmer organizations and informal institutions such as friends, neighbors and relatives that normally constitute the most accessible support group (Adger et al., 2007).

Agarwal et al. (2012) cited four major lessons on the relevance of local institutions for adaptation planning. These are: increasing capacity through transfers of information, financial, and technical resources; empowering communities and local governments to decentralize adaptation planning and implementation; creating mechanisms for information sharing among decision makers across sectors and improving accountability of local decision makers to their constituents.

A test was performed to ensure the reliability of the chosen criteria for feasibility. Based on the Cronbach's alpha results of 0.974, the four indicators of feasibility have very high level of reliability as shown in Table 17. The summary statistics are shown for the seven (7) items comprising the scale. The inter-item correlations for the seven items were also computed, i.e., the correlation between the first item and the sum of the other six items, the correlation between the second item and the sum of the other six items, and so forth. The higher the correlation, the better the reliability. Another item that needs direct primary attention is the Corrected Item-Total Correlation which is the correlation of the item designated with the summated score for all other items. Table 17 shows the correlation between the items which ranges from 0.85- 0.96. A rule-of-thumb is that these values should be at least .40 (George and Mallery, 2003). The Alpha if Item Deleted is also one of the most important column in the table representing the scale's Cronbach's alpha reliability coefficient for internal consistency if the individual item is removed from the scale.

Table 17 Reliability Analysis on Four Feasibility Criteria

	N	MEAN	VARIANCE	STD. DEVIATION	
STATISTICS FOR SCALE	7	12.61	108.688	10.425	
Item Means	7	1.801	.091		
Item Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AdapL1	11.10	83.516	.905	.889	.970
AdapL2	10.94	81.655	.949	.943	.967
AdapL3	11.00	82.960	.953	.932	.968
Adaptability	10.27	72.087	.965	.937	.967
Effectiveness	10.76	79.993	.906	.860	.970
Cost	10.56	78.524	.865	.785	.973
Support form SH	11.04	82.657	.858	.770	.973
	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items			
Reliability Coefficients	.974	.977			

Adaptation Measures

In this research, adaptation measures are categorized as technology-based, farm-based crop management, ecosystem-based adaptation (EBA), off-farm income diversification and other measures. They are discussed in detail in the succeeding sections.

Technology-based Measures

Farmers adapt to climate change employing different forms of technology. Farmers in particular have taken advantage of technological advances to cope better by utilizing new crop hybrids and techniques for efficient use of scarce water (Burton and Lim, 2001; Howden et. al., 2007; Hassan and Nhemachena, 2008). Farming methods have also evolved over time so as to optimally utilize local climate conditions. For this research, technology-based adaptation refers to the application of technology and/or techniques by rice-farming households in order to address saltwater intrusion. Technological approaches to adaptation include both hard technologies such as goods, physical capital and equipment, as well as soft technologies such as knowledge of methods and techniques which enable hard technologies to be applied. The identified measures are based on classification of the technology for rice production in the Philippines and in other countries (Below et al. 2012; Burton and Lim, 2001; Howden et. al., 2007; Hassan and Nhemachena, 2008; IRRI Rice Knowledge Bank; Rejesus et al., 2011; Umetsu, Lekprichakul, and Chakravorty, 2003; Villano et al., 2014).

This included, using salt-tolerant varieties, changing timing of use of fertilizers, improved water management and irrigation and crop rotation systems. The methods have been suggested and used to counteract the negative consequences of climate change (Yang et. al. 2007) and were also cited during the FGDs and KIIs. Saline-resistant variety rice is developed through innovation by IRRI that can withstand conditions brought about by soil problems due to high salt toxicity. Changing the timing of fertilizer use is considered as soft technology that involved techniques in the application of various chemicals for rice production to counter the intrusion of saltwater intrusion. Changing timing of irrigation is also considered as soft technology involving a technique in managing irrigation as major source of water for rice production. Lastly, crop rotation system is another soft technology that involved alternating production of crops that can withstand saltwater in land used for rice production to attain better soil quality to generate higher yield of rice.

Farm-based Crop Management Measures

Climate change will alter the environmental conditions for crop growth and require adjustments in management practices at the field scale. The main benefit of implementing improved farm-based crop management adaptation measures is expected to be higher and more stable yields, increased system resilience and, therefore, enhanced livelihoods and food security, and reduced production risk (Campbell, et al. 2000; Laville, 2000; Adger et al. 2005).

Farm-based crop management in this study refers to the measures to adapt to saltwater intrusion by modifying crop management in the rice farm and adjust to the actual environmental conditions (Below et al. 2012; Campbell, et al. 2000; Laville, 2000; Adger et al. 2005). In Plaridel, the farmers also employ the measures to improve productivity of the farms. Two major measures were included in this study: growing multiple crops and replacing the damaged rice plants. The first measure is growing multiple crops that do not compete with resources for rice production in the same area where rice is planted to increase farm produce while the second measure is replacing the damaged rice plants due to saltwater intrusion through appropriation of buffer seedlings. This measure is usually applied during the early stages of the rice plant.

Ecosystem-based Management Measures

Ecosystem based Adaptation (EBA) is an emerging paradigm for managing natural resources under increasingly variable and perturbed climatic conditions (Jones et al., 2012). The role of ecosystems in adaptation is recognized at the international level under the United Nations Framework Convention on Climate Change (UNFCCC, 2010), the Convention on Biological Diversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD). Ecosystem-based measures are particularly appropriate for slow onset events and processes because they involve long-term strategies for building resilience.

Using EBA to reduce impacts of climate change and resulting natural disasters has been proven to be effective in various studies for coastal marshes and mangrove forests protection especially in dissipating storm surge impacts and coastal flooding. In this research, ecosystem-based adaptation refers to the use of biodiversity and ecosystem services as part of an overall adaptation measures to help rice-farming households adapt to the effects of saltwater intrusion (Jones et al., 2012; UNFCCC, 2010). For this research, four measures were identified: desalination, filtering the water, planting of mangroves and fish culture in the rice fields. The first measure is the desalination which refers to the process of draining the sea water with fresh water from irrigation. The second involves filtering of the sea water to prevent it from intruding freshwater from irrigation in the rice field while the third involves planting of mangroves especially in rice fields near riparian zones to regulate the flow of sea water intrusion in the rice fields. The fourth measure involves fish culture in the rice fields especially raising fish that thrive in brackish water in the rice field in order to increase food production in the farm.

Off-farm Diversification of Income Sources

Smit et al. (2001) highlighted that income from off-farm sources and income coming from non-agricultural sources is a common adaptation measure to manage production through difficult years via different income sources. Diversity of employment opportunities to gain non-agricultural employment will help to sustain their enterprise in difficult years for agricultural production.

Meantime, in the consideration of income in the Philippines, many small-scale rural farmers face the need to increase family income when farm income alone cannot provide sufficient livelihood (Pulhin et al., 2016). Also, farmers see this as a means to provide flows of cash income that can be used to purchase farm inputs and hire labor for agricultural production (Sombilla and Hossain, 2001). Lastly, farmers consider the need to earn income to finance farm production in the absence of a reliable external financial support (Delgado, 1997).

The agricultural investment effect of off-farm income diversification is particularly important for poor farming households. This is because lack of liquidity and poor access to credit are the most pressing constraints to improved agricultural productivity among farm households in Philippines. In certain settings where land is considered inadequate as collateral for agricultural loans, possession of a steady off-farm income is very important (Noble et al., 2014).

In this study, off-farm diversification refers to the diversification of activities and opportunities to gain other employment and income to sustain the needs of rice-farming households in difficult seasons for rice production (Pulhin et al., 2016; Smit et al., 2001; Sombilla and Hossain, 2001). Off-farm (non-farm) income refers to the portion of farm household income obtained off the farm, including nonfarm wages and salaries, pensions, and interest income earned by farm families. Three measures were identified in this study. The first measure involved non-farming activities or income from off-farm and non-agricultural sources to increase cash flow of the household. The second involved livestock production usually raised near the farmer's dwelling or in areas outside of the rice farm while the third is aquaculture which is the farming of fish, crustaceans, mollusks, aquatic plants, algae, and other aquatic organisms or cultivating freshwater and saltwater under controlled conditions.

Other Measures

Other measures were also considered in this research. These are buying insurance and moving to other places away from the coastal areas.

Many of these rice farms may be within the unsafe distance from the coast, which implies that, no activity should be carried out within these areas. The delineation of easement under the provisions of the Philippine Presidential Decree No. 1067, the Water Code of the Philippines dated December 31, 1976, Presidential Decree 705 or the Forestry Code of the Philippines and Department Administrative Order No. 2007-29 on the Revised Regulations on Land Surveys issued on July 31, 2007 all have specific requirements.

Article 51 of the Water Code of the Philippines states that "the banks of rivers and streams and the shores of the seas and lakes throughout their entire length and within a zone of twenty (20) meters in agricultural areas, are subject to the easement of public use in the interest of recreation, navigation, flotage, fishing and salvage. No person shall be allowed to stay in this zone longer than what is necessary for recreation, navigation, flotage, fishing or salvage or to build structures of any kind". This implies that agricultural activities are not suitable within the areas. In Plaridel, Philippines most of the rice farms are situated very near these bodies of water, making them highly susceptible to both coastal flooding and flooding through the Langaran River and its tributaries.

Assessment of the Feasibility of the Adaptation Measures

The provision of systematic method in assessing measures for dealing with slow onset events may be attained through an operational tool that is relevant to real-world, resource constrained, decision makers. These virtues are especially desirable in the context of adaptation decision-making. Slow onset event such as saltwater intrusion at the spatial and temporal scales relevant to most adaptations are highly uncertain, and thus an intellectual framework capable of accounting for this is a necessary condition for successful decision-making. This should be formulated in terms of the decision criteria that are deemed relevant. The choice of criteria will also help determine which methods of evaluation are applicable (Dietz, 2012). A good rule of thumb for achieving this balance is to focus on those variables to which the system is most sensitive and ensure that they include plausible and worst-case events. This set involves feasible adaptation options which is feasible if it does not violate any of the constraints the decision maker may face. These may include budget, regulatory, geographical constraints and temporal scale. It is important, when defining these options, that their characteristics are adequately captured (Ranger, Millner, Lopez, Ruta, & Hardiman, 2010).

In this study, four major criteria were chosen in the assessment of the feasibility of the adaptation measures. These are: ability to implement the measures, effectiveness, cost efficiency and support from major stake holders. These criteria coincide with the coping appraisal under the protection motivation theory (PMT) (Floyd, Prentice-Dunn, & Rogers, 2000).

Perceived Ability to Implement the Adaptation Measures

Farmers often evaluate their perceived ability to undertake adaptation measures and perceived self-efficacy in preventing the threatened risk. If individual farmers feel capable of coping with the threat and have the ability to apply the new measures, then they will take protective actions and implement the measures. Perceived ability to apply the measure is tantamount to self-efficacy defined as “the perceived ability of the person to carry out adaptation measures” (Feng, Liu, Huo, & Ma, 2017). The measurements of self-efficacy were developed based on measuring how confident respondents felt about their ability to implement the measure in their rice production to protect it from saltwater intrusion. In this research, individual rice farmers were asked “are you able to appropriately implement the adaptation measures to reduce the impact of saltwater intrusion?”. The responses were based on 5-point Likert scale (1 = inadaptable to 5 = extremely adaptable).

Perceived Effectiveness of the Adaptation Measures

Effectiveness relates to the capacity of an adaptation measure to achieve its expressed objectives. Effectiveness can either be gauged through reducing impacts and exposure to risks and avoiding potential damages and promoting security (Jones, 2001). Accordingly, respondents were asked to rate the effectiveness of adaptation measures to climate change by asking “how effective are the measures at helping to reduce the impact of saltwater intrusion on your rice production and your household?” Consequently, all the adaptation measures were presented and each item was anchored by 1 = ineffective to 5 =

extremely effective. The subsequent sections discuss the perceived effectiveness of the various measures by those who implemented the measures.

Perceived Costs to Implement the Adaptation Measures

Any assessment of the feasibility of adaptation measures requires consideration of the distribution of the costs and benefits of the measures. The cost issue in adaptation has itself two specific dimensions: the balance between private and public costs and benefits of adaptation measures (W. N. Adger et al., 2009). The farmers were asked “how costly is the implementation of the measures to address the impact of saltwater intrusion?”. The cost was assessed based on 5-point Likert scales (1 = extremely costly to 5 = not costly).

Perceived Support from Major Stakeholders to the Adaptation Measures

Truelove, Carrico, & Thabrew (2015) pointed out that agricultural practices are social in nature in developing economies. That means that in order to determine the existence and effectiveness of new agricultural technologies, farmers communicate with others within their social network to strengthen their perception of these technologies or practices, and then adopt them to improve their behaviors. Social capital is one of the best means of improving farmers’ adaptation to climate change (Below, Mutabazi, Kirschke, Franke, & Sieber, 2012). Thus, in this research, the perceived support by major stakeholders was included as one of the major criteria. The farmers were asked “what is the level of support from major stakeholders to the measures to address the impact of saltwater intrusion?”. The level of support from major stakeholders was measured based on 5-point Likert scales (1 = poor to 5 = excellent).

During the FGDs and KIIs, most farmers consider the government through the agriculture extension workers very important in accessing support through seeds and other inputs and new techniques of farming rice. The farmers also cited that membership in the farmer's association through the farmers' irrigation either in the NGADIA or NIA is one of the institutions they consider important in growing rice. In most of the barangays surveyed, farmers are informally organized by "*cabicilla*" or groups of parcels of land in a given area with around thirty *"cabicilla*" groupings in the various barangays. This arrangement is very convenient in terms of communicating and organizing the farmers, such as calling for a meeting and even with their training needs. The presence of Agricultural Training Institute-Regional Training Center's "One Barangay, One Learning Site" has also been a very good support for the farmers. Most of the barangays are under the Agrarian Reform Community (ARC) and the support of the Department of Agrarian Reform (DAR) is felt in the area. The farmers also rely a lot from the friend, relative and neighbors for many inputs of production, especially seedlings, labor *("dumdom")*, farm equipment and sources of information on the most feasible measures. Thus, the major stakeholders for these farmers are the government agencies that support their rice farming and other farmers who are members of their associations, who are also commonly their relatives, friends or neighbors.

Farmers' Sources of Information for Adaptation Measures

Farmers in the Philippines consider the government, particularly LGU extension workers as their primary source of information for technology-based and farm-based crop management measures. This is followed by their friends, relatives and neighbors.

Successful adaptation implies strong support from the major source of information to improve knowledge about available options and determination of the most suitable ones (Smit & Pilifosova, 2003). In the case of technology-based measures, strong scientific understanding of the measures and involvement of government and the friends, relatives or neighbors are extremely important. Poor support from these stakeholders will limit their ability to implement the adaptation options.

In general, farmers often rely on the government for support and source of information. The role of adequate institutional support is frequently cited in the literature as crucial to adaptation (Adger, Agrawala, Monirul, & Mirza, 2007; Adger et al., 2009; Barnett et al., 2008; Tompkins et al., 2010).

a. Feasibility of Adaptation Measures in the Philippines

In terms of the ability to implement, engaging in non-farming activities is rated the highest at 3.96 (Table 18). This may be attributed to the fact that most rice-farming households are engaged in various activities to diversify sources of income. Most of these activities do not require large amount of financial resources. Other adaptation activities include draining of the saltwater through water sourced from irrigation which is considered a desalinization process. This is least costly to implement given that it does not require additional resources and has the highest level of support from stakeholders as this is widely practiced by most farmers and other entities within their support group.

In view of the measures implemented by the farmers during the last and current cropping cycles, desalination by draining the saltwater *("asgad")* with water from the irrigation is the most feasible as rated by the farmers. Desalination of saltwater with irrigation water was the most common measure implemented by at least fifty five percent (55%) of the farmers. The farmers mentioned during the FGD that this is the most common measure implemented by farmers because it requires minimal financial burden. The overall rating on the cost of implementation attest to this claim. Among all the feasibility criteria, this criterion got the highest average rating from farmers at 3.9. This has important implication because more than fifty percent (50%) of the farmers indicated that changing the timing of irrigation flow is a difficult measure to implement because they cannot control the water flow. Thus, on the occasion of saltwater intrusion due to high tide or coastal flooding, the water allocated for each *"cabicilla"* or farming district may not be sufficient to drain the saltwater in the rice plots. According to the President of NGADIA, they often encounter issues on illegal widening of water canals or illegal setting up of water obstruction measures to divert and increase irrigation flow to their plots to speed up the process of desalination.

The second most feasible measure is engaging in livestock. Livestock commonly maintained in the study areas is chicken, which is not too difficult to raise because they are free range and do not require mush resources from the famer's household. They are also reliable source of stable food and subsistence income. The third most feasible measures are replacing the dead plants and growing multiple crops, both of which are farm-based crop management. This is very common in the various barangays as it helps attain higher potential yield and reduce financial loss of farmers in their rice production. Growing multiple crops such as vegetables and fruit trees and engaging in non-agricultural activities are also widely practiced in many barangays because they are reliable source of staple food for subsistence and additional income.

Table 18 Farmers' Feasibility Assessment for Various Adaptation Measures (n=326) Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

Measure	Ability to Implement	Effectiveness	Cost of Implementation	Support from Major Stakeholder	General Average	Number of Implementers
Technology-based Measures						
Using saline-resistant variety	2.76	2.81	3.29	1.32	2.55	8
Changing timing of irrigation	3.01	3.05	2.7	1.46	2.56	68
Changing timing of chemical use	3.27	3.24	3.24	1.51	2.82	97
Using crop rotation	3.52	3.28	2.99	1.81	1.81	69
Farm-based Crop Management						
Growing multiple crops	3.66	3.12	3.24	2.5	3.13	77
Replacing the damaged plants	3.9	3.39	3.3	1.91	3.13	196
EBA Measures						
Desalination	3.67	3.47	3.94	2	3.27	181
Filtering irrigation water	3.45	2.78	2.2	1.91	2.59	58
Planting trees/mangroves	3.18	2.79	2.58	2.49	2.76	9
Fish culture in rice fields	2.4	2.6	3.3	1.6	2.48	2
Off-farm Income Diversification						
Engaging in non-farming activities	3.96	2.5	2.97	2.61	3.01	182
Engaging in livestock production	3.85	3.05	3.37	2.64	3.23	175
Engaging in aquaculture	2.44	2.77	3.11	1.88	2.55	3
Other Measures						
Moving to other place	2.4	2.8	3.73	1.87	2.70	2
Buying Insurance	3.36	3.39	2.42	2.53	2.93	25

The least feasible measure is crop rotation among majority of the farmers. Farmers claim that the fields are unsuitable for other crops, although some farmers have tried growing other crops such as "monggo" beans and string beans. This may be because relative to these crops, rice is deemed a more valuable crop.

Fish culture and aquaculture are also among the least feasible because of the capital requirement needed to engage in these forms of production. Also, farmers think the fish will not survive due to the various chemicals applied in the rice fields.

In summary, only five measures were considered feasible and currently practiced by at least fifty percent (50%) of the farmers. These are replacing the damaged plants, desalination, livestock production, growing multiple crops and engaging in non-farm income sources.

In all the typologies of adaptation measures, the observed adaptation for the previous, current and the future cropping cycles do not significantly vary. It can be gleaned from the results that farmers follow customarily what have been practiced. Farming is risky. Farmers live with risk and make decisions every day that affect their farming operations. Thus, small-scale rural farmers tend to be risk averse and are relatively conservative in practicing new techniques (Todaro, 2015).

b. Feasibility of Adaptation Measures in Vietnam

The majority of farmers do not implement diversified adaptation measures as shown in Table 19. One hundred thirty-eight (138) or sixty two percent (62%) of the farmers consider livestock production as the most feasible measure to address the challenges posed by saltwater intrusion in the rice farms.

Desalination is the second most common measure implemented by farmers in the communes of the two provinces. This is done by mixing sea water and fresh water through the drains, creeks, and rivers in the delta. Filtering of water is another measure which they claim is addressed through the construction of water management control measures such as dikes and sluices which helped keep the saline water out of irrigation areas. However, many canals have not yet been equipped with sluices to prevent saltwater intrusion.

Twenty-eight (28) farmers engaged in non-farming activities to make more money, but the rest do not know how to do this. Some went to find temporary work in other places. They claim that with the government support, the farmers might change their current practice to pursue a different agricultural livelihood. Most farmers however deem there is less immediate need to growing multiple crops due to fear of failures. Even though farmers are worried about the future of their agricultural production, they would at no time consider leaving their grounds. Farmers in have a deep connection to the land on which their ancestors are buried. They would often state that he is connected to his area for many years, and has built relations with other people. He also finds it difficult to change his customs of rice production as this is a longtime family tradition.

Most farmers are not familiar with the salt-tolerant rice varieties. However, they believe this is a potential measure of coping with the current salinity problems. Shifting rice crop seasons is considered a good measure to address salinity problems, whereas switching to growing other types of crops is not the desired adaptation measure, though some farmers planted vegetables on small plots. Farmers are hopeful that better farming techniques will be available in the future which will increase their rice yields.

In general, the farmers in the two provinces have traditional technologies and do not know how to grow another crop or where to find other sources of income, majority still grow rice. As a response to salinity intrusion, local governments try to save existing rice areas by building dikes along the affected area and investing in the irrigation system. Only a few communes have improved the gates and dike system. In some areas, salt-intrusion is too high and the rice area cannot be saved. Only a few as shifting to aquaculture but the provincial government (DARD) considers salt intrusion as an opportunity to change rice crops to aquaculture. To boost aquaculture farming, DARD provides training to increase knowledge on how to grow shrimp successfully.

Table 19 Farmers' Feasibility Assessment for Various Adaptation Measures (n=258) Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam, 2017

Measures	Ability to Implement	Effectiveness	Cost of Implementation	Support from Major Stakeholder	General Average	Number of Implementers
Technology-based Measures						
Using saline-resistant variety	3.07	3.16	3.14	1.82	2.80	17
Changing timing of irrigation	2.93	2.85	2.29	1.42	2.37	28
Changing timing of chemical use	2.82	2.82	2.43	1.15	2.31	8
Using crop rotation	2.05	2.27	2.57	1.05	1.99	5
Farm-based Crop Management						
Growing multiple crops	2.69	2.59	2.66	1.09	2.26	6
Replacing the damaged plants	3.16	2.84	2.32	1.4	2.43	9
EBA Measures						
Desalination	3.16	2.84	2.32	1.4	2.43	91
Filtering irrigation water	3.3	3.09	2.45	1.5	2.59	53
Planting trees/mangroves	1.88	2.98	2.69	1.16	2.18	3
Fish culture in rice fields	2.75	2	1.64	1	1.85	12
Off-farm Income Diversification						
Engaging in non-farming activities	2.93	2.63	2.34	1.5	2.35	28
Engaging in livestock production	2.57	2.86	2.87	3.28	2.90	138
Engaging in aquaculture	2.33	2.85	2.78	1.21	2.29	6

Adaptation Diversity

This study tried to come up with an aggregate indicator thru the diversity of adaptation measures in response to the perceived or experienced climate change that could be estimated by summing up the total number of adaptations with which each household is engaged in. A total of fifteen (15) adaptation measures were used by the sample households as a whole. The diversity of adaptation could range from zero to fifteen (15), where zero represents households without any adaptation measure and fifteen (15) represents the maximum number of adaptation measures a household could adopt.

a. Philippines

Actual adaptation measures implemented by the surveyed households ranged from one (1) to eleven (11), and the average were 5.16 and 2.84 measures. On the average, the farmers surveyed implemented around five (5) measures.

Households were also classified into low and high diversity adaptation categories by taking the mean number as a cutoff point. That is, households who implemented 1-3 measures were classified as low diversity adopters and those who implemented 8-11 measures were classified as high diversity adapters. The farmers explained during the surveys and the FGDs that the existing measures they are currently implementing are insufficient to combat the problem of saltwater intrusion.

About fifty four percent (54%) of the rice-farming households were in the low diversity adaptation category while forty four percent (44%) were in the average diversity category. Only two percent (2%) of the rice-farming households were classified with high diversity adaptation level (Table 20).

Table 20 Adaptation Diversity of Rice-Farming Households
Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

Total Number of Measures	Current Measures Implemented	
	Frequency	Percentage
1-3 Measures (Low Diversity)	176	54
4-7 Measures (Average Diversity)	144	44
8-11 Measures (High Diversity)	6	2
Total	326	100

At the barangay level, nine out of ten barangays have low adaptation measure diversity.

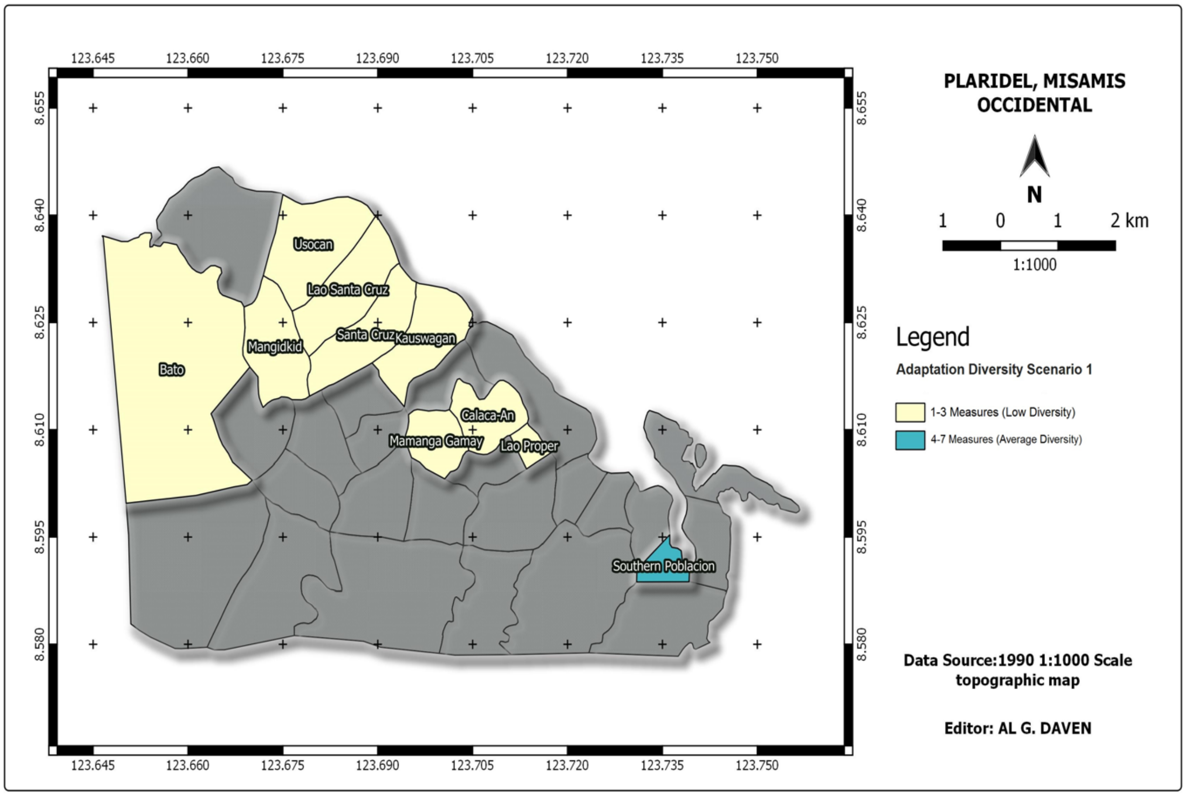


Figure 27 Barangay Level Adaptation Measure Diversity
Selected Barangays, Plaridel, Misamis Occidental, Philippines

b. Vietnam

Current adaptation measures implemented by the surveyed households in the communes in Ben Tre and Tra Vinh provinces ranged from one (1) to eleven (11). Forty three percent (43%) of the rice-farming households implemented 4-7 measures classified as average diversity adopters (Table 21).

Table 21 Adaptation Diversity of Rice-Farming Households
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam, 2017

Total Number of Measures	Current Measures Implemented	
	Frequency	Percentage
1-3 Measures (Low Diversity)	87	33.72
4-7 Measures (Average Diversity)	113	43.80
8-11 Measures (High Diversity)	58	22.48
Total	258	100

At the commune level, the rice-farming households in Ben Tre apply more diversified measures relative to the communes in Tra Vinh who are in the low diversity adaptation category (Figure 28).

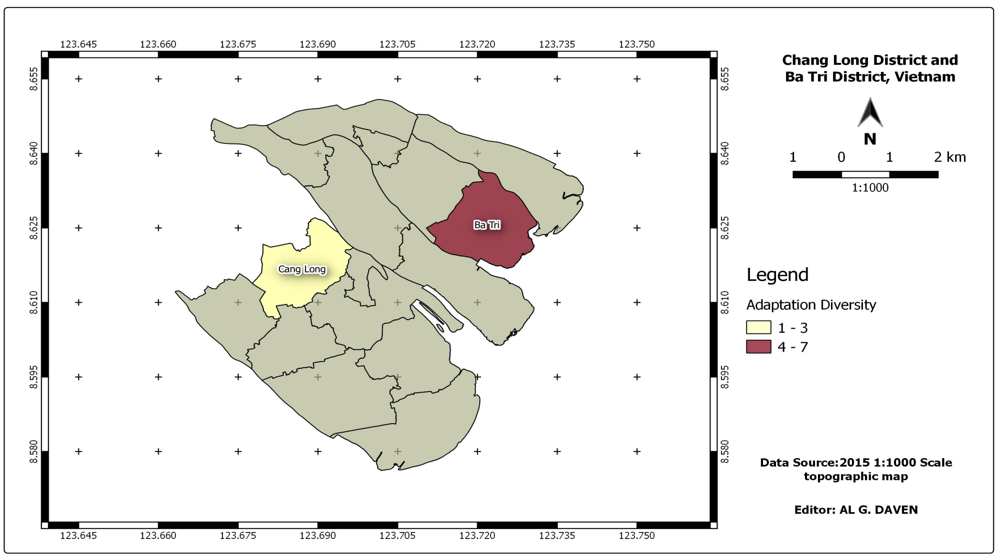


Figure 28 Commune Level Adaptation Measure Diversity
Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam, 2017

Measure-based Adaptation Index Formulation

The aim of developing the adaptation index is to make a theoretical concept operational. Because adaptation measures are varied, the index will be composed of several subcomponents that aggregate indicating variables. The composite structure of the index particularly raises the question of how the different variables and components should be weighted. The index studies that have been carried out to date have not found objective methods for selecting indicating variables and how to weigh them (Hinkel, 2011; Hinkel & Klein, 2009). As a contribution of this study, a more objective method is employed.

One major contribution of this research is the measurement of farmers household's adaptation as it accounts not only for the incidence of adoption of various measures but also to consider the scale at which these practices are carried out. This has been the limitation cited by a number of studies (Arshad et al., 2017; Below et al., 2017; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009). An improved measurement could be derived by indicating variables that measure not only actual adoption but also the likelihood of adoption. In this research, a scale of measurement is employed. This is referred as level of implementation which indicates the adaptation level (AL). There were three rice production cycles covered in this study. Thus, the farmers who have implemented the measure in the past cropping cycle and the current cropping cycle is given a score of 1, implying one hundred percent (100%) implementation while those who planned to implement it is associated with 0.5 or fifty percent (50%) probability of implementation. The farmers who answered they see the measure necessary but have not yet implemented is given a score of 0.3 or thirty three percent (33%) probability of adopting the measure and the farmers who do not consider adopting measure is assigned 0. The farmers implementation level will therefore enhance effective adaptation, making the probability for adaptation to be between one (1) and zero (0). Households considered to have fully adapted the measure if it had implemented the measure in the past and most recent production cycles.

Topic 4 of the IPCC Assessment Report 5 (2014) discussed the adaptation measures that must be increasingly implemented across regions in the public and private sector and within communities by emphasizing incremental adjustments and co-benefits. They also emphasized flexibility and learning of new measures to be incorporated in the adaptation planning to reduce adverse impacts and vulnerability. The report noted that very few studies are being conducted in assessing the processes of implementation or the effects of adaptation actions. As such this research attempted to account for the various measures being implemented and subjected these measures into various feasibility criteria in addressing saltwater intrusion.

a. Philippines

Thirty six percent (36%) of the rice farming households have MAI scores below average (Table 22). This is consistent with the results on adaptation diversity where most farmers have less than five measures practiced. Secondly, the scores on the level of adoption verify the results given that a number of farmers have not yet fully adopted most of the measures resulting to somewhat low level of adoption. Thirdly, the scores of the farmers indicate notable shortcomings in the implemented or planned adaptation options.

Table 22 Measure-based Adaptation Index Scores of Rice Farming Households Selected Barangays, Plaridel, Misamis Occidental, Philippines, 2017

RATING	SCORE	INDEX	FREQUENCY	PERCENTAGE
Low	0-0.20	1	56	17%
Below Average	0.21-40	2	117	36%
Average	0.41.-0.60	3	107	33%
Above Average	0.61-0.80	4	40	12%
High	0.81-1.0	5	6	2%
Total			326	100%

At the barangay level, seven barangays have relatively the same level of adaptation index (Figure 27). These barangays have relatively low adaptation index and indicated difficulty in implementing adaptation measures. Based on the analysis of feasibility criteria, the difficulty may be attributed to differences in farmers' abilities and costs of implementing the adaptation measures.

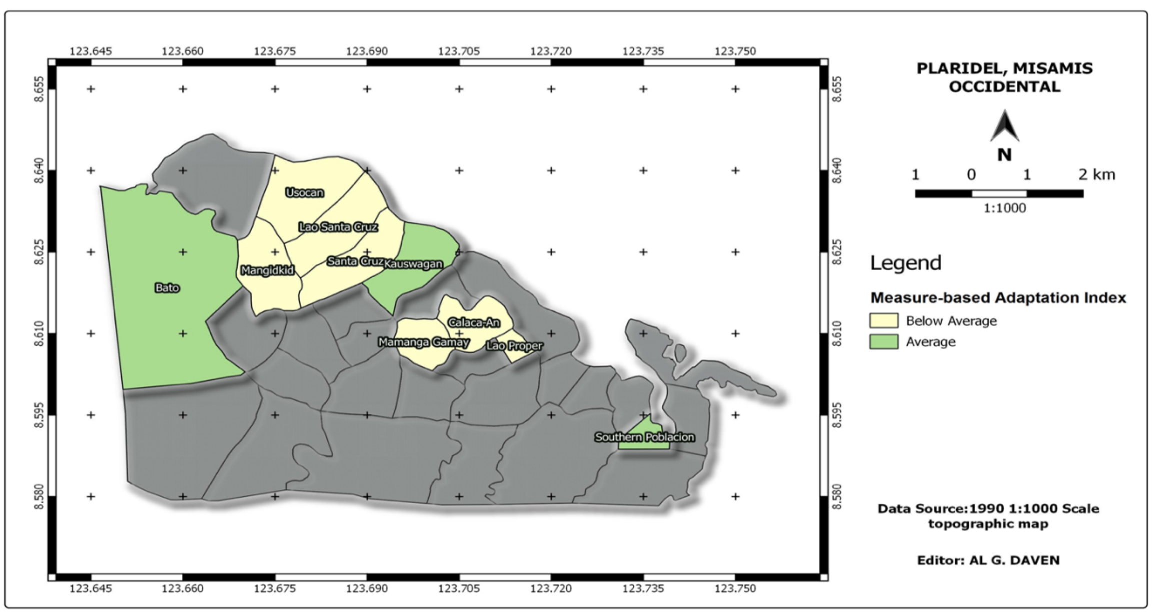


Figure 27 Barangay Level Measure-based Adaptation Index, Selected Barangays, Plaridel, Misamis Occidental, Philippines

b. Vietnam

Eighty percent (80%) of the farmers in the two provinces have MAI Scores below average (Table 23). This is consistent with the very low implementation of various adaptation measures which is further validated by the diversity scores. Most of the implemented measures by the farmers also scored very low in terms of feasibility.

Table 23 Measure-based Adaptation Index Scores of Rice Farming Households Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam, 2017

RATING	SCORE	INDEX	FREQUENCY	PERCENTAGE
Low	0-0.20	1	94	36.43
Below Average	0.21-40	2	113	43.80
Average	0.41.-0.60	3	41	15.89
Above Average	0.61-0.80	4	8	3.10
High	0.81-1.0	5	2	0.78
Total			258	100

At the commune level, both provinces have below average adaptation indices (Figure 28).

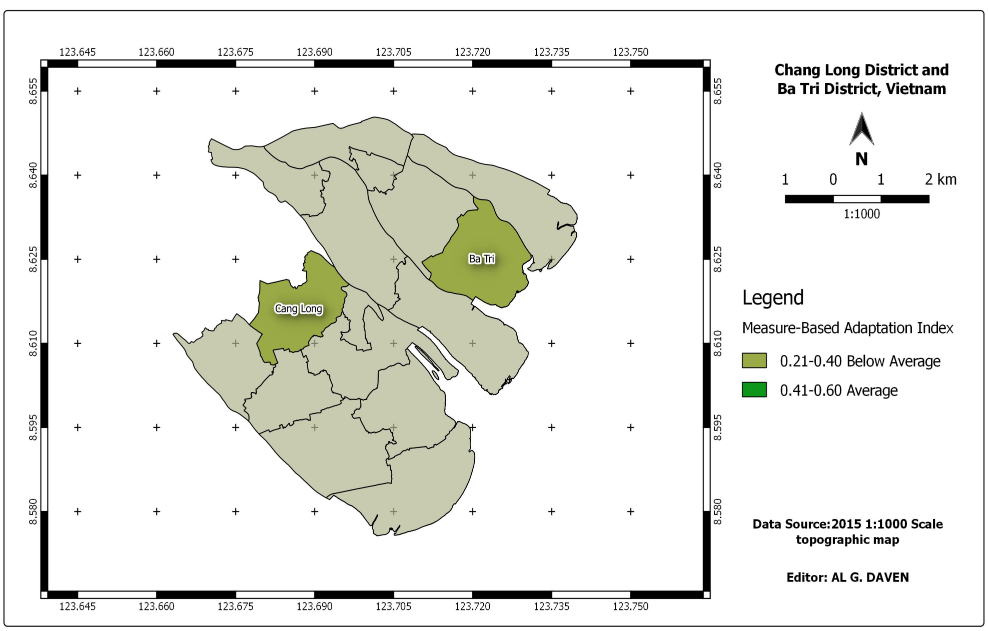


Figure 28 Commune Level Measure-based Adaptation Index, Selected Communes, Ben Tre and Tra Vinh Provinces, Vietnam, 2017

The construction of a measure-based index in this research is a helpful approach which can potentially provide insights on the adaptation measures that farmers favor or disfavor in a specific context, i.e. saltwater intrusion. This is important to understand farmers' attitudes towards adaptation to climate related risks (Ndamani & Watanabe, 2016; Shikuku et al., 2017; Taylor, Kuwornu, Anim-Somuah, & Sasaki, 2017). The process showed how different adaptation measures rank in the specific context of saltwater intrusion based on farmers' behavioral dispositions.

DETERMINANTS OF MEASURE-BASED ADAPTATION INDEX

One of the main objectives of this research is to come up with an empirical account of the adaptation processes and define household-level variables that will potentially explain adaptive capacity of rice farmers to saltwater intrusion. Farmer's livelihood security against climate change depends on their adaptive capacity (Smit & Pilifosova, 2003). This refers to how farmers' utilize their own capabilities and various assets, including psycho-social assets, as ability to earn a living, meet their consumption and economic needs and cope with uncertainties (Binh, 2015; Elum, Modise, & Marr, 2017; Hartter et al., 2012; Howden et al., 2007; Huang, Wang, & Wang, 2015; Kim, Elisha, Lawrence, & Moses, 2017; Limantol, Keith, Azabre, & Lennartz, 2016; Menapace, Colson, & Raffaelli, 2014; Truelove, Carrico, & Thabrew, 2015; Yohe & Tol, 2002). Accordingly, the farmers with better adaptive capacity against major impacts are more secure than others with low adaptive capacity.

It is widely believed that a farmer's adaptive capacity against climate change is influenced by different factors. However, the prevailing studies used relatively the same factors for almost all types of climate related events. The factors of adaptive capacity may be grouped as biophysical, demographic, socioeconomic, sociocultural characteristics and institutional arrangements (N. Adger et al., 2007; Below et al., 2012; Binh, 2015a; Smit & Wandel, 2006; Yohe & Tol, 2001). Apart from these, knowledge, and perceptions are also linked to adaptive capacity of a farmer (IPCC, 2012). It is in this context that factors influencing adaptation to saltwater intrusion were considered, given that there are only few studies dealing with adaptation to this phenomena (Bergqvist et al., 2012; Binh, 2015b; Filho, 2013; Le Dang, Li, Nuberg, & Bruwer, 2014).

Adaptive capacity is often viewed in terms of income, basic needs, security of person and property, sustainability, and empowerment/inclusion (Lemos, 2003; Ostrom, 2005). These are largely dependent on social factors such as household size, age and literacy of household head (Yesuf et al., 2008). Sex of the household head significantly influences household choice when adapting to climate change (Nhemachena and Hassan, 2007). Age is also considered of high importance since it is deemed as reflective of farmer’s experience. However, there are two contrasting effects of age (Deressa et al., 2009). On the one hand, it implies considerable experience of the famer and extensive observation-based knowledge which implies that older farmers are better in understanding adaptation measures. On the other hand, older farmers tend to be more conservative and may be wary of adopting new techniques (Nhemachena and Hassan, 2007).

In most of the recent adaptation literature, economic indicators predominantly constitute the multidimensional factors identified. Some resource management agencies now stress climate change adaptation as a function of these economic indicators influenced by the demand for resources, environmental constraints, infrastructure, and technological change that, particularly in combination, could require changes in investment plans and business models (IPCC, 2007; Brick et al., 2010).

In general, the poor and marginalized are the hardest hit due to their weak adaptive capacity and higher dependence on climate-sensitive natural resources for their livelihoods. Like human systems, ecological systems are also impacted by climate change and can become degraded and lose their capacity to deliver ecosystem services, which may generate resource use conflicts among users. They also argued that such conflicts would be higher among coastal resource users mainly due to their physical location at the forefront of climate change impacts in particular, sea level rise, cyclones, flooding, saline intrusion and erosion.

Most studies highlight that greater economic resources increase adaptive capacity, while a lack of financial resources limits adaptation options (Campbell, et al. 2000; Laville, 2000; Smit et al., 2001; Adger et al. 2005; Eichberger and Guerdjikova, 2013).

Adaptive capacity is not only incumbent upon investment in human capital and access to assets but the information and the institutional environment in which it takes place, including the ongoing development process (Smit and Pilifosova, 2003). Adaptive capacity is also seen by some emerging literature as a function of the institutional conditions in a community. Case studies in South America showed that the adoption of good governance mechanisms (such as stakeholder participation, openness to information, accountability and transparency) in policy-making may create the environment that is conducive to the kind of structural reform needed to build long-term adaptive capacity to climate-driven impacts (Smit et al., 2001; Degg and Chester, 2005; Nelson et al., 2007; Tompkins et al., 2008). These studies reasoned that institutions are a major determinant of adaptive capacity because well-developed social institutions help to reduce impacts of climate-related risks, and therefore increase adaptive capacity.

A number of household case-study survey results demonstrated that farmer's adaptation to climate change is a function of individual perceptions, information or knowledge on climate change. Several studies recognize level of knowledge as an important determinant that formulates adaptive capacity at the local level (O'Brien, Sygna, and Haugen, 2004; Knutsson and Ostwald, 2006; Hay and Mimura, 2006; Parkins and Mackendrick, 2007; Tschakert, 2007; Deressa et al., 2009; Mertz et al., 2009; Marin, 2010; Dilling and Lemos, 2011; Westley et al., 2013).

The accuracy of farmers' knowledge and perceptions are often based on past observations as predictors for future risk. Farmers, non-experts and experts making estimates without the use of formal methods often predict the likelihood of encountering an event in the future by consulting their past experiences with such events. Heuristic methods, in which the likelihood of an event is judged by the ease with which past instances can be brought to mind (Tversky and Kahneman, 1974; Berke et al., 1993).

In many instances, farmers who are unaware of climate change are less likely to apply agricultural measures that are effective against climate change. Thus, successful adaptation of farmers to climate change involves a two-stage process in which it is first necessary to perceive that climate change has occurred before deciding whether or not to apply an adaptive measure (Maddison, 2007). Adaptations to climate change often are not applied if the farmers are aware of climate change or recognize the problem and thus the necessity to adapt. Unawareness of climate change or its impact can occur if social habits and normative standards prohibit an understanding of the climatic stimulus.

Perceptions about the impacts of climate change could also have a significant effect on the derivative perception that any or all of the options would work. Low confidence in attribution or low opinion of significance would make all of the options relatively less feasible because none of them would be subjected to serious evaluation; low feasibility factors should then be assigned. High confidence in attribution and widespread recognition of significant exposure would, of course, have the opposite effect (Eisenack and Stecker, 2012).

To determine the significant factors of farming households' adaptive capacity, a multiple linear regression analysis was conducted using a licensed SPSS version 23. The basic assumption is that adaptation measures depends on rural households' farm, socio-demographic, economic, institutional affiliations and characteristics as well as their knowledge, awareness and perceptions on saltwater intrusion. The relevance of the explanatory variables attributed to the determinants of adaptive capacity is adopted from Chambers' (1989) concept of adaptation as well as Yohe and Tol (2002) and the methodology of Below, et.al. (2012). The resulting model was formulated using the following function:

MAI = f (farm characteristics, socio-demographic characteristics, socio-economic characteristics, institutional affiliations, knowledge, awareness and perceptions) + ε.

The relevance of the explanatory variables attributed to the determinants of adaptive capacity and the description of the explanatory variables and their expected relationship with MAI is provided in Table 24.

Table 24 Explanatory Variables and Their Expected Relationship with Measure-based Adaptation Index (MAI)

DIMENSIONS OF ADAPTIVE CAPACITY	INDICATORS	DESCRIPTION	CODE	EXPECTED RELATIONSHIP WITH MAI
Social	Age	Age of Farmer in years	Age	Positive
	Sex	Sex of Farmer	Sex	
	Farming Experience	Number of years respondent worked as a Farmer	FarmEx	Positive
	Household size	Total number of household members	HHSize	Positive
	Total Dependents	Total number of unproductive household members, i.e. younger than 15 years or household members challenged or/and older than 65 years	TDeps	Negative
	Education	Number of years in school completed by farmer	Educ	Positive
Economic	Total Employed Members	Total Number of Employed Family members	TEmp	Positive
	Household Income Level	Total household income from all sources as a ratio to the official standard of living for the province	YLevel	Positive
	Housing Tenure	Status of ownership of house and lot	HouseT	Positive
	Farm Size	Total lot area for rice production	AgSize	Positive
	Farm tenure	Status of ownership of farm	AgTenure	Positive
	Valuable Assets	Total number of valuable assets	TVI	Positive
	Membership to organizations	Total number of membership of farmer to relevant organizations	Orgs	Positive
Institutional	Sources of information	Total Sources of Information $INFO = (I_1 + \cdots I_8)/8$ INFO = Total number of information sources I = Info source	Info	Positive
	Trainings on adaptation measures	Total number of trainings on adaptation measures $Trainings = (T_1 + \ldots I_{13})/13$	Training	Positive

Table 24 continued…

		Trainings = Total number of trainings for each adaptation measure T = Training type		
Knowledge	Level of awareness on saltwater intrusion	Total score on facts about saltwater intrusion $ASWI = (S_1 + \cdots S_{10})/10$ ASWI= Awareness on Saltwater Intrusion $S_1 \ldots S_{10}$ = Empirical statements on saltwater intrusion	ASWI	Positive
Perception	Perception of climate change related problems	Number of weather related changes perceived by a farmer within the last decade $PI_j = \Sigma_{i=1}^{i=m} C_{ij}$ with: PI_j = Perceived changes by j^{th} farmer Cij = Parameters (Frequency, Intensity and Manageability)	FreqCCE IntCCE MagCCE	Positive

Multiple linear regression analysis makes several key assumptions: linear relationship multivariate normality, absence of auto-correlation, homoscedasticity and absence of multicollinearity.

Firstly, multiple linear regression needs the relationship between the independent and dependent variables to be linear. The linearity assumption can best be tested with scatter plots. Secondly, the multiple linear regression analysis requires all variables to be normal. This assumption can best be checked with a histogram. It makes possible the checking of the extent to which the residuals are normally distributed. In this study, the residuals histogram shows a fairly normal distribution. Thus, based on these results, the normality of residuals assumption is satisfied. Thirdly, multiple linear regression analysis requires that there is little or no autocorrelation in the data. Autocorrelation occurs when the residuals are not independent from each other. This can be checked with the Durbin-

Watson test. Durbin-Watson's an assume values between 0 and 4, values around 2 indicate no autocorrelation. The results generated imply absence of autocorrelation. Another assumption the multiple linear regression analysis makes is homoscedasticity. The scatter plot is also good way to check whether homoscedasticity is attained which shows that the residuals are not distributed in any pattern with the predicted values. Finally, multiple linear regression assumes that there is absence of multicollinearity in the data. Multicollinearity occurs when the independent variables are not independent from each other. Multicollinearity is checked in this research using a correlation matrix (Pearson's Bivariate Correlation) among all independent variables as well as the Variance Inflation Factor (VIF), wherein the values of the must be less than 10 (Gujarati and Porter, 2009).

The correlation matrices for the two countries revealed that a number of socio-economic variables are correlated which imply high chance of multicollinearity. This necessitated the conduct of a factor analysis or Principal component analysis (PCA) before the multiple regression analysis, to rotate the factors to insure independence of the factors in the linear regression analysis and to determine the number of factors to be retained. This research applied the direct oblimin technique to rotate the factor axes in order to ensure that variables are loaded maximally to only one factor, given that the underlying factors are correlated.

Indicators of Adaptive Capacity

Seventeen (17) independent variables have been derived based on the conceptual framework. The factor analysis was thus conducted on these variables using oblique rotation (direct oblimin). The Kaiser-Meyer-Olkin (KMO) criterion confirmed that factor analysis is appropriate for the sample. The value of the KMO for the analysis is .659. The Bartlett's test of sphericity should be statistically significant at $p<0.05$ and the KMO should be 0.6 as minimum value for a good factor analysis (Pallant, 2001). Barteltt's test of sphericity χ^2 (66) = 1170.314, $p< .00$, indicated that correlations between variables were sufficiently large for factor analysis. High and moderate loadings (above 0.5) indicate how the individual indicators are related to the principal component (OECD, 2008). The factor loadings of an absolute value greater .5 were considered in the interpretation of the factors. An initial analysis was conducted to generate eigenvalues for each component in the data.

a. Philippines

For the seventeen variables, five components generated eigenvalues greater than 1, which is the Kaiser criterion for the extraction of factors (Table 25). The five components, which were thus extracted, together explained 62.70% of the variance. With the five identified components in this study, fifteen indicators have loading value after rotation above 0.5. In Component 1, six indicators have loading value above 0.5, Components 2 and 4 has three indicators, whereas Components 3 and 5 have two indicators. Totally, the first two components include nine indicators, three components eleven indicators, four components thirteen indicators, five components fifteen indicators.

Table 25 Component Matrix for all Factors, Philippines

Components	1 (Economic Capacity)	2 (Knowledge and Training on Saltwater Intrusion)	3 (Rice-Farming Experience)	4 (Perception on CRE[2])	5 (Human Capital)
Income Level	.794				
Total Valuable Items	.792				
Size of Agricultural Land	.661				
Educational Attainment	.622				
Number of Organizations	.568				
Agricultural Tenure	.546				
Number of Trainings		.807			
Total Number of Information Sources		.712			
Awareness Index for SI[1]		.707			
Farming Experience			.879		
Age			.874		
Perception of Intensity of CRE[2]				.837	
Perception of Frequency of CRE[2]				.721	
Perception of Magnitude of CRE[2]				-.708	
Household Size					.825
Total Employed Household Members					.720

The application of the Scree-test method is suggestive of the retention of all factors above the “elbow”, or break in the plot, as these factors contribute the most to the explanation of the variance in the data set (Pallant, 2001). Figure 29 presents the scree plot of factor analysis showing the eigenvalue that suggests five components with eigenvalue above one. From the plot, there is a clear break between the second and third components. It also depicts another "elbow" after the fourth components. Therefore, the components remaining in the analysis should equal to four or less than six.

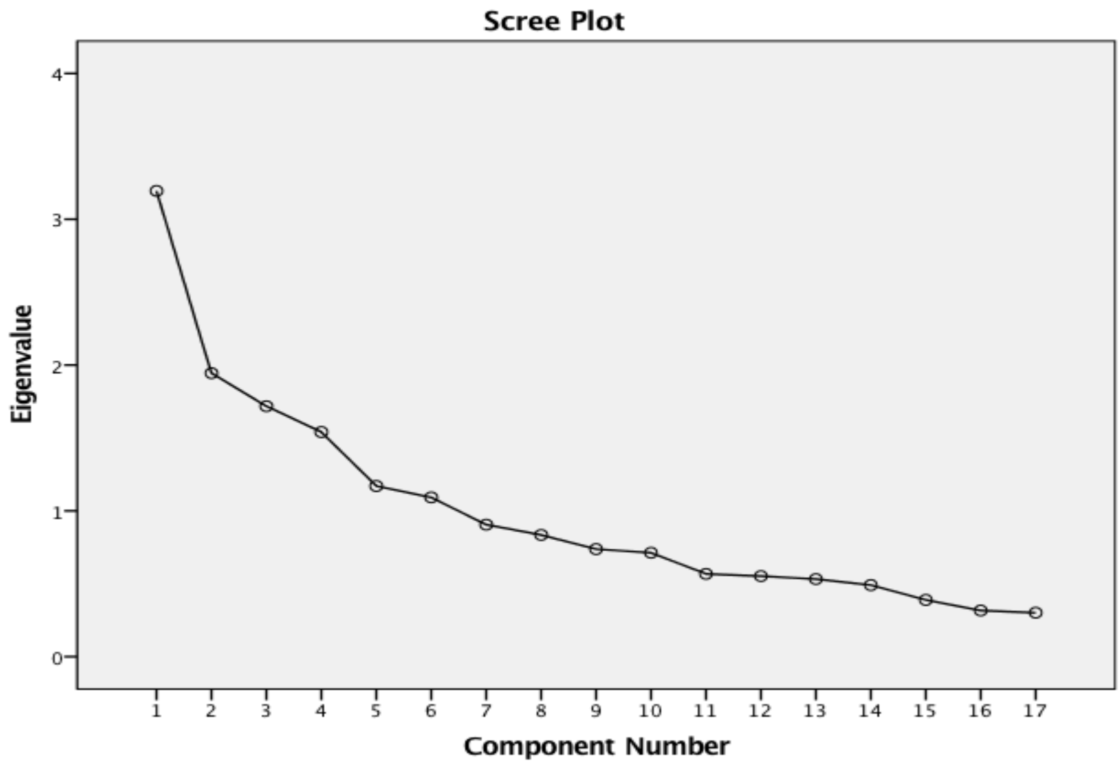


Figure 29 Scree Plot of the Factor Analysis for the Philippines

Factor 1 is called "economic capacity" which includes six economic indicators such as income level household income, total household valuable items (appliances, furniture, jewelry, vehicles), size of agricultural land, agricultural land tenure and total institutional affiliations. The income level (0.794) has the biggest loading value, followed by the total household valuable items (0.792), the size of agricultural land (0.661), education (0.622), the total number of organizational affiliations (0.568) and agricultural land tenure (0.546). It can be noted that the six indicators have positive loadings and relate to household economic capacity. In reality, education and income are usually positively related. Higher educational attainment often leads to bigger potential income. Also, household adaptive capacity in the context of climate related events is also dependent on the educational attainment of the farmers which enable them to anticipate changes and modify their livelihood opportunities in response to those anticipated changes (Byrne, 2014). In turn, income, total valuable items owned by the household and agricultural land all have positive relationships normally. This positive relationship is verified by the correlation analysis. It means that high income level generates more valuable assets. Higher income enables a household to use it to multiple purposes; for example, purchasing farming tools, motorcycles, appliances and other furniture. In many cases in rural areas, farmers often enlarge their farms by buying more land resulting from higher income levels. Farmers membership in organizations is also associated with the economic assets of a household. In most instances, the organizations most farmers are affiliated with, which include farmers association, irrigators' association, cooperatives, are intended for the pursuit of their livelihood. Therefore, this factor represents economic capacity and security of the household.

The second factor is named *"knowledge and trainings on saltwater intrusion"* because the components involve trainings, sources of information and level of awareness on saltwater intrusion. Their loading values are positive at (.807), (.712) and (.707), respectively. According to Binh (2015), adaptation to saltwater intrusion through knowledge management includes all sorts of practical trainings for farmers and agricultural extension officers, and the use of various information for decision support systems and generally increased experimentation by farmers and other stakeholders.

Using information networks for saltwater adaptation involves investing in community ties and social networks, collective provision of farm inputs, collective marketing of farm products, farmer-to-farmer training, and informal exchanges of best practices.

The various sources of information of farmers on adaptive measures usually are sourced from their friends, relatives, neighbors or extension workers which influence their adaptation assessments. Often, the sources of information that seem to have the most influence on farm households are those that were convenient to access, or for which they may have more trust. The usefulness of information on saltwater intrusion and adaptive measures can significantly influence their assessments. Rice-farming households who think information on saltwater intrusion that they received was useful usually perceive the adaptation measures they employ are more effective. Thus, they have more ability to implement the adaptive measures (Nhan et al., 2010).

The third factor is named *"farming experience"* because the indicators relate to age and the years the farmer engaged in farming. The loading values are negative for age (.874) and years in farming (.879). As noted in literature, there are two contrasting effects of age (Deressa et al., 2009). It suggests considerable experience of the famer and extensive observation-based knowledge which imply that they have better understanding of adaptation measures. However, they also tend to be more conservative and wary of adopting new techniques (Nhemachena and Hassan, 2007).

The fourth factor is named *"perception on climate related events"* because the three indicators refer to farmers' perception in terms of frequency, intensity of impact and manageability. The loading value of perception in terms of frequency, intensity of impact and manageability indicators are 0.837, 0.721, and -.708, respectively. Farmers perception on climate related events influence their practices in farming and make adjustments as a response. This has implications on their adaptation actions (De 2006; Binh, 2008).

The fifth factor is named *"household human capital"* as it includes household characteristics of the farmers such as total members and total employed members. The loadings are .825 and .720. Family farming is one of the most predominant forms of agriculture in many developing countries. It is a means of organizing agricultural production which predominantly reliant on family labor, including men, women and children (IFPRI, 2012). Moreover, family land holdings are often cultivated by family members. Thus, household members often support labor needs of farming. On the other hand, employed members of the household provide supplement to the seasonal income coming from farming. These types of human capital reduce the negative effects of climate change on farm production, household income and farmer livelihoods (Nhemachena and Hassan, 2007).

b. Vietnam

Fourteen variables have loading value after rotation above 0.5. They formed six components which generated eigenvalues greater than 1, which is the Kaiser criterion for the extraction of factors (Table 26). The six components which were thus extracted, together explained 59.48% of the variance. Components 1, 4, 5 and 6 have two indicators while Components 2 and 3 have three indicators.

Table 26 Component Matrix for all Factors, Vietnam

	Component (1) Household Resources	(2) Knowledge on Climate Change	(3) Income Propensity	(4) Rice Farming Ability	(5) Household Dependents	(6) Educational Aptitude
Total Employed Members	.751					
Total Valuable Items	.675					
Perception Index on Intensity of Climatic Events		.817				
Perception Index on Frequency of Climatic Events		.716				
Level of Awareness on SWI		.655				
Information Sources			-.706			
Income Level			.635			
Perception Index on Magnitude of Impact of Climatic Events			-.559			
Age				-.934		
Farming Experience				-.905		
Total Number of Dependents					.866	
Household Size					.748	
Sex						.742
Educational Attainment						-.568

Extraction Method: Principal Component Analysis.[a]
a. 7 components extracted.

The variables that have highest loadings are in Component 1 which include total employed household members and total household valuable items (appliances, furniture, jewelry, vehicles). These variables represent economic resources of the rice farming households. Component 2 which may be referred to as knowledge on climate change events, has three variables, namely, perceptions of the farmers on climate related events in terms of intensity and frequency and level of awareness on saltwater intrusion. Component 3 may be deemed as the income propensity. This component has variables which included sources of information, income level and perception on the manageability of climate related events. Among the three, only income level has positive coefficient. Component 4 can be gleaned as rice farming ability. This component involved two variables which have negative coefficients, namely: farmer's age and years of experience in farming. Component 5 consist of two variables: total household members and total number of dependents. This may be referred as household dependency level. Lastly, Component 6 included the sex of the farmer and educational attainment which has negative coefficients. This component can be considered as educational aptitude. The signs of the coefficients in all the six components are in line with the research expectations.

The application of the Scree-test Plot in Figure 30 is suggestive of the retention of all factors above the “elbow”, or break in the plot, implying the eigenvalues are above one. From the plot, there is a clear break between the third and fourth components. It also depicts another “elbow” after the fourth components. Therefore, the components remaining in the analysis should equal to four to six.

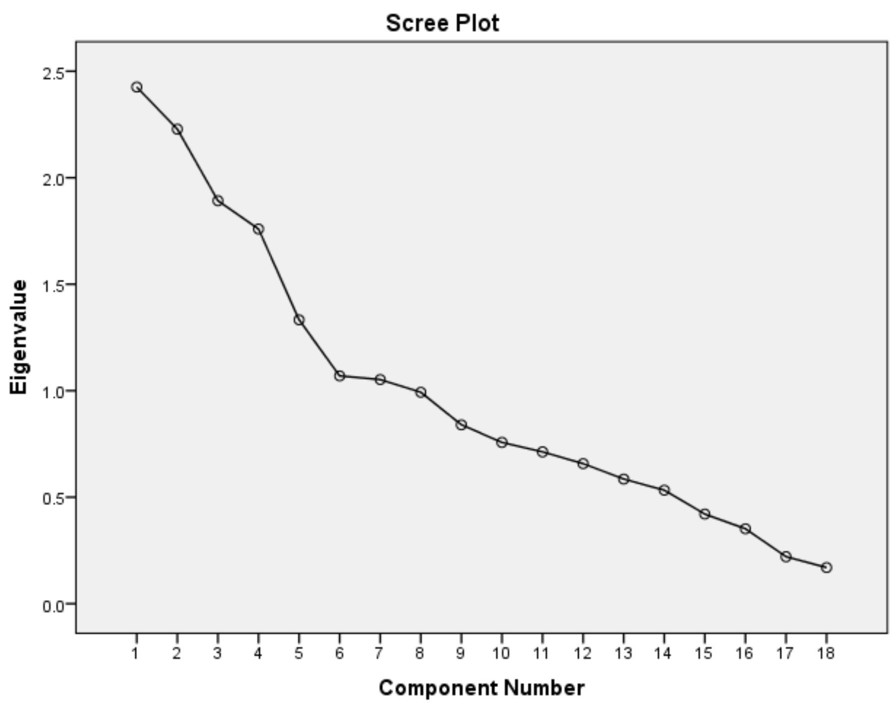


Figure 30 Scree Plot of the Factor Analysis for Vietnam

Determinants of Measure-based Adaptation

In order to determine the influence, the components have on adaptation level, a multiple linear regression analysis was conducted. Several combinations were tested, one applying various components, in combination of other independent variables and combinations employing the components with the highest loadings together with other independent variables.

a. Philippines

The final model utilized the combination consisting of the five components. The results are shown in Table 27. The model had an R value of 0.646 and adjusted R^2 value of 0.41 and, thus, explains forty one percent (41%) of the total variance in the measure-based index of adaptation. The explanatory power of the models is much higher to what was reported by Below et al., 2012; Nhan et al., 2010, who explored the relationship between socio-economic variables and farmers' adaptation behavior by means of an explanatory factor analysis and a multiple linear regression model. Their models explained between 22% to 28% of the observed variance.

The results imply that there are other variables not employed in the research that leave the unexplained variance in measure-based adaption index of rice-farming households. However, this is difficult to avoid when studying highly multifactorial systems of farmers' adaptation to saltwater intrusion since not all determinants that might influence farmers' choices on adaptation can be measured, given the different characteristics and contexts of individuals and their limited willingness to participate in interviews longer than 60 minutes. Nonetheless, the resulting model is significant based on the F-test.

Table 27 Regression Estimates (Dependent Variable: MAI)

INDEPENDENT VARIABLES	STANDARDIZED REGRESSION COEFFICIENTS	STD. ERROR	t	SIG.
Economic Capacity	.089**	.008	2.007	.046
Knowledge and Trainings on Saltwater Intrusion	.615**	.008	13.726	.000
Rice Farming Experience	-.065	.008	-1.486	.138
Perception on Climate Related Events	.025	.008	.578	.564
Human Capital	.019	.008	.433	.665

Note: R = .646
Adjusted R^2 = .41
F Stat: 15.552
** indicates significance at 99%

Two factors emerged as positive significant indicators. These are economic capacity and knowledge, trainings and level of awareness on saltwater intrusion. Determining the factors that influence adaptation through factor and regression analyses correspond well to a great deal of empirical research findings and the literature on farmers' adaptation to climate change. The outstanding role of the household economic capacity for successful adaptation has been well-established (Hartter et al., 2012; Howden et al., 2007; Huang, Wang, & Wang, 2015; Kim, Elisha, Lawrence, & Moses, 2017; Limantol, Keith, Azabre, & Lennartz, 2016; Menapace, Colson, & Raffaelli, 2014; Morton, 2007; Smit & Pilifosova, 2003; Yohe & Tol, 2002). The economic capacity of the household influences the demand for farming resources, infrastructure, and technological change that, particularly in combination, could require changes in agricultural production strategies (IPCC, 2007; Brick et al., 2010). Most studies highlight that greater economic resources increase adaptive capacity, while a lack of these resources limits adaptation options (Campbell, et al. 2000;Laville, 2000; Smit et al., 2001; Adger et al. 2005; Eichberger and Guerdjikova, 2013). The result further implies that rice-farming households with high income are more likely to adopt more measures than farmers with lower incomes. Moreover, rice farming requires economic resources to make adjustments in adaptation measures involving inputs such as seeds, fertilizer, pesticides, irrigation facilities, and more at rates which are stressors on farm budgets.

Involvement in organizations is included in the first factor. The result indicates it is positive and significantly related to adoption of adaptation measures, implying that the probability of adaptive strategy adoption in higher for those farmers who have connections with different organizations compared to farmers not participating in such coordinated actions and groups. This can be interpreted as an indication that membership and engagement in an organization encourages farmers to engage in a united strategies orientation; share knowledge and innovation ideas, discuss problems and challenges with others, and engage in collaborative decision-making.

The second significant factor is knowledge, trainings and level of awareness on saltwater intrusion. The result provides some support to involvement in organizations and the expectation regarding the influence of sources of information on the knowledge, trainings and awareness on saltwater intrusion in rice farms. The factor is positively related to adaptation measures. This parallels other researches that document the influence of awareness on climate change to adaptation measures (Kibue et al., 2016; Mertz et al., 2009; Mohammed Nassrasur Uddin et al., 2017).

This result highlights farmers' cognition and ability in adaptation to saltwater intrusion which may be a function of informational and capability training needs. The significance of each depends upon decision-making structures that can have parallel effects on choice of adaptation measures. Awareness about the impact of saltwater intrusion could have a significant effect on the derivative response that the farmers would implement. Knowledge about the causes of saltwater intrusion could also have comparable and consistent effects on the likelihood that any adaptation measure would be implemented. Low confidence in attribution or low opinion of potential impacts of saltwater intrusion may lead them to employ limited number of measures. High confidence in attribution and widespread recognition of saltwater intrusion causes and impacts would have the opposite effect. This could also influence the scale dimensions in the assessment of feasibility of the various measures. Since more measures become necessary as the inevitability of saltwater intrusion in rice farms will continue as the future unfolds, the feasibility of the measures would depend in part on the ability of the farmers to collect information and to process it properly so that more measures could be implemented timely.

The factor on household human capital and the factor on perception on climate related events did not emerge significant. The coefficient for farming experience though not significant is negative, confirming the results in some literature that older farmers tend to be more conservative and may be wary of adopting new techniques (Nhemachena and Hassan, 2007). This can be attributed to the fact that farmers who have been in rice farming are usually older, less educated and more resistant to change.

Perceptions of local farmers are important because farmers often manage rice production activities according to their perceptions and beliefs. However, in these communities, meteorological information from the scientific community is rarely available. Often, farmers rely on their own observations and subjective interpretations. Farmer's perceptions may not only be based on their individual but collective interpretations of their families, relatives or peers and are likely shaped by a number of interacting factors, such as access to information, formal education, social interactions, and life experience (Binh, 2015). The researcher is unable to detect significance of these variables in the model. However, they are likely still contributing to overall perceptions.

b. Vietnam

The final model consisted of six components. The results are shown in Table 28. The model had an R value of 0.482 and adjusted R^2 value of 0.214 and, thus, explains twenty one percent (21%) of the total variance in the measure-based index of adaptation. The explanatory power of the models is much relatively the same to what was reported by Below et al., 2012; Nhan et al., 2010, who explored the relationship between socio-economic variables and farmers' adaptation behavior by means of an explanatory factor analysis and a multiple linear regression model. Their models explained between 22% to 28% of the observed variance.

Table 28 Regression Estimates (Dependent Variable: MAI)

INDEPENDENT VARIABLES	STANDARDIZED REGRESSION COEFFICIENTS	STD. ERROR	t	SIG.
Household Resources	.067	.010	1.191	.235
Knowledge on CRE	.229**	.010	4.092	.000
Income Propensity	-.417**	.010	-7.502	.000
Rice Farming Capacity	.071	.010	1.261	.208
Household Dependents	-.002	.010	-.036	.971
Educational Aptitude	-.051	.010	-.906	.366

Note: R = .482
Adjusted R^2 = .214
F Stat: 12.644
** indicates significance at 99%

Two factors emerged as significant indicators. These are knowledge on climate related events and income propensity.

The component on knowledge on climate change events is positively associated with the farmers' measure-based adaptation index. This component has three variables, namely, perceptions of the farmers on climate related events in terms of intensity and frequency and level of awareness on saltwater intrusion. The result suggests that more farmers are aware and knowledgeable of the changes in climatic variables, especially their increasing frequency and intensity, the more diversified will be the adaption measures and the higher the adaptation index. These variables are instrumental in processing climate change information, as few farmers read newspapers or other print media offerings, as most of the farmers in the study areas are less educated. The results validate existing literature that promote the importance of better understanding of the interrelatedness of farmers' awareness and knowledge of their biophysical surroundings and concern about environmental changes (Alam, Alam, & Mushtaq, 2017; Arbuckle, Morton, & Hobbs, 2015b; Bewket, 2017; Elum, Modise, & Marr, 2016; Frondel, Simora,

& Sommer, 2017; Nguyen et al., 2016). Hence, awareness and knowledge is a critical component of adaptation through which farmers can adopt new ideas to reduce adverse impacts of climate variability.

The component on income propensity included sources of information, income level and perception on the manageability of climate related events. Among the three, only income level has positive coefficient. Given that there are negative correlations among the variables, the loadings will be negative too. Looking at the correlation matrix, sources of information and perception on the manageability of climate related events are negatively correlated with income. This suggests that rice farmers who tend to receive higher levels of income tends to have lower levels of information sources and have lower perception levels of the magnitude of the impact of climate related events. This makes sense given that the descriptive results showed that most farmers have very limited information sources. Also, since most farmers tend to have relatively high levels of rice productivity, they may not get as much information and be bothered with the potential magnitude of the impact of climate change. As a result, the higher their income propensity, the lower the diversity in terms of adaptation measures as well as their measure-based adaptation index. For most farmers in the two provinces, this may be the case of insufficient adaptation or even maladaptation (Adger et al., 2009; Fujisawa, Kobayashi, Johnston, & New, 2015; Huang et al., 2015). This situation is aligned with the concern about the ability of farmers from low-income countries to adapt effectively. In most low-income countries, farmers are used to dealing with climate stress and their response strategies are often probably insufficient in the face of anthropogenic climate change, which is a shock of a different nature and magnitude (Fankhauser, 2016).

The factors on four components did not emerge significant. The farming experience though not significant is negative which is similar to the results for the Philippines. It confirms the results in some literature that older farmers tend to be more conservative and may be wary of adopting new techniques (Nhemachena and Hassan, 2007).

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

SUMMARY OF FINDINGS

This study is motivated by the limited evidence-based and empirically derived information to support the localized adaptation planning pressures of saltwater intrusion in rice farms in the Philippines and Vietnam. The researchers found it necessary to carry out research in the field to understand not only who may be more vulnerable, but also what factors influence adaptive capacity. This research orientation is important such that it is localized, especially at the rural household level to assess their exposure, susceptibility and adaptive capacity to natural disasters and climate variability in order to provide insight for better local climate change adaptation planning. Though assessments of adaptive capacity to climate change hazards are not new, further research is still needed, particularly regarding slow-onset events. Slow-onset events tend to receive less attention due to their gradual development which often goes unnoticed in the early phases. Thus, this study analyzed adaptive capacity of rice-farming households in the context of saltwater intrusion.

Rice Production in Areas Prone to Saltwater Intrusion

The spatial distribution of the saltwater intrusion zones of the in the study areas in the Philippines and Vietnam has shown that they are highly susceptible to the hazard due largely to the degree of risk presented by their elevation and proximity to the coast. The coastal low-lying areas are not only susceptible to coastal flooding but have become highly vulnerable to saltwater intrusion. The unpredictability and intensification of saltwater intrusion could increase the occurrence of salinity in the rice fields, potentially affecting the greater land areas.

The farmers in the Philippines at most can only one successful cropping cycle annually while their counterparts in Vietnam at most can attain three cropping cycles for the same period. Filipino farmers mostly own approximately one third of a hectare while Vietnamese farmers own relatively sizable landholdings ranging from one to two hectares. More than seventy percent of farmers in the two countries reported that they finance their rice farming activities personally.

Rice is usually a monocrop for most farmers in these two countries. However, more than ninety percent (90%) of the Filipino farmers have less than fifty percent (50%) of the expected productivity levels for a given parcel of land which is very low compared to the Vietnamese rice farmers productivity levels. Farm gate prices in Vietnam are relatively lower than the farm gate price in Philippines. This could explain why Philippines is a major exporter of rice from Vietnam.

Characteristics of the Rice Farmers and their Households

Majority of the farmers in the two countries share common socio-demographic characteristics. They are between 51 to 60 years old. More than eighty percent (80%) of the farmers are married and around sixty percent (60%) belong to a household with three to five members. Eighty percent (80%) of are full-time farmers who are actively engaged in the various phases of rice production, i.e., land preparation to harvest and distribution.

Most of the farmers in the Philippines have finished elementary and attained high school levels, some are even college graduates but Vietnamese farmers mostly finished elementary levels. Majority of the farmers in the two countries are solely focused on farming activities. However, forty four percent (44%) of the Filipino farmers have secondary jobs either as workers in other subsectors of agriculture and in the service sectors. This allowed the Filipino farmers to earn secondary income sources. They also receive additional income from pensions, government subsidy and/or income by other members of the household.

Fifty four percent (54%) of the Filipino farmers have monthly household per capita income below the country's official poverty threshold. Almost the same proportion (52%) of Vietnamese farmers below the official poverty level. Nonetheless, seventy seven percent (77%) of the Filipino farmers would fall below the international poverty line (US$1.90/day) while only twenty six percent (26%) of the Vietnamese farmers would belong to same category.

Ninety eight percent of the Vietnamese farmers owned their house and lot while, only sixty three percent (63%) of Filipino farmers are owners. Interestingly, relatively the same proportion of Filipino and Vietnamese farmers own cellphone, television and karaoke.

Majority of the Filipino farmers are actively involved in an organization. Most of them are also active in the irrigators association. The irrigators' association is one of the institutions they consider important in growing rice. In most of the barangays surveyed, farmers are informally organized by "cabicilla" or groups of parcels of land in a given area. Only a handful of Vietnamese farmers reported involvement in some form of organizations.

Farmers' Awareness, Perceptions and Experience on Climate Change Related Events and Saltwater Intrusion

Unseasonal and erratic rainfall have long been experienced in both countries. However, the variability has not been very frequent as claimed by majority of the farmers in the two countries. Farmers in both countries nonetheless noted that the prolonged rains is becoming more challenging especially if it coincides with high tide which causes saltwater intrusion in rice farms.

Farmers in both countries claimed that typhoons, storms, flooding and drought affect the municipality less frequently. Though not very frequent, these climate related events are big source of risk according to majority of the farmers, specifically the devastating event of drought that took place in 2016 in both countries.

Among all the climate change related events, saltwater intrusion was the only climatic event considered as taking place more frequently by majority of the farmers in both countries. According to the farmers, coastal flooding has become more frequent exacerbated by heavy rains that simultaneously occur with high tide. Saltwater intrusion has also become more frequent in the recent years and was perceived to have extremely severe impact. In the Philippines, the damages could take place at the various stages of production. During the planting season, this could mean replanting of seedlings more often than necessary. As a result, Filipino farmers would often allocate extra seedlings as replacement for damaged plants.

Majority of the farmers in both countries were extremely aware of the four major conditions related to saltwater intrusion, specifically in terms of incidence in coastal areas; the occurrence in the rice farms; frequency of occurrence; and the negative effects to rice productivity. In both countries, farmers claimed that saltwater intrusion has been occurring since the last three decades.

Feasibility of the Adaptation Measures to Address Saltwater Intrusion

One major contribution of this research is the measurement of adaptation as it accounts not only for the incidence of adoption of various measures but also considering the scale at which these practices are carried out. This has been the limitation cited by a number of studies.

At least eighty percent (80%) of the farmers in both countries claimed they are not aware of salt-resistant variety. Their interest on the variety was heightened given their perceived severity of the impact of saltwater intrusion in their rice farms. Majority of the farmers in both countries also reported that changing the timing of irrigation flow is not relevant because they cannot control the water flow from the irrigation since it is a communal system and any alteration in the water flow will affect other users. Around the same number of farmers in both countries do not apply changing the timing of chemical use, crop rotation, growing multiple crops in the rice fields, filtering of water in their rice fields, planting of mangroves**.** Among all the measures, fish culture within the rice fields and aquaculture are measures very rarely implemented.

In summary, only four measures were considered relevant and currently practiced by at least fifty percent of the farmers in the Philippines. These are replacing the damaged plants, desalination by draining the saltwater with fresh water from irrigation and engaging in non-farm income sources and livestock production. Whereas, only two measures are practice by rice farmers in Vietnam. These are desalination and livestock production.

In all the typologies of adaptation measures, the observed adaptation for the previous, current and the future cropping seasons do not significantly vary. It can be gleaned from the results that farmers follow customarily what have been practiced.

Four major criteria were chosen in the assessment of the feasibility of the adaptation measures. These are: ability to implement the measures, effectiveness, cost efficiency and level of support from major stake holders. The farmers' assessment of their ability to implement the measures are concentrated on the most common measures they are currently implementing.

Majority of the farmers in both countries did not have insurance due to lack of awareness. Despite the insurance being provided for free in the Philippines, farmers are often intimidated in instruments coming from formal financial institutions. It also stresses the need to strengthen the popularity of insurance as an adaptation option among farmers through various supporting programs that may include premium subsidies and insurance sensitization through the government extension workers and the farmers' associations where they often source support to their farming activities and access primary information.

There are several measures implemented in the two countries but there is a concentration on very few measures that are traditionally practiced by the farmers. Majority of the farmers are quite averse in changing their agricultural and farming practices to deal with saltwater intrusion. This may be attributed to the fact that most of these activities do not require special skills and large amount of financial resources. The most feasible are desalinization process and livestock production. They are the least costly to implement as do not require a lot of resources. The measures are rated the highest in terms of level of support from stakeholders as this is widely practiced by most farmers and other entities within their support group.

Rice Farming Households' Measure-based Adaptation Index for Saltwater Intrusion

Actual adaptation measures implemented by the surveyed households ranged from one (1) to eleven (11). Households were classified somewhat subjectively into low and high diversity adaptation categories. That is, households who used 1-3 measures were classified as low diversity adopters and those with 8-11 measures were classified as high diversity adapters. With this classification, the diversity of adaptation for each Scenario was determined. In the Philippines, fifty four percent (54%) of the rice-farming households were in the low diversity adaptation category while forty four percent (44%) were in average diversity category. The adaptation index is relatively similar. In Vietnam, eighty percent (80%) of the farmers to have low diversity of adaptation, thus, low adaptation index.

The adaptation index of the farmers in the two countries reveal that notable shortcomings in the implementation of autonomous adaptation options. The low measure-based adaptation index of the rice farming households make them more vulnerable to multiple and compounded climate stresses, variability and climate induced natural disasters in the agriculture sector apart from the saltwater intrusion challenge that they face. In order to reduce the saltwater intrusion induced loss and damage, a series of adaptation options which are not currently being implemented by farmers must be further evaluated.

Determinants of Measure-Based Adaption Index

Seventeen (17) independent variables have been derived based on the conceptual framework. The final model for the Philippines explains forty one percent (41%) of the total variance in the measure-based index of adaptation while that for Vietnam explains twenty one percent (21%). The explanatory power of the model for the Philippines is much higher to what was reported by existing studies with models explaining between 22% to 28% of the observed variance. The results imply that there are other variables not employed in the research that leave the unexplained variance in measure-based adaption index of rice-farming households.

Two factors emerged as positive significant indicators for the Philippines and Vietnam. Knowledge and level of awareness on climate related events and saltwater intrusion is significant for the models of both countries. Determining the factors that influence adaptation through factor and regression analyses correspond well to a great deal of empirical research findings and the literature on farmers' adaptation to climate change. The result provides some support for the expectation regarding the influence of sources of information on the knowledge, trainings and awareness on saltwater intrusion in rice farms. The factor is positively related to adaptation measures which is in line with other research documenting the influence of awareness on climate change to adaptation measures. This result highlights farmers' cognition and ability in adaptation to saltwater intrusion which may be a function of informational and capability training needs.

CONCLUSION

The research confirmed that saltwater intrusion in the two countries depends on many weather factors and the hydrological regimes such as rainfall, upstream flow and tidal movement from the sea due to the relatively low elevation of the rice farms. The findings of the research show that the adverse effects of this slow onset hazard have increased through the years and has become more pronounced recently. Through the years, saltwater intrusion has affected more rice farms inland and remains longer in the river and canal networks when it is coupled with heavy rains. This has resulted in degradation and in some cases, abandonment of some rice fields in the Philippines which impacted local peoples' livelihoods. Impressively, the coastal rice farmers in the two countries remained persistent in pursuing rice production despite the environmental challenges they face due to saltwater intruded rice farms.

The findings also showed that most farmers are in the Philippines are technically inefficient and proved that farmers will continue to remain in rice farming despite the environmental challenges they face when their household subsistence and food security is at stake. This substantiate the economic importance of rice importation of the Philippines from Vietnam, given that the rural rice farmers in this country have higher levels of rice productivity.

This research analyzed the social and economic characteristics and institutional affiliations of the farmers by looking at their social, economic and institutional affiliations. These indicators are also associated with the factors of production such as land, labor and other critical inputs to rice farming. The characterization of the farmers depicts their capacity to pursue their basic needs and engage in various farming and livelihood activities. It also reveals the constraints and challenges they face. The analysis of their social, economic and institutional characteristics help identify and understand emergent conditions that may influence their choices and strategies in rice farming. The results showed that the coastal rice farmers exhibit attributes characteristic of the rural rice farmers in many developing countries. Most of them are engaged in small-scale, subsistence level of production and produce at the margin as indicated by the very low levels of their primary income from rice production. Rice-producing households have unfavorable socio-economic conditions and have limited ability to widen their opportunities in the face of adversity of slow onset events such as saltwater intrusion. The small-scale Filipino rice farmers' active involvement in formal and informal organizations indicate the importance of polycentric associations (eg., *"cabicilla",* barangay level farmer's association, municipal level irrigators' association, etc.) which can potentially lower transaction costs for accessing vital information, inputs for rice production and markets.

This research established that rice farmers are highly aware on the changes in their natural environment such as the climate change related events and more importantly the saltwater phenomenon and its impacts. The rice farmers perception that climate related events have occurred is supported by statistical evidence from data provided by climate agencies in the two countries. Thus, farmers' perceptions about climate change are consistent with reality.

Farmers were able to establish from their actual experience the risks they face under varying conditions of saltwater intrusion. Their awareness and experience influence the accuracy of their perception which is a necessary condition for appropriate choice of adaptation measures. However, despite the heightened awareness on various climate change related events. Particularly saltwater intrusion, famers adaptation behavior remains very traditional in nature. Despite heightened perception on climate change, farmers are not responding to it. Therefore, awareness on saltwater intrusion and impacts does not necessarily lead to more adaptation. Though the level of awareness is an important factor, farmer's choice of adaptation measures is also influenced by other factors. So, we may conclude that farmers are passively taking initiatives to adapt to climate related events. In the Philippines, the study has noted a strong network effect as farmers learn from other progressive farmers by working collectively through labor arrangement. These could be instrumental in boosting adaptation strategies in rice production in response to saltwater intrusion.

This research also premised on the farmers' decision to adopt a measure depends on the rational decision of the famer, particularly on certain feasibility criteria. The research substantiated that farmers' decision on the choice of adaptation is not only influenced by their ability to implement, evaluation of effectiveness and cost of implementation but can be also gauged from the support of their immediate network. This validates the importance of farmers institutional affiliation in the sourcing of information about the different measures and their outcomes. The research highlights the societal influences on farmer's decision-making process. Farmers are assumed to be interdependent with other players in society and make decisions based on these players' implementation and assessments on the benefits of certain adaptation measures.

These research findings further reinforced that there are variations in the level of adaptation of measures for saltwater intrusion. It can be said that variations exist in term of the specific measures used which often lean toward conventional categories and less emphasis on technology-based measures. In most developing countries, the adoption rate of technology-based measures has been low, despite the desirable impacts such as the new rice technologies and considerable effort put into persuading farmers to adopt them.

Water control through desalination using irrigation water is the most important adaptation measure employed currently by the farmers in the two countries. However, the current Filipino farmers' practices of water management in terms of controlling irrigation flow violate the communal system regulations which can impose significant costs on other users in the community. Therefore, the challenges brought about by saltwater intrusion has important implications on water rights regime in which farmers operate. The institutional context within which a farmer operate may restrict a farmer's adaptive capacity directly through rules and regulations or increase capacity by providing support for adopting certain adaptation measures.

Coastal rice farmers in both countries also face decisions on how to optimize their earnings outside of rice farming including optimization of their engagement in livestock production and off-farm livelihoods which are two of the most important measures currently implemented. The sustainability of such practices usually has two main aspects: abundance and stability of supply of natural resources which serve as major inputs to these activities (availability of space and indigenous feedstocks for livestock and natural supply of resources such as marine products for entrepreneurial activities of the household) and the social and economic conditions of the local market.

There are several measures implemented in the two countries but there is a concentration on very few measures that are traditionally practiced by the farmers. There are only two measures (desalination and livestock production) commonly implemented in the two countries. These measures are very critical in attaining additional income to supplement their rice-farming livelihood to support the basic needs of their households. All these measures may be perceived effective but they are short-term solutions and do not prepare the farmers for long-term consequences of saltwater intrusion. The study revealed the importance of cost efficiency, implying that adaptation measures that require high cost outlay is likely to be episodic and implemented staggered, such as the adoption of saline resistant seed variety and buying insurance. Majority of the farmers are also passive adapters as they are quite averse in changing their agricultural and farming practices to deal with saltwater intrusion as shown by the intertemporal choices they make. Exploring the combination of measures employed by the rice-farming households becomes imperative, especially under varying conditions. Determining the criteria that influence their choice of adaption measures is equally important.

This research also discussed the combination of adaptation measures farmers employ captured through the measure-based adaptation index (MAI). The combination of measures and the rate at which they are implemented represents a practical means of coping with changes and uncertainties brought about by saltwater intrusion, including its variability and extremes. The measure-based adaptation index of the farmer indicate that adaptation takes place at different levels, i.e., the propensity to adapt, the variety and diversity of adoption of various measures, the feasibility of the various measures and the varying conditions of saltwater intrusion.

The low measure-based adaptation index of the coast rice farming households in the two countries make them more vulnerable to multiple and compounded climate stresses, variability and climate induced natural disasters in the agriculture sector apart from the saltwater intrusion challenge that they face. In order to reduce the saltwater intrusion induced loss and damage, a series of adaptation options which are not currently being implemented by farmers must be further evaluated.

The key concern of farmers is their adaptability to the varying conditions of saltwater intrusion due to changes in climatic conditions, especially that the severity of the phenomenon has become more pronounced based on the most recent events they experienced. At the moment, the coastal communities may be deemed adaptable to changes given the existing conditions, particularly if they are gradual. However, under various temporal scales, these communities are less adaptable.

Finally, this research has shown that there are critical indicators of adaptation. The research has established that the model of adaptation for saltwater intrusion is largely influenced by the economic capacity of the farmers which is crucial in the optimization of the adaptation measures employed. The farmers' economic capacity includes ability to implement agricultural technology, alternative crop varieties, chemical use, among others. Thus, this research support that building adaptive capacity of rice farming households will require higher levels of economic capacity.

Any adaptation measure to address saltwater intrusion will invariably involve certain costs. Farmer's will be financially constrained especially when an adaptation technology is not readily available (e.g. salinity tolerant variety) or if the relative costs to gather information on adaptation are high. Other economic constraints are associated with the prices and other benefits produced by the technology, and the risks associated with its use. Thus, the farmers must be economically capable in investing in adaptation measures which requires cost outlays. It should also be considered that their perceptions about costs and benefits of different adaptation measures depend on their economic characteristics; therefore, the farmers' economic capacity influences their choice of adaptation measures to saltwater intrusion.

This research substantiated that farmers' knowledge and awareness on saltwater intrusion and the sources of information enhance adoption of measures. Therefore, the model for adaption to saltwater intrusion also include farmers awareness and general knowledge on the incidence of saltwater intrusion and its impacts. This implies the necessity to enhance farmers' knowledge through training and regular dissemination of vital information on various measures and their advantages which will contribute to the expansion of the array of measures they can implement.

This place-based research focused on the dynamics of adaptation in human systems, the processes of adaptation decision-making, the conditions that stimulate or constrain adaptation and the role of non-biophysical factors. The lessons from this research is the local-level adaptive capacity which is context-specific on saltwater intrusion in rice farms. It confirmed that coastal rice farmers in both countries are already adapting to saltwater intrusion. It established that farmer's economic capacity, awareness and knowledge critically influence the adaptation to saltwater intrusion. Conclusively, the research provides empirical data to improve understanding on the multi-dimensional adaptation to slow-onset hazards in general and saltwater intrusion in particular which received less attention in other studies. It addresses a number of knowledge gaps and constraints in the current situation of the research approaches and insights in assessment of adaptive capacity. Specifically, it provided an empirical analysis determining farmers' adaptation decisions and how adaptation can be measured quantitatively as well as the perceived assertion on farmers' adaptation behavior.

RECOMMENDATIONS

Coastal rice farmers are responding to the impacts of saltwater intrusion by adopting different measures, the choices of which are largely dependent on many factors. The findings have several important policy implications.

The spatial distribution of the rice farms covered in the study has proven that these farms are in the coastal flooding risk zones and highly susceptible to saltwater intrusion. Therefore, it is necessary to reduce or steer away rice production from the delineated potentially high susceptibility areas to low susceptibility areas. These farms are also found in areas where agricultural activities are prohibited based on the Philippine Water Code provisions. However, some of the farms in the Philippines are located in agrarian reform communities, therefore, the tenure of the farms is institutionally arranged by the government. Restructuring might be needed given the boundary conflicts due to the potential hazards in allowing the farmers pursue their rice production and other livelihood activities in the area. The severe environmental and ecological problems caused by saltwater intrusion has led to enormous economic losses which should not be neglected, especially from long-term perspective.

Results indicate that the economic importance of rice as a commodity drive the farmers to continue engagement in rice farming despite the negative effects of slow-onset hazard such as saltwater intrusion which is strongly affected by environmental factors like rainfall, temperature, hydrological conditions and state of the ecological system. It is therefore recommended that physical vulnerability assessment should be conducted and take into account especially at the local scale. Through this initiative, the scale at which the impact of saltwater intrusion may have on rice production and consequently on household food security may be assessed. Consequently, adjustments in current farming systems and types of farming systems could be implemented in the future.

The characterization of the rice farmers provide greater understanding of the circumstances under which they are operating. The profiling of farmers in terms of their social, economic and institutional background can assist in identifying their interest and ways to design the programs to complement their socioeconomic circumstances. This paves the way for tailored rice production programs specific to the needs and conditions of these farmers. The insights on famers socioeconomic conditions and their diversity will complement the intuitive understanding of extension workers and those who design development programs for rice farming. This has significant implications on the improvement of the equity and efficiency of extension programs based on farmers' socioeconomic characteristics and institutional affiliations.

There was difficulty in analyzing the nature of climate change events based on famers' perceptions particularly, slow-onset hazard such as saltwater intrusion varies with different social-ecological systems and the forecasted scenarios of sea level rise. This made necessary the collection of periodic data on meteorological information and monitoring of biophysical characteristics of the rice fields to have more accurate basis of the assessment of the likely impact to rice production.

The farmers' current knowledge on adaptation measures is insufficient for reliable choice of adaptations and rigorous evaluation of planned adaptation options. Therefore, institutions and meso-scale social interactions, are also important factors. Social interactions between the farmer and members of his family, as well as interactions with peers, and others, can influence a farmer's perceptions of the feasibility and/or desirability of different adaptive actions. If different sources convey varying or conflicting information, such interactions may produce barriers to adoption by changing a farmer's perception of uncertainty and the risks associated with adaptation choice.

The results of this research enumerated the different measures adopted by farmer autonomously forming a baseline against which the need for planned anticipatory adaptation measures can be evaluated and implemented. The measures implemented currently provide short-term benefits which may not be able to address varying conditions with higher levels of risks in the future. Therefore, planned adaptation is imperative which may necessitate deliberate policy decision on the part of the government, based on an awareness that varying conditions are already experienced in the municipality and that action is required to minimize losses.

The farmers' choice of adaptation measures rests on the underlying assessment of some feasibility criteria. The choice of adaptation measures depends not only on its effectiveness in meeting defined goals, but also on the farmers' perceived cost of implementation and perceived support by the most important stakeholders. Therefore, it is important to note here that present-day adaptations of farmers to saltwater intrusion are largely dependent on farmers' own adaptation decisions.

However, the public has an important role in improving the measures to adapt to climate change. Most measures to reduce the physical impact of saltwater intrusion require the design and provision of service or protection, such as more advance and effective adaptation measures. This may involve technology based measures or the provisioning of some physical infrastructures given that the farmers current adaptation measures are geared toward short-term solutions. For example, farmers are very hopeful that the flood protection infrastructures could protect them from storm surge and coastal flooding especially that the risks of coastal flooding are becoming more inevitable.

When planning for slow onset events such as saltwater intrusion, the importance of the different feasibility criteria must be considered. The results reveal that the cost of a given measure is a priority among the farmers. Thus, the net costs of the various measures as well as the distribution of costs of the implementation of a given measure is important not only on the affected rice farming communities but also the local and national decision-makers who will design interventions.

At higher levels of adaptation, improving the economic status of the rice farming households in both countries is crucial as this significantly influence adaptation diversity and contribute to improved overall adaptation index in the long-run. Long-term adaptive transformation will, however, require more investments that most farmers cannot afford and so would require some form of assistance from the government and other agencies. This includes development of salt tolerant variety suitable for the biophysical characteristics of the coastal rice farms and increased investment in human, social, physical capital and technology-based measures to complement adoption of water and farm-based management practices.

Adaptation measures to climate change in general and saltwater intrusion in particular should be developed based on community needs and capacities. These adaptation policies should be considered not only based on the ecological environment but also on economic factors especially the economically vulnerable rice farming households. The findings support the design of measures to create off-farm livelihoods activities so that farmers can diversify and supplement their income and continue their agricultural operations in the face of uncertainties due to saltwater intrusion. These off-farm livelihoods should build on new skills and capabilities and reduce dependence on natural resource extraction activities.

Since the poorest farmers are those least likely to adopt costly measures, they need special attention when policies are designed to promote specific techniques and technologies analyzed in this study. Clearly, financial viability is a major consideration in the choice of adaptation measures. Thus, increasing farmers' income in the short term will motivate them to adapt relatively costly measures. Hence, measures to combat saltwater intrusion that directly increase farmers' income are needed; providing social safety nets will also be very useful. As such efforts to ease liquidity constraints and improve farmers risk taking behavior in the adoption of new technology may be attained by increasing access to insurance.

Tailored extension programs that encourage adoption of specific measures may be highly effective instruments, not only for improving ability to combat saltwater intrusion but also for reducing vulnerability, especially in coastal rice farms most susceptible to the phenomenon. Currently, the feasibility of most measures rated poorly on cost-efficiency and support from major stakeholders. Possibly, one major way of encouraging technology-based adaptation measure is to improve access to the inputs necessary for the implementation of the measures and build on people's community solidarity especially if more farmers can be convinced that this would have positive effects on their families and that of their immediate community.

At a lower level of adaptation, the findings imply that providing climate related information to increase preparedness in timely planting, promoting livelihood diversification, and encouraging adoption of various measures might be successful to enhancing adaptation of rice farmers to saltwater intrusion in the short-term. Farmers' knowledge on saltwater intrusion and trainings on adaptation measures positively and significantly influence the farmers' decisions to take-up adaptation measures. Equally important are policies aimed at interventions that will generate incentives for formation and active participation in farmers' groups if efforts to boost adaptability of coastal rice farmers and their livelihoods are to be successful.

In the case of the desalination as the most widely adopted measure, the communal water system, especially the century old irrigation, adaptive cooperation is essential for pooling labor and other resources to construct and maintain canals and channels, allocate and share water, regulate and monitor the provision and use of water. The cooperation of the farmers for irrigation plays a significant role in shaping responses to issues of social trust, reciprocity, competition, conflicts, equity, and other mutual concerns related to water access especially that it is one of the most important measure to combat saltwater intrusion. Effective social organization and rules for collective action are crucial to coordinate cooperation for irrigation use.

Group and labor collaboration activities manifested by the “domduman” or labor pooling system in the Philippines is widely practiced by farmers may be an effective means to incentivize participation in groups. Furthermore, farmers when perceive they get strong support from within their groups, this may strengthen sharing of indigenous knowledge, experiences and exchange of information about new technologies. Group membership can, therefore, enhance social learning and knowledge spillover on adaptation to saltwater intrusion. Enhanced social learning may shape problem awareness and increase adoption attitudes important in framing the expectations of farmers towards resource problems and choice of adaptation measures. This improvement in attitudes might lead to subsequent changes in management practices and might enhance farmers’ adaptation. Improved access to extension services will increase rice farmers’ knowledge on adaptation measures and their benefits. There is therefore a need to strengthen the existing extension services provision in the widest possible means and by bringing in the private sector on board.

Lastly, management of saltwater intrusion in rice farms requires an active participation of related stakeholders including community level, coordination and collaboration must be strengthened especially the institutional arrangements that can resolve conflicts over communal rights.

The application of multi-criteria analysis (MCA) technique to supplement the mixed method is a structured way of making assessment of measures when there is a need to incorporate qualitative and quantitative information or when the information base is varied and incomplete. It can be used to evaluate and prioritize adaptation measures at multiple scales or issues. Along with the experience, the preferences and values of the farmers, as well as local knowledge, form the information basis for making adaptation decisions. The MCA process is very useful in the assessment of feasibility of the range of adaptation measures, and as an input to the formulation of the measure-based adaptation index (MAI), is a useful means of systematizing the farmer's preferences. The index was quite effective in determining the propensity to adapt different measures and the diversity of adaptation of farmers. The conceptual work building such index needed more specificity in terms of weight assignments, in that, it should not only be based on farmers qualitative assessment but should also consider the actual feasibility indicators.

The investigation on rice famers adaptation levels should be continued to determine the overall adaptation strategy against the impact of saltwater intrusion through adjudging the suitable options and how the combinations of measures perform across the spatio-temporal scale, i.e., under varying conditions of saltwater intrusion. Combination of adaptation measures will be best suited against the risk of adverse impacts of saltwater intrusion as it is based on long term realizations/observations of rice farmers. Moreover, the customized approach of measure-based assessment may help to achieve the intended objectives of explaining the linkage of saltwater intrusion adaptation to multidimensional indicators of adaptive capacity.

The spatial analysis through GIS mapping is a powerful tool to illustrate the physical characteristics of the barangays prone to saltwater intrusion as well as identify their productivity, income and adaptation levels. In the current study, the availability of spatial data analysis also played a vital role in assessing the perception and level of awareness on the risks emanating from climate related events and saltwater intrusion. The assemblage of information and analysis using the spatial analysis, not only quickened the data analysis of the study, but it unveiled the location of the rice producing barangays that require special attention for effective interventions. Accordingly, GIS technique as applied in this study contributes to the literature as a relevant decision support tool. Its use should be broadened by combining it with other GIS databases such as other socio-economic indicators, soil characteristics, farming practices and infrastructures. Geographical presentation of these development indicators can be valuable for designing and planning more appropriate strategies to improve their overall welfare.

For future research, the researcher recommends a transdisciplinary approach by coupling these data and results with biophysical data sets including plot level characteristics in order to fully capture impact of biophysical conditions, such as water, soil and plant assessments and production yields. The inclusion of a more scientific methodology in the analysis of the biophysical nature of the varying conditions of saltwater intrusion is highly recommended. Knowledge communication and transfer from the scientists must be complemented with the analysis from cross-disciplinary experts that can be translated into appropriate facts for local decision-makers. The need to provide socio-cultural and legal knowledge requires the inclusion of experts from those fields and must be closely linked to the participation of key stakeholders.

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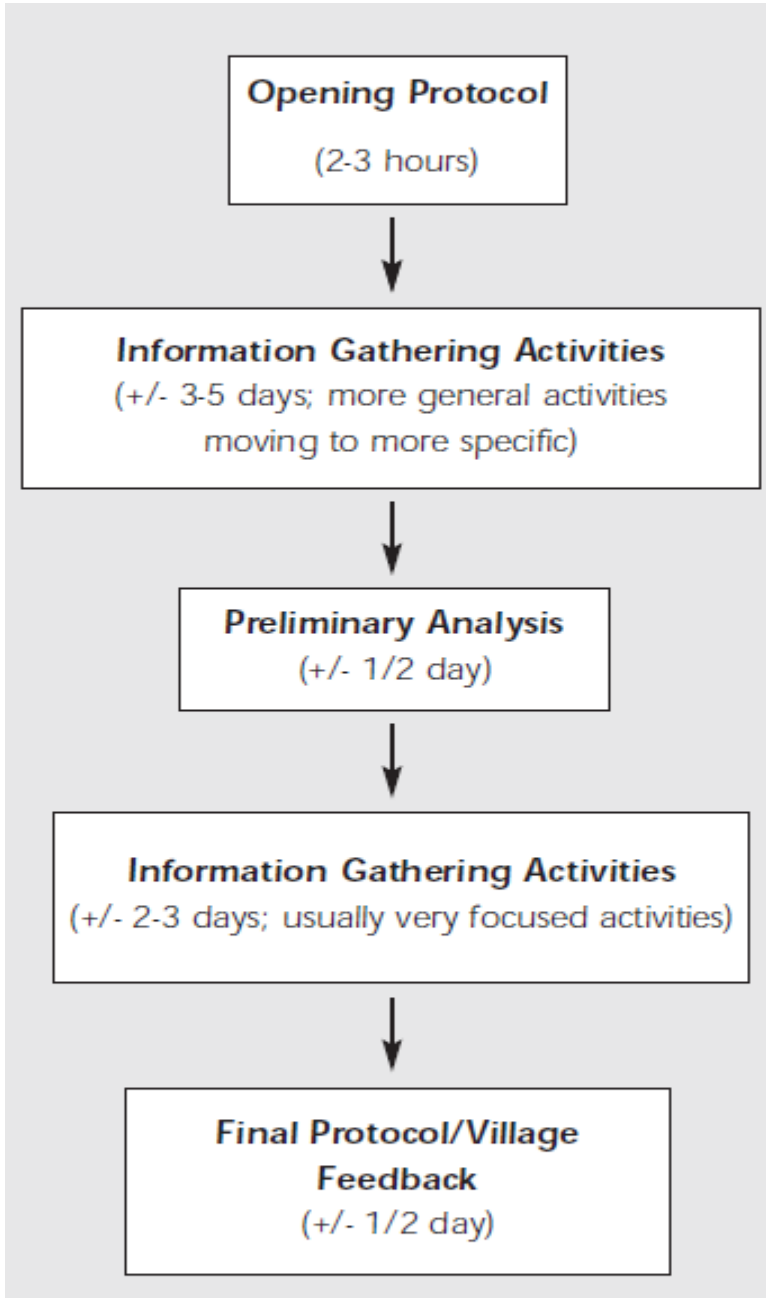
APPENDICES

Appendix A Rapid Rural Appraisal

Flow of the Rapid Rural Appraisal Activity



Objectives of the Rapid Rural Appraisal

I. Profile the Community
- History
- Geography
- Household and Community Social Structure
- Economy

II. Describe rice production strategies of different groups
- Rice production cycle
- Characteristics of good/average/poor seasons

III. Identify principal constraints to rice production
- principal threats to present and the future
- safety net strategies and their effectiveness

IV. Identify strategies/measures employed by households to combat saltwater intrusion and the criteria used in determining the measures employed.

V. Identify entities and counterpart roles in implementing these strategies.

Appendix B Survey Questionnaire

Good day. This survey is being conducted by Catherine Roween C Almaden of Xavier University-Ateneo de Cagayan for the Research Project on Household Adaptation to Saltwater Intrusion. You are one of the households randomly chosen to be one of the respondents for this study. The household member involved in rice farming activities is requested to answer the questionnaire. The questions will be about your household and farm characteristics, adaptation to salt-water intrusion in your rice farm and perception and opinion of climate change. Please rest assured that any information provided will remain confidential and will not be used for any reason other than the study. Should you choose to participate, please sign your signature below. Please remember that there is no right or wrong answer. Your honest answers and opinions will be most needed. It will probably take about 45 minutes to complete the questionnaire. You have the right to withdraw the interview any time. Thank you very much.

If you have any questions, please feel free to contact her by emailcalmaden@xu.edu.ph.She can also be reached at 09088999753.

Maayong Adlaw! Kini na survey gipahigayon ni Catherine Roween C Almaden, sa Xavier University-Ateneo de Cagayan para sa pagtuon mahitungod sa Panimalay nga Adaptasyon sa Pagsulod sa Tubig Dagat sa mga Humayan. Ikaw usa sa mga panimalay nga gipili nga mutubag alang niini nga pagtuon. Ang sakop sa panimalay nga nalambigit sa mga kalihokan sa pag-uma sa humay gihangyo nga tubagon ang pangutana. Ang mga pangutana kabahin sa imong panimalay ug umahan, pagpahiangay sa pagsulod sa tubig dagat diha sa imong humayan ug panglantaw ug opinyon sa pagbag-o sa klima. Ginasiguro nga bisan unsang kasayuran nga imong ihatag magpabilin nga kompidensyalug dili magamit alang sa bisan unsang hinungdan gawas sa pagtuon. Kung mopili ka sa pag-apil, palihug pirma para pagpamatuod. Palihug hinumdomi nga walay husto o sayup nga tubag. Ang imong matinuoron nga mga tubag ug mga opinyon labing gikinahanglan. Mahimong makumpleto ang mga pangutana sa sulod sa 45 ka minutos. Ikaw adunay katungod sa pag-withdraw sa interbyu bisan unsang orasa. Daghang salamat.

Kon duna kay mga pangutana, mahimo siyang makontak pinaagi sa email calmaden@xu.edu.ph.
Maabot usab siya sa 09088999753.

Questionnaire Code				
Enumerator				
Date of interview 1st		Time Started		Time Ended
2nd		Time Started		Time Ended
Name of Respondent			Signature	
Complete address of respondent				
Coordinates	Latitude		Longitude	
Contact number of respondent				

Assessment of the quality and reliability of elicited information:

____

____

A. Demographic Profile

A1	A2	A3	A4	A5	A 6	A7	A8	A9
Role of the Respondent ***(katungdanan sa panimalay)***	Sex	Date of Birth ***(Petsa sa pagkatawo)***	Age ***(Edad)***	Civil Status ***(Sibil na Kahimtang)***	Total Number of HH Member ***(Kinatibuk-an nga membro)***	Total Number of Members below 15 years old ***(Kinatibuk-an nga membro nag-edad kinse paubos)***	Total Number of Members above 65 years old ***(Kinatibuk-an nga membro nag-edad saysentay sais pataas)***	Total Number of Members w/ work ***(Kinatibuk-an nga membro nga nay trabaho)***
A1 **1** – Head/Breadwinner ***(Tigpangita)*** **2** – Spouse ***(Bana/Asawa sa Tigpangita)*** **3** - Son/Daughter ***(Anak sa Tigpangita)*** **4** - Son/Daughter-in-law ***(Umagad sa Tigpangita)*** **5** – Grandchildren ***(Apo sa Tigpangita)*** **6** – Others, specify	A2 1 - Male 2 - Female		**1** –Single ***(Ulitawo/Dalaga)*** **2** - Legally Married ***(Minyo)*** **3** –Widowed ***(Balo)*** **4** - Divorced/Separated ***(Bulag)*** **5** - Common Law/"Live in" ***(Nagpuyo)***					

B. Socioeconomic Characteristics

B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Highest Educational Characteristics ***Pinkataas nga nahuman na edukasyon*** (see codes below)	Primary Job ***(Nagapa nguna nga trabaho)*** (see codes below)	Monthly Income ***(Binula n nga Kita)***	Secondary Job ***(Ikaduha nga trabaho)***	Monthly Income ***(Binulan nga Kita)***	Entreprene urial Activities ***(Negosyo)*** (see codes below)	Monthly Income ***(Binulan nga Kita)***	Other Sources of Income (see codes below) ***(Ubang mga tinubdan sa kita)***	Monthly Income ***(Binulan nga Kita)***	Total Household Income ***(Kinatibuk -an nga Binulan nga Kita)***

B1 Highest Educational Attainment

0 - No Grade Completed
01 - Day Care
02 - Kindergarten /Preparatory
03 - Grade I
04 - Grade II
05 - Grade III
06 - Grade IV
07 - Grade V
08 - Grade VI/ VII
09 – Elementary graduate
10 - 1st Year HS
11 - 2nd Year HS
12 - 3rd Year HS
13 - 4th Year HS
14 - HS Graduate
15 - 1st Yr /Post Secondary/College
16 - 2nd Yr Post Secondary/College
17 - 3rd Yr Post Secondary/College
18 - Post Secondary Graduate
19 - 4th Year College or higher
20 - College Graduate (specify course)
21 - Post Grad w/ units
22 - Graduate (Master's course)
22 - Graduate (PhD)

B2/B4 Job, occupation or business

01-Professionals***(Propesyonal)***
02-Technicians ***(Technician)***
03-Service workers ***(Pahinante)***
04-Farmers***(Mag-uuma)***
05- Farm workers ***(Trabahante sa Umahan)***
06-fisherfolk***(Mangingisda)***
07-Plant and machine operators ***(Mekaniko)***
08-Real Estate ***(Ahente ug Balay)***
09-Mining and Quarrying ***(Minero)***
10- ConstructionLaborers ***(Panday/Mason)***
11-Sales/Trade workers ***(Tindero/Mamaligyaay)***
12-Driver
13- Home Service
14- Unskilled workers/Laborer

B6 Entrepreneurial Activities

01- Store Owner***(Tindahan)***
02- Fresh Produce(Vegetable/Fruits/Ornamental Plants) ***(Pagtinda ug abot sa umahan)***
03- Livestock ***(Pagbuhi ug mananap)***
04- Aquaculture
05- Forest products

(Kahoy/Tabla, sugnod, driftwood, ug uban pa)
06-Vending/Peddling ***(pagsuroy ug mga paninda)***

07- Crafts (food/clothing, household items, etc.) ***(pagdawat ug mga hinimo nga pagkaon, sanina o gamit panimalay)***

B8 Other Sources of Income

01- Rental Income
02- Interest Income
03- Investment Dividends
04- Remittances
05- Pension
06- 4Ps
07 Earnings of member 1 with work
08 Earnings of member 2 with work
09 Earnings of member 3 with work
10 Other source not mentioned

B. Socioeconomic Characteristics		**C. Institutional Affiliation**	
B11 : Housing Tenure	**B12:** Valuable Items (Multiple Responses)	**C1**Membership in Community Organization	_____ **YES** _____ **NO**
☐ **1** Owner, owner (possession of house of the house and lot) ***(Tag-iya sa lote ug balay)*** ☐ **2** Rent house/room including lot ***(Nagrenta sa lote ug balay)*** ☐ **3** Own house, rent lot ***(Tag-iya sa balay pero Nagrenta sa lote)*** ☐ **4** Own house, rent-free lot with consent of Owner ***(Tag-iya sa balay pero libre gamit sa lote nga nay pagtugot sa tag-iya)*** ☐ **5** Own house, rent-free lot without consent of Owner ***(Tag-iya sa balay pero libre gamit sa lote nga walay pagtugot sa tag-iya)*** ☐ **6** Rent-free house and lot with consent of Owner ***(Libre nga gipapuyo sa Tag-iya sa balay)*** ☐ **7** Rent-free house and lot without consent of Owner ***(Libre gamit sa balay nga walay pagtugot sa tag-iya)*** ☐ **8** others	☐ **1 Sewing Machine** ☐ **2 Television** ☐ **3 DVD Player** ☐ **4 Stereo** ☐ **5 Karaoke** ☐ **6 Refrigerator/ Freezer** ☐ **7 Electric Fan** ☐ **8 Electric Iron** ☐ **9 LPG Gas Stove/Range** ☐ **10 Washing Machine** ☐ **11 Microwave Oven** ☐ **12 Personal Computer/Laptop** ☐ **13 Mobile Phone** ☐ **14 Landline Telephone** ☐ **15 Air-conditioner** ☐ **16 Jewelry** ☐ **17 Motorcycle** ☐ **18 Car** ☐ **19 Jeep** ☐ **20 Others**	**C2** Institutional Affiliation (Multiple Responses: Check all that applies) **1 – Farmer's organization** **2 – Cooperative** **3 – Religious Organization** **4 – Community – based such as purok, sitio, barangay councils** **5 – Civic Organization (eg Rotary, Senior Citizen, Veterans, etc)** **6 – Others**	

D. Farm Characteristics	
D1: Number of years as a rice farmer : ______ yrs ***(katibuk-an nga tuig isip usa ka mag-uuma sa humay)***	
D2: Total Agricultural Land: ________ square meters ***(katibuk-an nga luna pang-agrikultura)***	**D3:** Tenure ***(Pagpanag-iya)*** 1 – Owned (***gipanag-iya)***, _____sqm 2 – Rented ***(renta)***,_____ sqm 3 – Sharecropped ***(gabahin sa tag-iya)*** ______ sqm 4 – Free Use ***(libre gamit)*** _____ sqm

E. Rice Production

	E1 Variety of Rice ***(Klase sa Humay)***	E2 Months ***(Mga Bulan)***	E3 Total Area Planted ***(Kinatibuk-an nga Luna)***	E4 Qty of Seeds ***(kadaghanon sa liso pang semilya)*** (Kilogram)	E5 Farm Inputs Used	E6 Water Source ***(Tinubdan sa Tubig)***	E7 Was it successful or failure?	E8 Total Labor Hired ***(Mga Trabahante sa Umahan)*** (Qty)	E9 Total Yield ***(Kinatibuk-an nga ani)***
Cycle 1 ***(unang pagtanum)***	Please enumerate variety				☐ 1 Fertilizer (Commercial) ☐ 2 Fertilizer (Organic) ☐ 3 Pesticide ☐ 4 Herbicide ☐ 5 Others ___________	☐ 1 Irrigation ☐ 2 Rain fed***(ulan)*** ☐ 3 Ground water/Tube Well/or Protected Borehole ***(Atabay)*** ☐ 4 Surface water***(Suba, sapa, spring)*** ☐ 5 Others, please specify	0 – No 1 - Yes		
Cycle 2 ***(ikaduhang pagtanum)***	Please enumerate variety				☐ 1 Fertilizer (Commercial) ☐ 2 Fertilizer (Organic) ☐ 3 Pesticide ☐ 4 Herbicide 5 Others ___________	☐ 1 Irrigation ☐ 2 Rain fed***(ulan)*** ☐ 3 Ground water/Tube Well/or Protected Borehole ***(Atabay)*** ☐ 4 Surface water***(Suba, sapa, spring)*** ☐ 5 Others, please specify	0 – No 1 - Yes		
Cycle 3 ***(ikatulong pagtanum)***	Please enumerate variety				☐ 1 Fertilizer (Commercial) ☐ 2 Fertilizer (Organic) ☐ 3 Pesticide ☐ 4 Herbicide 5 Others ___________	☐ 1 Irrigation ☐ 2 Rain fed***(ulan)*** ☐ 3 Ground water/Tube Well/or Protected Borehole ***(Atabay)*** ☐ 4 Surface water***(Suba, sapa, spring)*** ☐ 5 Others, please specify	0 – No 1 - Yes		

F. Rice Production Tools/Equipment/Technology/Financing Support				
F1Tools & Equipment ***(Mga himan pang-uma)*** 1 Cow/Carabao ***(Baka/Kabaw)*** 2 Plow ***(Daro)*** 3 Harrow***(Sudlay)*** 4 Mower 5 Thresher	6 Rice sheller 7 Farm tractor 8 Hand tractor 9 Turtle/Mudboat 10 Planter/Transplanter	11 Mechanical dryer 12 Multipurpose drying pavement 13 Rice mill/feed mill 14 Harvester, any crop	15 Warehouse granary 16 Farmshed 17 Water Pump 18 Irrigation pump 19 Rented 20 Others	F2 Source of Financing 1 Personal 2. Loan (Formal) 3. Loan (Informal) 3. Government Subsidy 4. NGO 5. Farmer Association 6. Others, please specify

G. Agricultural Production							
G1 Crops planted this year ***(Mga pananum Karon Tuiga)***	**G2** Total Area Planted ***(Kinatibuk-an nga Luna gitamnan)***	**G3** Tenure ***(Pagpanag-iya)***	**G4** Yield of the latest harvest ***(kinatibuk-an nga ani sa pinaka-ulahing pagtanum)***	**G5.1** Livestock ***(Mga binuhi nga kahayupan)***	**G5.2** Livestock Quantity ***(kadaghanon)***	**G6.1** Aquaculture	**G6.2** Aquaculture Qty

H. Changes in Natural Phenomena and Climate Affecting Rice Production in the Last 10 years (Mga Kausaban sa Panahon nga naka-apekto sa pag-uma ug humay sa niaging napulo ka tuig)						
H1 Nature of Climate change or natural phenomena ***(Kabag-uhan sa klima)***	**H2** Frequency of Occurrences ***(kadaghanon sa panghitabo)*** 0 - no change ***(walay kausaban)*** 1 - less frequent ***(dili kanunay)*** 2 - more frequent ***(mas kanunay)***	**H3** Intensity of Impact ***(Kadakuon sa Epekto)*** 1 –No effect ***(walay epekto)*** 2 - Slightly severe ***(dili grabe)*** 3 - Moderately severe ***(medyo grabe)*** 4 – Severe ***(Grabe)*** 5 - Extremely Severe ***(hilabihan ka grabe)***	**H4** Perceived Ability to manage climate change and natural Phenomena ***(Abilidad sa pagdumala sa kabag-ohan nga nay kabutan sa klima)*** 1 - Unmanageable ***(dili macontrol)*** 2 - Slightly manageable ***(medyo macontrol)*** 3 – manageable ***(macontrol)*** 4 - Very manageable ***(kaya macontrol)*** 5 - Extremely manageable ***(hilabihan nga macontrol)***	**H5** Sources of Information ***(Tinubdan sa mga impormasyon kalabot sa pag-bag-o sa klima)*** 5.1 Primary ***(Panguna)***	5.2 Secondary ***(Ikaduha)***	**H5 CODE** 1- Radio 2- Television 3- Government, extension workers 4- NGO project officers 5- Friends, relatives or neighbors 6- Farm Inputs Dealer 7- Teachers in local schools 8- Newspaper 9- Traditional /indigenous knowledge ***(tradisyunal na kahibalo)*** 10- own observations ***(obserbasyon)*** 11- Local group/gatherings/meetings 12- Religious faith 13- Cell phones 14- Internet 15- Others
1.1 Floods ***(Baha)***						
1.2 Storms ***(Bagyo)***						
1.3 Droughts ***(Hulaw)***						
1.4 Unseasonal and erratic rain ***(Pag-usab usab sa ting ulan)***						
1.5 Hotter weather ***(Kainit sa panahon)***						
1.6 Lower water supply ***(Pag-ubos sa supply sa tubig)***						
1.7 Salinity intrusion ***(Pagsulod sa tubig dagat)***						
1.8 Pest and diseases ***(pag-atake sa mga peste ug ubang sakit sa humay)***						
Others ***(Laing kausaban nga na sinati)***						

I. Level of Awareness of Salt-water Intrusion (Kasinatian sa Pagsulod sa Tubig Dagat sa mga kaumahan)	Level of Awareness *(Lebel sa kaalam)*	
1. Saltwater intrusion in rice farms is actually happening. ***Ang pagsulod sa tubig dagat sa mga kaumahan gakahitabo na.***		1 - not at all aware ***(wala nakabantay)*** 2 - Slightly aware ***(nakabantay gamay)*** 3 – Moderately Aware ***(Medyo nakabantay)*** 4 - Very aware ***(nakabantay kaayo)*** 5 - Extremely aware ***(hilabihan nga nakabantay)***
2. The effects of saltwater intrusion can be seen in the rice plant. ***Ang epekto sa pagsulod sa tubig dagat makita sa tanum humay.***		
3. Saltwater intrusion can reduce soil fertility. ***Ang pagsulod sa tubig dagat sa mga kaumahan makaubos sa katambok sa yuta.***		
4. There are ways of coping with saltwater intrusion. ***Naay mga pamagi sa pagsagubang sa pagsulod sa tubig dagat sa mga kaumahan.***		
5. Saltwater intrusion occurs in low coastal regions. ***Ang pagsulod sa tubig dagat mahitabo sa mga kaumahan duol sa baybay.***		
6. Saltwater intrusion is a result of climate change. ***Ang pagsulod sa tubig dagat resulta sa pagbag-o sa klima.***		
7. More extreme rain events will increase the likelihood of flooding and saturated soils. ***Ang labi nga sobra nga ulan makadugang sa posibilidad nga pagbaha ug pagsunop sa asin sa yuta.***		
8. Saltwater intrusion has negative effects to rice productivity. ***Ang pagsulod sa tubig dagat nay negatibo nga epekto sa abot sap ag-uma ug humay.***		
9. Salinity intrusion in recent years is more frequent than that in 10 years ago. ***Ang pagsulod sa tubig dagat sa mga kaumahan mas kanunay nahitabo sa niaging napulo ka tuig.***		
10. Bad natural resource (forest, land, water, etc) management causes salinity intrusion in rice farms. ***Ang dili mayo nga pagdumala sa kinaiyahan maoy hinungdan pagsulod sa tubig dagat sa mga kaumahan.***		

1 Measures **(Please refer to percentage guides for the ratings for J3-J6))**	**J2** Adaptation Status ***(Kasamtangan sa Pag-implementar)*** 0- not relevant ***(dili pwede)*** *1-* not yet planned but necessary ***(wala pa sa plano pero kinahanglan)*** 2- planned***(gi-plano)*** 3- the measure is implemented ***(gi-implimentar)***				**J3** Perceived Ability to Adapt and Apply the Measure ***(Abilidad sa Pag-implementar)*** 1- Extremely inadaptable ***(Lisud i-implementar)*** 2- Slightly adaptable ***(medyo kaya nga i-implementar)*** 3- Adaptable ***(ma-implementar)*** 4- Very adaptable ***(ma-implemetar kaayo)*** 5- Extremely adaptable ***(pinakasayon ma-implementar)***	J4 Perceived Effectiveness ***(Pagka-epektibo)*** 1- Extremely Ineffective ***(dili epektibo)*** 2- Slightly Effective ***(medyo epektibo)*** 3- Effective ***(epektibo)*** 4- Very Effective ***(epektibo kaayo)*** 5- Extremely Effective ***(pinaka epektibo)***	**J5** Perceived Cost of Adaptation ***(Gasto sa Pag-implementar)*** 1- Not Costly ***(dili gasto)*** 2- Slightly Costly ***(gamay lang ang gasto)*** 3- Average ***(sakto lang ang gasto)*** 4- Very Costly ***(gasto kaayo)*** 5- Extremely Costly ***(pinaka gasto)***	**J6** Perceived level of support from major stakeholders ***(Suporta sa lain-lain nga sector)*** 1 – Poor ***(kulang ang suporta)*** 2 – Fair ***(nay suporta)*** 3 - Good ***(sakto ug suporta)*** 4 - Very good ***(daghan ug supporta)*** 5 – Excellent ***(pinakadag han ug suporta)***	**J7** **Number of trainings** ***Plia ka tao or organisasyon ang nagtudlo nya or ikapila sya nag attend ug training***	**J8** Source of Information 1- Radio 2- Television 3- Government, extension workers 4- NGO project officers Friends, relatives or neighbors 5- Farm Inputs Dealer 6- Teachers in local schools 7- Newspaper 8- Traditional /indigenous knowledge 9- own observations 10 - Others
	J2.1 Last crop cycle ***(ulahi na pag-ani***	**J2.2** Present crop Cycle ***(kasam tangan)***	**J2.3** Future Crop cycle ***(Umaa bot nga pagta num)***	**J2.4** Reason for non-adaptati on ***(Rason ngano wala gi implem entar)***						
1.1 Technology-based										Primary/ Secondary
1.1 Using saline-resistant variety ***(pag gamit ug semilya nga mabuhi sa parat nga tubig)***										
1.2 Changing timing of irrigation ***(pag-usab sa timing pag-paawas sa irigasyon***										
1.4 Changing timing of application of chemicals (fertilizer, pesticides, herbicides, etc) ***(pag-usab sa timing pag-gamit ug kemikal (fertilizer,pesticides, herbicides, etc)***										
1.4 Using crop rotation ***(pagpuli-puli ug mga tanum)***										
2.2 Farm-based crop management										

2.1 Growing multiple crops ***(pagtanum ug lain lain nga mga tanum)***										
2.4 Replacing damaged plants ***(pag-usab sa pagtanum)***										
3.3Ecosystem-based management										
3.1 Draining the saltwater through water sourced from irrigation. ***(Pagpaawas ug tubig tab-ang nga tubig gikan sa irrigation para mapagawas ang tubig dagat (asgad))***										
3.2 Filtering water ***(Pagsala sa tubig nga ipaawas sa umahan)***										
3.3 Planting trees/mangroves ***(pagtanum ug mga kahoy ug bakhaw)***										
3.4 Fish Culture in rice fields ***(pagbutang ug aquaculture sa humayan)***										
4.4 Diversification of income sources										

4.1 Engaging in non-farming activities (partially or totally) ***(panginabuhian sa lain nga sector)***										
4.2 Engaging in livestock (partially or totally) ***(pagbuhi ug kahayupan)***										
4.3 Engaging in aquaculture (partially or totally) ***(pag-aquaculture)***										
5.5 Other measures										
5.1 Migrating to other places ***(pagbalhin sa laing lugar)***										
5.2 Buying insurance (physical assets, crop insurance) ***(pagpalit ug insurance para sa mga pananum)***										
Others										

Additional comments/remarks:

(Na aka pa bay idugang nga impormasyon?)

---------- END OF SURVEY ----------
THANK YOU VERY MUCH!!!

Operational Definition of Terms

Adaptation – Refers to the adjustments made by rice farming households to address saltwater intrusion or their effects.

Adaptation Measures – Refers to the strategies to address saltwater intrusion that were developed and implemented by the rice-farming households.

a. Ecosystem-based adaptation – Refers to the use of biodiversity and ecosystem services as part of an overall adaptation measures to help rice-farming households adapt to the effects of saltwater intrusion (Jones et al., 2012; UNFCCC, 2010).

- desalination – the process of draining the sea water with fresh water from irrigation
- filtering the water – the process of filtering the sea water to prevent it from intruding freshwater from irrigation in the rice field
- planting of mangroves – applied in rice fields near riparian zones to regulate the flow of sea water intrusion in the rice fields.
- fish culture in the rice fields – raising fish that thrive in brackish water in the rice field in order to increase food production in the farm

b. Technology-based adaptation – Refers to the application of technology and/or techniques by rice-farming households in order to address saltwater intrusion. Technological approaches to adaptation include both hard technologies such as goods, physical capital and equipment, as well as soft technologies such as knowledge of methods and techniques which enable hard technologies to be applied. The identified measures are based on classification of the technology for rice production in the Philippines and in other countries (Below et al. 2012; Burton and Lim, 2001; Howden et. al., 2007; Hassan and Nhemachena, 2008; IRRI Rice Knowledge Bank; Rejesus et al., 2011; Umetsu, Lekprichakul, and Chakravorty, 2003; Villano et al., 2014).

- Saline-resistant variety – rice variety developed through innovation by IRRI that can withstand conditions brought about by soil problems due to high salt toxicity
- changing timing of use of fertilizers – considered as soft technology that involved techniques in the application of various chemicals for rice production to counter the intrusion of saltwater intrusion
- changing timing of irrigation – considered as soft technology that involved a technique in managing irrigation as major source of water for rice production
- crop rotation system – considered as soft technology that involved alternating production of crops that can withstand saltwater in land used for rice production to attain better soil quality to generate higher yield of rice

c. Farm-based crop management – Refers to the measures to adapt to saltwater intrusion by modifying crop management in the rice farm and adjust to the actual environmental conditions (Below et al. 2012; Campbell, et al. 2000; Laville, 2000; Adger et al. 2005).

- growing multiple crops – refers to growing other crops that do not compete with resources for rice production in the same area where rice is planted to increase farm produce
- replacing the damaged rice plants – refers to appropriation of buffer seedlings to replace damaged rice plants due to saltwater intrusion. It is sually applied during the early stages of the rice plant.

- Off-farm diversification – Refers to the diversification of activities and opportunities to gain other employment and income to sustain the needs of rice-farming households in difficult seasons for rice production (Pulhin et al., 2016; Smit et al., 2001; Sombilla and Hossain, 2001).
- non-farming activities – refer to income from off-farm and non-agricultural sources to increase cash flow of the household.
- Livestock production – raising livestock near the farmer's dwelling or in areas outside of the rice farm
- aquaculture – the farming of fish, crustaceans, mollusks, aquatic plants, algae, and other aquatic organisms or cultivating freshwater and saltwater under controlled conditions.

Adaptive capacity – Refers to the ability of the rice farming households to adapt to saltwater intrusion inherent in their set of resources available for adaptation, as well as their ability or capacity to use their resources effectively in the pursuit of adaptation. Alternatively, adaptive capacity is composed of a set of factors which determine the capacity of the rice farming households to generate and implement adaptation measures. These factors relate largely to the rice farming households' social, economic, institutional characteristics, level of knowledge and perceptions.

a. Social Indicators
   - Age of Farmer: Length of life measured by years from birth to last birthday
   - Sex of Farmer: respectively as female or male
   - Farming Experience: Number of years respondent worked as a Farmer
   - Household size: Total number of household members
   - Total Dependents: Total number of unproductive household members, i.e. younger than 15 years or household members challenged or/and older than 65 years
   - Farmer's Education: highest level of education completed by the farmer

b. Economic Indicators
   1. Total Employed Members: Total Number of Employed Family members
   2. Household Income Level: Total household income from all sources as a ratio to the official standard of living for the province
   3. Housing Tenure: Status of ownership of house and lot based on tenure status of housing released by the former National Statistics Office (now PSA) is based on the 2010 Census of Population and Housing classified as follows:
      a. Owned/Being Amortized - the household is the owner and has legal possession of the housing unit, or the household claims to own it. Includes also housing units which are being amortized or on mortgage;
      b. Rented - the occupant actually pays rent either in cash or in kind;
      c. Being occupied for free with consent of owner - the household occupies the housing unit with owner's permission and without paying any rent in cash or in kind to the owner, tenant/lessee or subtenant/sub lessee; and
      d. Being occupied for free without consent of owner - the household occupies the housing unit without the consent or knowledge of the owner. Examples are squatters who occupy public and private buildings.
   4. Farm Size: Total lot area for rice production
   5. Farm tenure: Status of ownership of farm
   6. Valuable Assets: Total number of valuable assets

c. Institutional Indicators
   - Membership to organizations: Total number of membership of farmer to relevant organizations

- Sources of information: Total Sources of Information
- $INFO = (I_1 + \cdots I_8)/8$
- INFO = Total number of information sources

- Trainings on adaptation measures: Total number of trainings for Saltwater adaptation measures
- Total number of trainings on adaptation measures
- $Trainings = (T_1 + \ \ldots I_{13})/13$

- Trainings = Total number of trainings for each adaptation measure

- T = Training type

d. Awareness on Saltwater Intrusion: Level of awareness on saltwater intrusion measured based on total score on statements about saltwater intrusion
$ASWI = (S_1 + \cdots S_{10})/10$
ASWI= Awareness on Saltwater Intrusion
$S_1 \ldots S_{10}$ = Empirical statements on saltwater intrusion

e. Perception of climate change related problems: Number of weather related changes perceived by a farmer within the last decade.

$$PI_j = \Sigma_{i=1}^{i=m} C_{ij}$$

PI_j = Number of perceived changes by the household
i: climatic event
j: individual farming household
Cij = Changes of the climate change related events indicators

Composite Index – Refers to the aggregate value of the various measures of adaptation employed by rice farming household to address saltwater intrusion calculated through the Measure-based Adaptation Index (MAI). The index was calculated as the sum of the weighted adaptation measures of the household. This is expressed as

$MAI_{ij} = (AL_{ij}\ x\ AW_{ij} + \ldots AL_n\ x\ AW_n)$
where:
MAIij = Measure-based adaptation index of rice-farming household *j* for all the *i* measures employed from 1- n
i: the measure employed
j: individual rice-farming household
n = the last *i* measure employed by the *jth* rice farming household
AL_{ij} = *jth* rice farming household's value for a given *i* measure employed $(0 \leq AL \leq 1)$
AW_{ij} = weighting factor for each adaptation measure *i* employed by the *jth* rice-farming household

Feasibility Criteria - farmers' own appraisals of the viability of applying the various measures to address saltwater intrusion. There are four major criteria included in this study.
a. Perceived Ability to Implement the Adaptation Measures: Farmer's perception of his own self-efficacy or ability to carry out adaptation measures appropriately. The farmers

were asked to rate in terms of the percentage they were able to appropriately implement the measure under different cropping cycles.

1: 1-20% (inadaptable)
2: 21-40% (slightly adaptable)
3: 41-50% (adaptable)
4: 51-70 (highly adaptable)
5: over 70% (extremely adaptable)

b. Perceived Effectiveness of the Adaptation Measures: Farmer's perceived effectiveness on the capacity of an adaptation measure to achieve its expressed objectives. In this research this is gauged through the efficacy of the measure in reducing the impacts and exposure to risks and avoiding potential damages of saltwater intrusion. The farmers were asked to rate in terms of the percentage of impact reduction under different cropping cycles.

1: 1-20% (ineffective)
2: 21-40% (slightly effective)
3: 41-50% (effective)
4: 51-70% (highly effective)
5: over 70% (extremely effective)

c. Perceived Costs to Implement the Adaptation Measures: Farmer's personal assessment of the private costs of implementing the measures. The farmers were asked to rate in terms of the percentage to total production cost under different cropping cycles.

1: over 70% (Extremely Costly)
2: 51-70% (Highly Costly)
3: 41-50% (Average)
4: 21-40% (Slightly Costly)
5: 1-20% (Not Costly)

d. Perceived Support from Major Stakeholders to the Adaptation Measures: Farmers perception of the importance of the measure trough the number of people within their social network who provide reliable information and resources, support the implementation of the measures and practice them regularly. The farmers were asked to rate in terms of the percentage of stakeholders supporting the measure under different cropping cycles.

1: 1-20% (poor)
2: 21-40% (fair)
3: 41-50% (average)
4: 51-70% (very good)
5: over 70% (excellent)

Moreover, the respondents were also asked which adaptation measures were most feasible under three scenarios of saltwater intrusion.

Indicator – An indicator is an estimate of given concept and its corresponding variable.

Multidimensional – Refers to the various aspects of the adaptive capacity of the rice farming households to address saltwater intrusion, particularly, social, economic and institutional.

Saltwater intrusion – Refers the movement of saline water in the low lying coastal areas which lead to saline contamination of rice farms.

Appendix D Kobo Collect App Survey Form

Final (Sept 2017) Household Adaptation to Salt Water Intrusion - Mindanao

Questionnaire Code

CONSENT FORM

Maayong Adlaw! Kini na survey gipahigayon ni Catherine Roween C Almaden, sa Xavier University-Ateneo de Cagayan para sa pagtuon mahitungod sa Panimalay nga Adaptasyon sa Pagsulod sa Tubig Dagat sa mga Humayan. Ikaw usa sa mga panimalay nga gipili nga mutubag alang niini nga pagtuon. Ang sakop sa panimalay nga nalambigit sa mga kalihokan sa pag-uma sa humay gihangyo nga tubagon ang pangutana. Ang mga pangutana kabahin sa imong panimalay ug umahan, pagpahiangay sa pagsulod sa tubig dagat diha sa imong humayan ug panglantaw ug opinyon sa pagbag-o sa klima. Ginasiguro nga bisan unsang kasayuran nga imong ihatag magpabilin nga kompidensyal ug dili magamit alang sa bisan unsang hinungdan gawas sa pagtuon. Kung mopili ka sa pag-apil, palihug pirma para pagpamatuod. Palihug hinumdomi nga walay husto o sayup nga tubag. Ang imong matinuoron nga mga tubag ug mga opinyon labing gikinahanglan. Mahimong makumpleto ang mga pangutana sa sulod sa trenta minutos. Ikaw adunay katungod sa pag-withdraw sa interbyu bisan unsang orasa. Daghang salamat. Kon duna kay mga pangutana, mahimo siyang makontak pinaagi sa email calmaden@xu.edu.ph. Maabot usab siya sa 09088999753.

SIGNATURE

Reason for refusal

Enumerator

- ◯ ACTUB, Kennith G.
- ◯ CABIGAS, Jeric Lemuel M.
- ◯ GACASAN, Ronald A.
- ◯ CUIZON, Sharmine D.
- ◯ DACOCO, Whissabel
- ◯ LABLA, Sean Wade
- ◯ MENDOZA, Dave Alexys
- ◯ NG, Apple Christie A.
- ◯ OCLARIT, Leowfil B.
- ◯ POPERA, Alicia Claire C.
- ◯ VISTA, Alexa Dominique B.
- ◯ Caroline Laarni R Sereñas
- ◯ Ana Trillo
- ◯ Catherine R. C. Almaden

Date of Interview

yyyy-mm-dd
____

Time Started

hh:mm
____

Name of Respondent

____

Complete address of respondent

____

Contact number of respondent

BASIC INFORMATION

A1: Role of the Respondent
katungdanan sa panimalay

- ◯ Head / breadwinner
- ◯ Spouse
- ◯ Son/Daughter
- ◯ Son/Daughter-in-law
- ◯ Grandchildren
- ◯ Parents
- ◯ Other relatives, specify
- ◯ Housemaid/boy
- ◯ Others, specify

Other relatives, specify

Others, specify

A2: Sex

- ◯ Male
- ◯ Female

A3: Date of Birth

yyyy-mm-dd

A4: Age

Appendix E FGD/KII Guide Questions

FGD GUIDE QUESTIONS

Good day. This activity is being conducted by Catherine Roween C Almaden of Xavier University-Ateneo de Cagayan for the Research Project on Household Adaptation to Saltwater Intrusion. You are one of the households randomly chosen to be one of the respondents for this study. The household member involved in rice farming activities is requested to answer the questionnaire. The questions will be about your household and farm characteristics, adaptation to salt-water intrusion in your rice farm and perception and opinion of climate change. Please rest assured that any information provided will remain confidential and will not be used for any reason other than the study. Should you choose to participate, please sign your signature below. Please remember that there is no right or wrong answer. Your honest answers and opinions will be most needed. It will probably take about 1 hour and 30 minutes to complete the questionnaire. You have the right to withdraw the interview any time. Thank you very much.

If you have any questions, please feel free to contact her by email calmaden@xu.edu.ph. She can also be reached at 09088999753.

Maayong Adlaw! Kini na activity gipahigayon ni Catherine Roween C Almaden, sa Xavier University-Ateneo de Cagayan para sa pagtuon mahitungod sa Panimalay nga Adaptasyon sa Pagsulod sa Tubig Dagat sa mga Humayan. Ikaw usa sa mga panimalay nga gipili nga mutubag alang niini nga pagtuon. Ang sakop sa panimalay nga nalambigit sa mga kalihokan sa pag-uma sa humay gihangyo nga tubagon ang pangutana. Ang mga pangutana kabahin sa imong panimalay ug umahan, pagpahiangay sa pagsulod sa tubig dagat diha sa imong humayan ug panglantaw ug opinyon sa pagbag-o sa klima. Ginasiguro nga bisan unsang kasayuran nga imong ihatag magpabilin nga kompidensyal ug dili magamit alang sa bisan unsang hinungdan gawas sa pagtuon. Kung mopili ka sa pag-apil, palihug pirma para pagpamatuod. Palihug hinumdomi nga walay husto o sayup nga tubag. Ang imong matinuoron nga mga tubag ug mga opinyon labing gikinahanglan. Mahimong makumpleto ang mga pangutana sa sulod sa usa ka oras ug trenta minutos. Ikaw adunay katungod sa pag-withdraw sa interbyu bisan unsang orasa. Daghang salamat.

Kon duna kay mga pangutana, mahimo siyang makontak pinaagi sa email calmaden@xu.edu.ph. Maabot usab siya sa 09088999753.

Date of FGD		Time Started		Time Ended	

A. RICE PRODUCTION

1. Variety of Rice **(Klase sa Humay)**

Respondent Number	Answer/Questions

2. Rice Production Cycles in a Year & Duration **(Pila ka anihan sa is aka tuig ug Kadugayon)**

Respondent Number	Answer/Questions

3. Farm Inputs and Suppliers
   1 Fertilizer (Commercial)
   2 Fertilizer (Organic)
   3 Pesticide
   4 Herbicide
   5 Others ____________

Respondent Number	Answer/Questions

4. Water Source **(Tinubdan sa Tubig)**
   1 Irrigation
   2 Rain fed **(ulan)**
   3 Ground water/Tube Well/or Protected Borehole **(Atabay)**
   4 Surface water **(Suba, sapa, spring)**
   5 Others, please specify

Respondent Number	Answer/Questions

B. Irrigation

5. Uses of Irrigation (Ubang gamit sa Irrigasyon)

Respondent Number	Answer/Questions

6. Rainy Season (Bulan nga ting-ulan. Unsay kahimtang sa irrigasyon kung ting-ulan)

Respondent Number	Answer/Questions

7. Rainy Season Conditions (Bulan nga ting-init. Unsay kahimtang sa irrigasyon kung ting-ulan)

Respondent Number	Answer/Questions

8. Source of Financing for Irrigation Maintenance **(Suportang Pinansyal)**
   1 Personal
   2 Loan (Formal)
   3 Loan (Informal)
   4 Government Subsidy
   5 NGO
   6 Farmer Association
   7 Others, please specify

Respondent Number	Answer/Questions

9. Pila ug unsa ang pamaagi sa pagbayad? Obligasyon sa Members sa Irrigation

Respondent Number	Answer/Questions

10. Issues and Challenges in Irrigation Maintenance **(Mga Issue sa Pagmentinar sa Irrigasyon)**

Respondent Number	Answer/Questions

C. Changes in Natural Phenomena and Climate Affecting Rice Production in the Last 10 years (Mga Kausaban sa Panahon nga naka-apekto sa irigasyon sa pag-uma ug humay sa niaging napulo ka tuig)

1. Floods **(Baha)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

2. Storms **(Bagyo)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

3. Drought **(Hulaw)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

4. Unseasonal and erratic rain **(Pag-usab usab sa ting ulan)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)**

		4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

5. Hotter weather **(Kainit sa panahon)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

6. Water supply **(Supply sa tubig)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

7. Pest and diseases **(pag-atake sa mga peste ug ubang sakit sa humay)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

8. Saltwater intrusion **(Pagsulod sa tubig dagat)**

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

9. Others

Respondent Number	**Kadaghanon sa Panghitabo** 0 - no change **(walay kausaban)** 1 - less frequent **(dili kanunay)** 2 - more frequent **(mas kanunay)**	**(Kadakuon sa Epekto)** 1 – No effect **(walay epekto)** 2 - Slightly severe **(dili grabe)** 3 - Moderately severe **(medyo grabe)** 4 – Severe **(Grabe)** 5 - Extremely Severe **(hilabihan ka grabe)**

D. **Level of Awareness of Salt-water Intrusion (Kasinatian sa Pagsulod sa Tubig Dagat sa mga kaumahan)**

11. Saltwater intrusion in rice farms is actually happening.
Ang pagsulod sa tubig dagat sa mga kaumahan gakahitabo na.

Respondent Number	**Answer/Questions**

12. The effects of saltwater intrusion can be seen in the rice plant.
(**Ang epekto sa pagsulod sa tubig dagat makita sa tanum humay.)**

Respondent Number	**Answer/Questions**

13. Saltwater intrusion can reduce soil fertility.
Ang pagsulod sa tubig dagat sa mga kaumahan makaubos sa katambok sa yuta.

Respondent Number	**Answer/Questions**

14. There are ways of coping with saltwater intrusion. **Naay mga pamagi sa pagsagubang sa pagsulod sa tubig dagat sa mga kaumahan.**

Respondent Number	**Answer/Questions**

15. Saltwater intrusion only occurs in low coastal regions. **Ang pagsulod sa tubig dagat mahitabo lamang sa mga kaumahan duol sa baybay.**

Respondent Number	**Answer/Questions**

16. Saltwater intrusion is a result of climate change. **Ang pagsulod sa tubig dagat resulta sa pagbag-o sa klima.**

Respondent Number	**Answer/Questions**

17. More extreme rain events will increase the likelihood of flooding and saturated soils. **Ang labi nga sobra nga ulan makadugang sa posibilidad nga pagbaha ug pagsunop sa asin sa yuta.**

Respondent Number	**Answer/Questions**

18. Saltwater intrusion has negative effects rice production. **Ang pagsulod sa tubig dagat nay negatibo nga epekto sa mga kaumahan**

Respondent Number	**Answer/Questions**

19. Salinity intrusion in recent years is more frequent than that in 10 years ago. **Ang pagsulod sa tubig dagat sa mga kaumahan mas kanunay nahitabo sa niaging napulo ka tuig.**

Respondent Number	Answer/Questions

20. Bad natural resource (forest, land, water, etc) management causes salinity intrusion in rice farms. **Ang dili mayo nga pagdumala sa kinaiyahan maoy hinungdan pagsulod sa tubig dagat sa mga kaumahan.**

Respondent Number	Answer/Questions

Additional comments/remarks (Na aka pa bay idugang nga impormasyon?)

Respondent Number	Answer/Questions

---------- END ----------

THANK YOU VERY MUCH!

Appendix F Informed Consent

INFORMED CONSENT
(PAGPAHIBALO SA PAG-UYON)

Good day. This survey is being conducted by Catherine Roween C Almaden of Xavier University-Ateneo de Cagayan for the Research Project on Household Adaptation to Salt Water Intrusion. You are one of the households randomly chosen to be one of the respondents for this study. The household member involved in rice farming activities is requested to answer the questionnaire. The questions will be about your household and farm characteristics, adaptation to salt-water intrusion in your rice farm and perception and opinion of climate change. Please rest assured that any information provided will remain confidential and will not be used for any reason other than the study. Should you choose to participate, please sign your signature below. Please remember that there is no right or wrong answer. Your honest answers and opinions will be most needed. It will probably take about 30 minutes to complete the questionnaire. You have the right to withdraw the interview any time. Thank you very much.

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Kon duna kay mga pangutana, mahimo siyang makontak pinaagi sa email calmaden@xu.edu.ph. Maabot usab siya sa 09088999753.

Questionnaire Code	0912103	**Date of interview**	7/13/17
Enumerator			
Name of Respondent	Gina R. Balnarte	**Signature**	

Appendix Coastal Flooding in Plaridel due to Low Pressure Area, January 16, 2017

(Source: Official Facebook Page, Municipality of Plaridel)

Coastal Flooding Through the Sluice Gate ("Tapadera") of Barangay Southern Poblacion

(Source: Official Facebook Page, Municipality of Plaridel)

Flooded Rice Fields in Barangay Lao Proper

Appendix Rice Seedling Allowance for Replacement of Damaged Rice Plants

(Source: Researcher's Photo)

Rice Seedlings for Replacement of Damaged Rice Plants

(Source: Researcher's Photo)

Rice Plot With Empty Spaces Due to Rice Plant Mortality

Appendix: Reliability of Items on Level of Awareness on Saltwater Intrusion

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	326	99.7
	Excluded[a]	1	.3
	Total	327	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.866	.874	10

Item Statistics

	Mean	Std. Deviation	N
SW1	4.08	1.154	326
SW2	4.30	.939	326
SW3	4.00	1.152	326
SW4	3.34	1.328	326
SW5	4.14	.982	326
SW6	3.56	1.332	326
SW7	3.67	1.284	326
SW8	4.42	.829	326
SW9	3.89	1.199	326
SW10	3.63	1.317	326

Inter-Item Correlation Matrix

	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
SW1	1.000	.710	.481	.325	.535	.316	.367	.382	.491	.352
SW2	.710	1.000	.457	.320	.501	.383	.389	.507	.436	.383
SW3	.481	.457	1.000	.283	.400	.394	.415	.376	.406	.222
SW4	.325	.320	.283	1.000	.355	.399	.277	.377	.305	.221
SW5	.535	.501	.400	.355	1.000	.394	.408	.449	.499	.359
SW6	.316	.383	.394	.399	.394	1.000	.495	.442	.419	.405
SW7	.367	.389	.415	.277	.408	.495	1.000	.448	.542	.449
SW8	.382	.507	.376	.377	.449	.442	.448	1.000	.497	.380
SW9	.491	.436	.406	.305	.499	.419	.542	.497	1.000	.458
SW10	.352	.383	.222	.221	.359	.405	.449	.380	.458	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
SW1	34.95	49.841	.629	.590	.849
SW2	34.74	51.678	.656	.585	.849
SW3	35.03	51.110	.546	.351	.856
SW4	35.70	51.141	.448	.243	.866
SW5	34.90	51.595	.628	.419	.851
SW6	35.48	48.638	.593	.395	.853
SW7	35.37	48.707	.617	.433	.850
SW8	34.62	53.190	.624	.426	.853
SW9	35.14	48.930	.659	.477	.847
SW10	35.40	50.081	.515	.326	.860

Appendix: Manifestation of Effects of Salinity on Rice Plant

Source: Researcher's Picture

"Pula-Pula" or Yellowing of the Leaves of Rice Plant

Source: Researcher's Picture

"Asgad" or Saltwater Flooded Rice Plot

Source: Researcher's Picture

Uneven Distribution of Rice Plants Due to Effects of Saltwater Intrusion

Appendix: Abandoned Rice Fields Due to Trapped Saltwater in the Plots

Source: Researcher's Picture

Abandoned Rice Field Due to Trapped Saltwater (Barangay Lao Proper)

Source: Researcher's Picture

Abandoned Rice Field Due to Trapped Saltwater (Barangay Bato)

Appendix: Reliability of Items on Feasibility Indicators on Adaptation Measures

Case Processing Summary

		N	%
Cases	Valid	326	100.0
	Total	326	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.974	.977	7

Inter-Item Correlation Matrix

	AdapL1	AdapL2	AdapL3	Adaptability	Effectiveness	Cost	Support
AdapL1	1.000	.933	.907	.897	.811	.762	.809
AdapL2	.933	1.000	.957	.922	.864	.831	.827
AdapL3	.907	.957	1.000	.925	.872	.842	.842
Adaptability	.897	.922	.925	1.000	.917	.865	.869
Effectiveness	.811	.864	.872	.917	1.000	.850	.778
Cost	.762	.831	.842	.865	.850	1.000	.748
Support	.809	.827	.842	.869	.778	.748	1.000

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	1.801	1.512	2.340	.828	1.548	.091	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AdapL1	11.10	83.516	.905	.889	.970
AdapL2	10.94	81.655	.949	.943	.967
AdapL3	11.00	82.960	.953	.932	.968
Adaptability	10.27	72.087	.965	.937	.967
Effectiveness	10.76	79.993	.906	.860	.970
Cost	10.56	78.524	.865	.785	.973
Support	11.04	82.657	.858	.770	.973

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
12.61	108.688	10.425	7

Appendix: Intercropping/Planting of Multiple Crops Near the Rice Plots

(Source: Researcher's Photo)

Tomatoes Intercropped within the Rice Field

Appendix : Rice Seedling Allowance for Replacement of Damaged Rice Plants

(Source: Researcher's Photo)

Rice Seedlings for Replacement for Damaged Rice Plants

Appendix: Manifestation of Effects of Salinity on Rice Plant

(Source: Researcher's Photo)

"Pula-Pula" or Yellowing of the Leaves of Rice Plant

Appendix : Rice plot with Empty Spaces

(Source: Researcher's Photo)

Rice Plot With Empty Spaces Due to Rice Plant Mortality

Appendix : 1 Rice Crop Insurance Requirements and Process of Application

GENERAL INFORMATION ON THE RICE CROP INSURANCE PROGRAM

OBJECT OF INSURANCE

The object of insurance shall be the standing rice crop planted on the farmland specified in the insurance application and which the assured farmer has an insurable interest on.

AMOUNT OF COVER

The insurance shall cover the cost of production inputs per Farm Plan and Budget, plus an additional amount of cover (at the option of the farmer) of up to a maximum of 20% hereof to cover portion of the value of the expected yield, subject to the following prescribed cover ceilings:

Inbred Varieties	
Irrigated/Rainfed	P41,000 per ha.
Seed Production	P50,000 per ha.
Hybrid Varieties	
Commercial Production (F1)	P50,000 per ha.
Seed Production (A x R)	P65,000 per ha.

TYPES OF INSURANCE COVER

Multi-Risk Cover - This is a comprehensive coverage against crop loss caused by natural disasters (i.e., typhoon, flood, drought, earthquake, and volcanic eruption) as well as pest infestation and plant diseases.

Natural Disaster Cover - This is a limited coverage against crop loss caused by natural disasters.

PERIOD OF COVER

The insurance coverage shall be from direct seeding or upon transplanting up to harvesting, provided that insurance coverage shall commence from the date of issuance of the Certificate of Insurance Cover (CIC) or, from the emergence of seed growth (coleoptiles), if direct seeded or upon transplanting, whichever is later.

INSURABLE RICE VARIETIES

All rice varieties accredited for production by the National Seed Industry Council (NSIC) are insurable.

PREMIUM RATE

Premium rate is variable per region, per season and per risk classification. This shall be shared by the farmer, lending institution and the government.

National Composite Rates and Premium Sharing (%)

Borrowing Farmers

	Multi-Risk Cover		
	Low Risk	Medium Risk	High Risk
Farmer	1.46	2.91	4.37
L.I.	2.00	2.00	2.00
Gov't.	5.90	5.90	5.90
Total	**9.36**	**10.81**	**12.27**
	Natural Disaster Cover		
	Low Risk	Medium Risk	High Risk
Farmer	1.12	2.23	3.35
L.I.	1.50	1.50	1.50
Gov't.	4.22	4.22	4.22
Total	**6.84**	**7.95**	**9.07**

Self-Financed Farmers

	Multi-Risk Cover		
	Low Risk	Medium Risk	High Risk
Farmer	3.46	4.91	6.37
Gov't.	5.90	5.90	5.90
Total	**9.36**	**10.81**	**12.27**
	Natural Disaster Cover		
	Low Risk	Medium Risk	High Risk
Farmer	2.62	3.73	4.85
Gov't.	4.22	4.22	4.22
Total	**6.84**	**7.95**	**9.07**

COVERED RISKS

- Natural disasters including typhoons, floods, drought, earthquakes, and volcanic eruptions.
- Plant diseases, e.g., tungro, rice blast/neck rot, grassy stunt, bacterial leaf blight and sheath blight.
- Pest infestation by any of the following major pests: rats, locusts, armyworms/cutworms, stemborer, black bugs and brown planthopper/hopperburn.

EXCLUDED RISKS

Losses arising from:

- Fire from whatever cause;
- Theft and robbery, pillage, sequestration, strikes or other commotion, war, invasion, acts of foreign enemies, hostilities (with or without declaration of war), civil war, rebellion, revolution, insurrection, acts of terrorism, military or usurped power or radio-active contamination whether controlled or uncontrolled;
- Any measure resorted by the government in the larger interest of the public;
- Avoidable risk emanating from or due to neglect of the assured/non-compliance with the accepted farm management practices by the assured or person authorized by him to work and care for the insured crop;
- Strong winds and heavy rains not induced by typhoon; and
- Any cause or risk not specified in the covered risks;
- Unintentional acts of persons, natural or judicial, that may cause damage to the insured crop; and
- Losses arising from failure to comply with the eligibility requirments.

Losses occurring:

- Prior to the effectivity of insurance;
- Prior to seed growth (coleoptile);
- Beyond the scheduled date of harverst, unless harvesting could not be undertaken on such scheduled dates due to adverse weather conditions as certified to by the production technician/municipal agricultural officer or death of the insured and the the subject loss occurs within five (5) days after the scheduled date of harvest.

FARMER/FARMER ORGANIZATION ELIGIBILITY

- Any borrowing farmer or group of farmers who obtains production loans from any lending institution participating in the government-supervised rice production program and GOCCs/GFIs/NGOs/DILG-LGUs-sponsored credit programs.
- Any self-financed farmer/farmer organization (FO)/ people's organization (PO) or group of farmers who agrees to place himself/themselves under the technical supervision of PCIC-accredited agricultural production technician.
- Any Farmer Organization (FO) or People's Organization (PO) or group of farmers duly qualified under the Government Corporation Insurance System (GCIS).

Source: Philippine Crop Insurance Corporation (http://pcic.gov.ph//wpcontent/uploads/2015/08/rice_crop.pdf)

Appendix Rice Crop Insurance Requirements and Process of Application

FARM ELIGIBILITY

- The farm must not be part of a riverbed, lakebed, marshland, shoreline or riverbank;
- The farm must have an effective irrigation and drainage systems. Rainfed areas are eligible farms during wet cropping season subject to planting cut-off date;
- The farm must be accessible to regular means of transportation;
- The farm must be suitable for production purposes in accordance with the recommended Package of Technology (POT), e.g., right zinc content; and
- Farm location must have generally stable peace and order condition and not hazardous to health.

DOCUMENTS REQUIRED IN APPLYING FOR COVER

Individual Borrowing Farmer

- Application for Production Loan (APL) which also serves as application for crop insurance.
- Farm Plan and Budget (FPB) - showing schedule of farm activities, e.g.,date of planting and harvest, etc.
- Location Sketch Plan (LSP)/Control Map (CM)- showing landmarks and names of adjoining lot owners.

Farmers Borrowing as a Group

- List of Borrowers (LOB)- containing the names and addresses of the borrowers, the farm area, location, planting schedules, variety, amount of loan and signatures of borrowers.
- Standard Farm Plan and Budget (SFPB)
- Control Map (CM)

Self-financed Farmer

- Application for Crop Insurance (ACI)
- Farm Plan and Budget (FPB)
- Location Sketch Plan (LSP)/Control Map (CM)

WHERE TO FILE APPLICATION FOR COVERAGE

- Lending institution where farmers obtained their production loans.
- PCIC Regional Offices/PCIC authorized underwriting agents.

WHEN TO FILE APPLICATION FOR COVERAGE

Any day before the date of planting up to fifteen (15) calendar days after planting.

NOTICE OF LOSS

In the event of loss arising from risks insured against, a written Notice of Loss (NL) shall be sent to the PCIC Regional Office within ten (10) calendar days from occurrence of loss and before the scheduled date of harvest. In cases where the cause of loss is due to pest infestation, disease or drought and where the effect of damage is gradual or the full extent thereof is not immediately determinable, the NL shall be filed upon discovery of loss. In no case shall this be later than twenty (20) calendar days before the scheduled date of harvest. The NL shall at least contain the following information: name of the assured farmer, CIC number, lot number, time of occurrence of loss, stage of cultivation, nature, cause and extent of loss.

CLAIM FOR INDEMNITY

The Claim for Indemnity (PCIC Indemnity Form) shall be filed by the assured farmer or any immediate member of his family with the concerned PCIC Regional Office within forty five (45) calendar days from occurrence of loss.

ADJUSTMENT AND SETTLEMENT OF CLAIM

Verification and Loss Assessment

A team of adjusters composed of two (2) members, one from PCIC and the other from either the DA/DILG or DAR or NIA or concerned LI, shall verify the claim.

Loss Category:

- Total loss - if loss is 90% and above.
- Partial loss - if loss is more than 10% and below 90%
- No loss - if loss is 10% or less.

Amount of Indemnity

The amount of indemnity shall be based on the ff:

- Stage of cultivation at time of loss.
- Actual CPI (per FPB) already applied at time of loss.
- Percentage of yield loss.

Settlement of Claim

A claim shall be settled as expeditiously as possible but not later than sixty (60) calendar days from submission by the affected farmers of complete claims documents to PCIC RO. A claim not acted upon 60 calendar days shall be considered approved.

NO-CLAIM BENEFIT

The assured is entitled to a no-claim benefit of ten percent (10%) of his net premium paid if he/she has not filed any claim during the immediately preceding three (3) insured crop seasons not subject of any claim.

DEATH BENEFIT

This is a built-in death benefit component of the insurance package for rice crop equivalent to P10,000 per assured farmer who may suffer death within the term of coverage; provided said farmer is not more than 75 years of age at the inception of insurance.

CROP INSURANCE FOR RICE

General Information on the Rice Crop Insurance Program

DEPARTMENT OF AGRICULTURE
PHILIPPINE CROP INSURANCE CORPORATION

"Sa Paglaban sa Kahirapan at Gutom, Crop Insurance, Katulong sa Pagbangon."

7th Floor, Building A, NIA Complex, EDSA, Diliman, Quezon City, Philippines
TeleFax (02) 441-1324
Email rmg@pcic.gov.ph

Source: Philippine Crop Insurance Corporation (http://pcic.gov.ph//wpcontent/uploads/2015/08/rice_crop.pdf)

Appendix: Table Total Variance Explained by the Various Factors (Philippine Data)

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.194	18.790	18.790	3.194	18.790	18.790	2.867
2	1.944	11.438	30.228	1.944	11.438	30.228	2.159
3	1.718	10.105	40.333	1.718	10.105	40.333	1.834
4	1.541	9.062	49.395	1.541	9.062	49.395	1.827
5	1.170	6.885	56.280	1.170	6.885	56.280	1.185
6	1.092	6.424	62.704	1.092	6.424	62.704	1.373
7	.905	5.326	68.030				
8	.835	4.911	72.940				
9	.738	4.339	77.280				
10	.712	4.191	81.471				
11	.568	3.340	84.811				
12	.552	3.249	88.059				
13	.532	3.131	91.190				
14	.491	2.888	94.078				
15	.389	2.289	96.367				
16	.316	1.861	98.228				
17	.301	1.772	100.000				

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

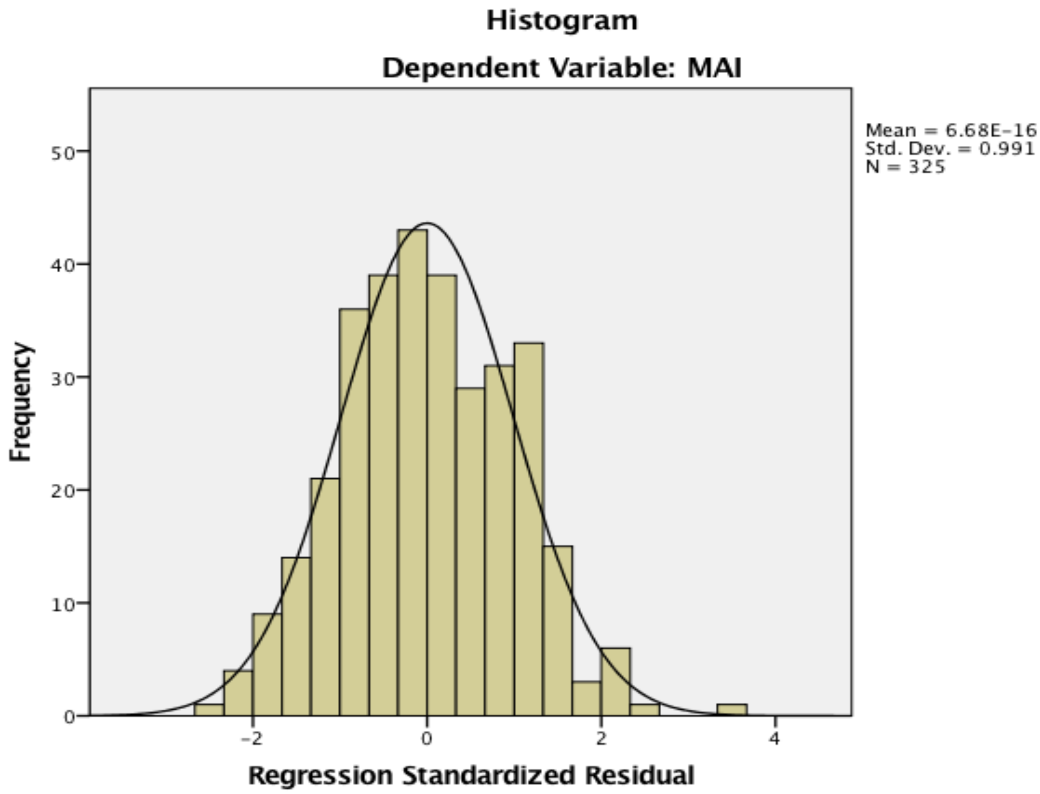
Appendix : Table Total Variance Explained by the Various Factors (Vietnam Data)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Total
1	2.426	13.477	13.477	2.426	13.477	2.013
2	2.228	12.377	25.854	2.228	12.377	2.016
3	1.892	10.510	36.365	1.892	10.510	1.690
4	1.759	9.774	46.139	1.759	9.774	2.013
5	1.333	7.405	53.543	1.333	7.405	1.564
6	1.069	5.941	59.484	1.069	5.941	1.332
7	1.052	5.845	65.329	1.052	5.845	1.553
8	.992	5.514	70.843			
9	.840	4.666	75.509			
10	.757	4.207	79.716			
11	.713	3.960	83.675			
12	.658	3.653	87.328			
13	.585	3.251	90.579			
14	.533	2.961	93.540			
15	.421	2.337	95.878			
16	.352	1.955	97.833			
17	.221	1.225	99.058			
18	.170	.942	100.000			

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Appendix : Multiple Linear Regression Assumptions (Philippines)

Multiple Linear Regression Assumption: Normality



Source: SPSS-generated

Multiple Linear Regression Assumption: Absence of Auto-correlation

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.646[a]	.417	.406	.14474	.417	38.098	6	319	.000	2.188

a. Predictors: (Constant), Sex, PCCE, HumanCap, EconCap, RFarmExp, KTASWI
b. Dependent Variable: MAI

Multiple Linear Regression Assumption: Absence of Multicollinearity

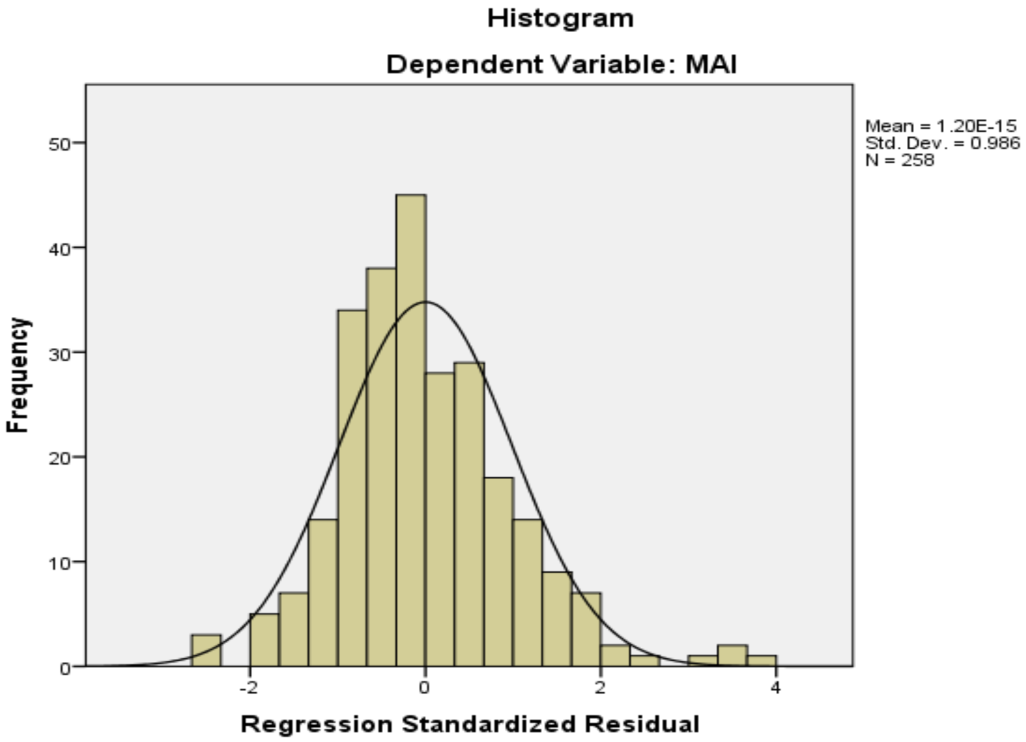
Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.392	.013		30.610	.000					
	EconCap	.017	.008	.089	2.007	.046	.231	.112	.086	.925	1.081
	KTASWI	.116	.008	.615	13.726	.000	.636	.609	.587	.909	1.100
	RFarmExp	-.012	.008	-.065	-1.486	.138	.000	-.083	-.064	.960	1.041
	PCCE	.005	.008	.025	.578	.564	.010	.032	.025	.984	1.016
	HumanCap	.004	.008	.019	.433	.665	.110	.024	.019	.963	1.038
	Sex	.014	.017	.038	.874	.383	.083	.049	.037	.960	1.042

a. Dependent Variable: MAI

Appendix : Multiple Linear Regression Assumptions (Vietnam)

Multiple Linear Regression Assumption: Normality



Source: SPSS-generated

Multiple Linear Regression Assumption: Absence of Auto-correlation

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		Durbin-Watson
					R Square Change	F Change	
1	.650[a]	.422	.406	.140626	.422	26.123	2.108

a. Predictors: (Constant), Household Resources, Knowledge on Climate Change, Income Propensity, Rice Farming Capacity, Household Dependents, Educational Aptitude
b. Dependent Variable: MAI

Multiple Linear Regression Assumption: Absence of Multicollinearity

Coefficients[a]

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
(Constant)	.295	.010		29.311	.000					
HHRes	.012	.010	.067	1.191	.235	0.61	0.75	0.66	.978	1.023
KnowCCE	.042	.010	.229	4.092	.000	.226	.250	.226	.981	1.020
YProp	-.076	.010	-.417	-7.502	.000	-.412	-.428	-.415	.990	1.010
RFCap	.013	.010	.071	1.261	.208	.018	.079	.070	.976	1.025
HHDeps	.000	.010	-.002	-.036	.971	-.005	-.002	-.002	.984	1.017
EducAp	-.009	.010	-.051	-.906	.366	-.065	-.057	-.050	.983	1.017

Correlation Matrix (Philippines)

		IncLevel	Educ	Sex	Age	HHSize	TeDeps	TEmp	HouseT	TotVI	Orgs	FarmExp	AgriSize	AgriTen	ASWI	PFreq	PInt	PMag
IncLevel	Pearson Correlation	1																
	Sig. (2-tailed)																	
	N	326																
Educ	Pearson Correlation	.324**	1															
	Sig. (2-tailed)	.000																
	N	326	326															
Sex	Pearson Correlation	.087	-.054	1														
	Sig. (2-tailed)	.117	.327															
	N	326	326	326														
Age	Pearson Correlation	.081	-.175**	.104	1													
	Sig. (2-tailed)	.146	.002	.062														
	N	326	326	326	326													
HHSize	Pearson Correlation	-.264**	.001	-.013	-.144**	1												
	Sig. (2-tailed)	.000	.981	.815	.009													
	N	326	326	326	326	326												
TDeps	Pearson Correlation	-.091	-.070	-.069	-.147**	.168**	1											
	Sig. (2-tailed)	.099	.209	.216	.008	.002												
	N	326	326	326	326	326	326											
TEmp	Pearson Correlation	.053	.038	-.062	.007	.238**	.024	1										
	Sig. (2-tailed)	.343	.493	.267	.897	.000	.662											
	N	326	326	326	326	326	326	326										
HouseT	Pearson Correlation	.149**	.146**	.029	.197**	-.014	-.055	-.009	1									
	Sig. (2-tailed)	.007	.008	.605	.000	.804	.326	.873										
	N	325	325	325	325	325	325	325	325									
TotVI	Pearson Correlation	.534**	.426**	.102	.144**	.011	-.044	.028	.272**	1								
	Sig. (2-tailed)	.000	.000	.065	.009	.840	.432	.610	.000									
	N	326	326	326	326	326	326	326	325	326								
Orgs	Pearson Correlation	.390**	.263**	-.084	.047	.048	-.061	.159**	.162**	.347**	1							
	Sig. (2-tailed)	.000	.000	.130	.394	.383	.275	.004	.003	.000								
	N	326	326	326	326	326	326	326	325	326	326							

FarmExp	Pearson Correlation	.055	-.179**	.166**	.619**	-.073	-.123*	.065	.109	.030	.153**	1						
	Sig. (2-tailed)	.323	.001	.003	.000	.190	.026	.244	.050	.584	.005							
	N	326	326	326	326	326	326	326	325	326	326	326						
AgriSize	Pearson Correlation	.490**	.218**	.102	-.033	.008	-.013	.074	.053	.383**	.300**	-.020	1					
	Sig. (2-tailed)	.000	.000	.066	.550	.892	.809	.182	.344	.000	.000	.722						
	N	326	326	326	326	326	326	326	325	326	326	326	326					
AgriTen	Pearson Correlation	.335**	.301**	-.075	.162**	-.083	-.088	.010	.256**	.401**	.326**	.103	.152**	1				
	Sig. (2-tailed)	.000	.000	.174	.003	.135	.113	.853	.000	.000	.000	.063	.006					
	N	326	326	326	326	326	326	326	325	326	326	326	326	326				
ASWI	Pearson Correlation	.130*	.082	.063	.000	.029	-.180**	.093	.042	.117*	.343**	.078	.151**	.103	1			
	Sig. (2-tailed)	.019	.139	.256	.993	.604	.001	.095	.455	.034	.000	.160	.006	.062				
	N	326	326	326	326	326	326	326	325	326	326	326	326	326	326			
PFreq	Pearson Correlation	-.060	-.101	.001	-.081	-.028	-.033	.023	-.072	-.063	.055	-.009	-.022	-.045	-.009	1		
	Sig. (2-tailed)	.283	.068	.982	.144	.612	.554	.679	.195	.253	.326	.868	.691	.422	.871			
	N	326	326	326	326	326	326	326	325	326	326	326	326	326	326	326		
PInt	Pearson Correlation	-.043	-.044	-.004	-.148**	.033	.038	-.037	-.113*	-.092	-.018	-.053	-.016	-.048	.027	.411**	1	
	Sig. (2-tailed)	.438	.424	.940	.007	.552	.500	.504	.042	.099	.750	.343	.769	.386	.633	.000		
	N	326	326	326	326	326	326	326	325	326	326	326	326	326	326	326	326	
PMag	Pearson Correlation	.142*	.129*	.084	.114*	-.105	-.042	-.028	.074	.205**	.115*	.009	.202**	.125*	.096	-.227**	-.466**	1
	Sig. (2-tailed)	.011	.019	.132	.039	.058	.445	.616	.184	.000	.039	.864	.000	.024	.084	.000	.000	
	N	326	326	326	326	326	326	326	325	326	326	326	326	326	326	326	326	326

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlation Matrix (Vietnam)

Correlations

		Sex	Age	HHSize	Temp	Tdeps	YLevel	HouseT	TVI	Orgs	FarmEx	AgriSize	FreqCCE	IntCCE	MagCCE	PI	ASWI	MAI	MAInd	Training	Info
Sex	Pearson Correlation	1	-.103	-.057	-.061	-.088	-.020	-.059	-.128*	-.146*	-.032	-.061	-.113	.042	-.087	-.110	-.067	-.112	-.093	-.130*	-.018
	Sig. (2-tailed)		.100	.362	.325	.156	.753	.346	.040	.019	.608	.329	.071	.498	.162	.077	.281	.074	.136	.037	.768
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Age	Pearson Correlation	-.103	1	.037	.070	.017	-.055	-.042	.007	.176**	.764**	.026	-.035	.069	.078	.056	.089	-.017	-.022	-.007	.153*
	Sig. (2-tailed)	.100		.558	.265	.791	.380	.498	.914	.005	.000	.679	.572	.269	.213	.369	.154	.786	.729	.908	.014
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
HHSize	Pearson Correlation	-.057	.037	1	.570**	.549**	.111	.029	.283**	.147*	.044	.044	.002	-.111	.089	-.004	-.124*	.003	.006	-.021	.058
	Sig. (2-tailed)	.362	.558		.000	.000	.076	.639	.000	.018	.482	.484	.979	.075	.154	.946	.047	.967	.922	.739	.355
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Temp	Pearson Correlation	-.061	.070	.570**	1	-.018	.152*	.014	.276**	.211**	.110	.109	.014	-.009	.106	.068	.049	.024	-.006	.018	.016
	Sig. (2-tailed)	.325	.265	.000		.771	.015	.827	.000	.001	.078	.080	.818	.881	.088	.277	.429	.698	.927	.778	.804
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Tdeps	Pearson Correlation	-.088	.017	.549**	-.018	1	.006	.004	.084	.108	.007	.010	.033	-.128*	.077	.002	-.068	.015	.014	.028	.034
	Sig. (2-tailed)	.156	.791	.000	.771		.928	.944	.180	.084	.915	.877	.602	.040	.217	.971	.276	.811	.825	.659	.584
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
YLevel	Pearson Correlation	-.020	-.055	.111	.152*	.006	1	-.011	.270**	.014	-.078	.256**	.004	.021	-.164**	-.083	-.130*	-.182**	-.155*	.008	-.173**
	Sig. (2-tailed)	.753	.380	.076	.015	.928		.855	.000	.826	.211	.000	.949	.741	.008	.185	.036	.003	.012	.892	.005
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
HouseT	Pearson Correlation	-.059	-.042	.029	.014	.004	-.011	1	.003	-.050	-.090	-.026	-.044	-.080	.053	-.042	-.065	-.013	.004	-.006	-.049
	Sig. (2-tailed)	.346	.498	.639	.827	.944	.855		.960	.422	.151	.675	.481	.201	.393	.503	.298	.833	.950	.921	.433
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
TVI	Pearson Correlation	-.128*	.007	.283**	.276**	.084	.270**	.003	1	.203**	.014	.138*	.058	-.131*	.086	.024	.000	.051	.062	.048	.080
	Sig. (2-tailed)	.040	.914	.000	.000	.180	.000	.960		.001	.820	.026	.356	.035	.169	.704	.998	.418	.318	.443	.202
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258

Orgs	Pearson Correlation	-.146*	.176**	.147*	.211**	.108	.014	-.050	.203**	1	.196**	-.027	.185**	-.109	.203**	.195**	.084	.186**	.151*	.208**	.211**
	Sig. (2-tailed)	.019	.005	.018	.001	.084	.826	.422	.001		.002	.672	.003	.081	.001	.002	.177	.003	.015	.001	.001
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
FarmEx	Pearson Correlation	-.032	.764**	.044	.110	.007	-.078	-.090	.014	.196**	1	.061	.031	.107	.049	.107	.128*	-.013	.014	-.035	.208**
	Sig. (2-tailed)	.608	.000	.482	.078	.915	.211	.151	.820	.002		.330	.619	.087	.434	.088	.041	.837	.825	.577	.001
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
AgriSize	Pearson Correlation	-.061	.026	.044	.109	.010	.256**	-.026	.138*	-.027	.061	1	-.121	.121	-.237**	-.164**	-.015	-.222**	-.178**	-.186**	-.096
	Sig. (2-tailed)	.329	.679	.484	.080	.877	.000	.675	.026	.672	.330		.051	.053	.000	.008	.813	.000	.004	.003	.123
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
FreqCCE	Pearson Correlation	-.113	-.035	.002	.014	.033	.004	-.044	.058	.185**	.031	-.121	1	.373**	-.129*	.837**	.372**	.311**	.337**	.159*	.207**
	Sig. (2-tailed)	.071	.572	.979	.818	.602	.949	.481	.356	.003	.619	.051		.000	.039	.000	.000	.000	.000	.010	.001
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
IntCCE	Pearson Correlation	.042	.069	-.111	-.009	-.128*	.021	-.080	-.131*	-.109	.107	.121	.373**	1	-.494**	.497**	.373**	.043	.060	-.126*	.087
	Sig. (2-tailed)	.498	.269	.075	.881	.040	.741	.201	.035	.081	.087	.053	.000		.000	.000	.000	.487	.337	.043	.165
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
MagCCE	Pearson Correlation	-.087	.078	.089	.106	.077	-.164**	.053	.086	.203**	.049	-.237**	-.129*	-.494**	1	.238**	-.070	.198**	.171**	.153*	.285**
	Sig. (2-tailed)	.162	.213	.154	.088	.217	.008	.393	.169	.001	.434	.000	.039	.000		.000	.264	.001	.006	.014	.000
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
PI	Pearson Correlation	-.110	.056	-.004	.068	.002	-.083	-.042	.024	.195**	.107	-.164**	.837**	.497**	.238**	1	.420**	.362**	.375**	.139*	.361**
	Sig. (2-tailed)	.077	.369	.946	.277	.971	.185	.503	.704	.002	.088	.008	.000	.000	.000		.000	.000	.000	.026	.000
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
ASWI	Pearson Correlation	-.067	.089	-.124*	.049	-.068	-.130*	-.065	.000	.084	.128*	-.015	.372**	.373**	-.070	.420**	1	.305**	.299**	.093	.313**
	Sig. (2-tailed)	.281	.154	.047	.429	.276	.036	.298	.998	.177	.041	.813	.000	.000	.264	.000		.000	.000	.138	.000
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
MAI	Pearson Correlation	-.112	-.017	.003	.024	.015	-.182**	-.013	.051	.186**	-.013	-.222**	.311**	.043	.198**	.362**	.305**	1	.946**	.557**	.460**
	Sig. (2-tailed)	.074	.786	.967	.698	.811	.003	.833	.418	.003	.837	.000	.000	.487	.001	.000	.000		.000	.000	.000
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
MAInd	Pearson Correlation	-.093	-.022	.006	-.006	.014	-.155*	.004	.062	.151*	.014	-.178**	.337**	.060	.171**	.375**	.299**	.946**	1	.535**	.442**

	Sig. (2-tailed)	.136	.729	.922	.927	.825	.012	.950	.318	.015	.825	.004	.000	.337	.006	.000	.000	.000		.000	.000
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Training	Pearson Correlation	-.130*	-.007	-.021	.018	.028	.008	-.006	.048	.208**	-.035	-.186**	.159*	-.126*	.153*	.139*	.093	.557**	.535**	1	.080
	Sig. (2-tailed)	.037	.908	.739	.778	.659	.892	.921	.443	.001	.577	.003	.010	.043	.014	.026	.138	.000	.000		.199
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
Info	Pearson Correlation	-.018	.153*	.058	.016	.034	-.173**	-.049	.080	.211**	.208**	-.096	.207**	.087	.285**	.361**	.313**	.460**	.442**	.080	1
	Sig. (2-tailed)	.768	.014	.355	.804	.584	.005	.433	.202	.001	.001	.123	.001	.165	.000	.000	.000	.000	.000	.199	
	N	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).