Journal of Environmental Science and Management 17(2): 48-62 (December 2014)
ISSN 0119-1144

Measuring Adaptive Capacity of Farmers to Climate Change and Variability: Application of a Composite Index to an Agricultural Community in the Philippines

Gay Defiesta[1] and Corazon L. Rapera[2]

ABSTRACT

Farming households in the Philippines are most vulnerable to climate change and variability due to their climate/weather-sensitive livelihood and lack of resources to finance adaptation measures. In order to formulate appropriate programs and policies addressing this vulnerability, it is essential to understand their adaptive capacity.

This study analyzed the adaptive capacity to climate change and vulnerability of 520 farming households in Dumangas, a town in central Philippines confronting climate/weather-induced risks. The objectives were: to determine the levels of adaptive capacity of farming households to climate change, analyze the factors that cause the differences in adaptive capacity and find out whether adaptive capacity translates to adaptation.

The level of adaptive capacity of each farming household was determined using a composite index based on previous studies. The index included five indicators namely human resources, physical resources, financial resources, information and diversity. Results showed that variations in adaptive capacity were caused by differences in information resources, physical and financial resources. Farming households that scored low in these three indicators had lower adaptive capacity. It was also found out that despite their level of adaptive capacity, households employed measures to adapt to climate change and variability. Households with higher adaptive capacity however employed more adaptation strategies.

Key words: *Climate change, adaptive capacity, index*

INTRODUCTION

The Philippines is one of the most vulnerable countries to climate risks because of its geographical location and level of economic development. Situated along the Pacific typhoon belt, it is ravaged every year by more than 20 typhoons and associated disasters such as torrential rains, floods, landslides and storm. It has also one of the longest coastlines in the world, which makes it highly susceptible to sea level rise. The country was identified as one of the most vulnerable to climate change in South East Asia (*Yusuf and Francisco 2009*). Moreover, the high incidence of these disasters and the magnitude of their impacts landed the country at the number three spot on the United Nation's list of natural disaster hotspots in the world (*United Nations University 2012*).

One of the sectors in the Philippines that have been severely affected by climate change is small-scale agriculture. Manifestations of the changing climate have been observed in the trend of increasing temperatures, precipitation, sea levels, and extreme weather events. The number of typhoons that entered the country increased from 27 in 2000-2003 to 39 in 2004-2007 (*DENR 2010*). Three of the five strongest cyclones occurred only in the recent decade, from 2003 to 2006 (*Virola 2008, as cited in DENR 2010*). All these have been wreaking havoc on the country's agriculture and the lives of the people it employs. From 2000 to 2010, the total damage on agriculture caused by typhoons, floods and droughts amounted to PhP 106,882.70 Million (*Israel and Briones 2012*).

The vulnerability of small-scale agriculture to climate variability and change is caused by the inherent climate and weather-sensitivity of agricultural livelihoods and the chronic poverty that plagues the sector. Adaptation has been recognized as an important strategy to reduce these impacts because it can lower vulnerability, and can increase resilience to climate change (*ADB 2009*). The enhancement of adaptive capacity is an effective means of facilitating adaptation to climate change and variability especially for vulnerable groups such as small-scale farmers in developing cuntries (*IPCC 2001*).

Adaptation however is costly and can strain the already limited funds of individual farmers and government in developing countries like the Philippines.

[1] Division of Social Sciences, College of Arts and Sciences, University of the Philippines Visayas, Miag-ao, Iloilo. E-mail: gay.defiesta@gmail.com (corresponding author)
[2] Department of Agricultural Economics, College of Economics and Management, University of the Philippines Los Baños

This paper was presented at the International Conference on Climate Change Impacts and Adaptation for Food and Environmental Security (ICCCIAFES), 21-22 November 2012, jointly organised by University of the Philippines Los Baños (UPLB), Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and partners.

Policies and support program for adaptation must be therefore effective and not waste valuable resources. Measures of adaptive capacity are useful in this context. Adaptive capacity is the “the ability of farmers to adjust to climate change, to temper/lessen potential damages, and to take advantage of opportunities or to cope with consequences” (*IPCC 2001*). It is an inherent characteristic of farming households, which indicates potential adaptation to climate change. Thus, measures of adaptive capacity would be valuable inputs in designing policies and interventions for adaptation.

Currently, however, there are very few studies in the Philippines that measure household level adaptive capacity to climate change. Most of the researches are either macro in scope, focusing on the municipal, provincial, or regional level. These studies cannot capture the unique social coping mechanisms and best practices or the hindrances to adaptation of households to climate change. This study fills this gap by focusing on the understanding of adaptive capacity at the household level. It provides insights into the causes and composition of adaptive capacity for households that are exposed to similar climate risks and analyzes how particular household characteristics relate to adaptive capacity (*Eakin and Bojorquez-Tapia 2008*). All these are valuable inputs in formulating policies and targeting beneficiaries.

This study aims to: determine the levels of adaptive capacity of farming households to climate change; identify the factors that cause the differences in adaptive capacity and; find out whether adaptive capacity translates to adaptation.

Adaptive capacity in this study was determined using a menu of indicators based mainly on the sustainble livelihoods (SL) framework which seeks to better understand the factors that affect poor people's livelihoods and the relationships between these factors (www.ifad.org). This framework has been widely applied in poverty and vulnerability studies of rural communities. More recently, the SL approach has also been applied in vulnerability and impact assessments of disasters and climate change. The *Department for International Development* (*1992*) defines a “livelihood to comprise the capabilities, assets (including both material and social resources), and activities required for a means of living” and “a livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base”. Livelihoods are therefore strategies or means of coping with shocks such as climate change. The SL framework identifies five asset categories; human, social , natural, physical and financial capital; from which livelihoods are built (*DFID 1999*).

The indicators of adaptive capacity enumerated in the third assessment report of the *IPCC* (*2001*) were generally based on assets and resources which reflect the SL framework. These include economic resources, technology, infrastructure, information and skills, institutions and equity (*IPCC 2001*). *Eakin and Bojorquez-Tapia* (*2009*) from which the indicators in this study were largely based on, points out that local capacity to address climatic risk is a function of indicators of access to different resources namely information, technology, wealth and finance, and institutional resources.

MATERIALS AND METHODS

Study site, respondents and method of gathering data

The study was conducted in Dumangas, a rice-farming town in the province of Iloilo in central Philippines. Dumangas was the chosen study site because of the climate risks that confront its farmers. The town, being a low lying area, is flooded during rainy season but suffers from drought during dry season because of its location at the tail end of the irrigation source.

There were two sets of respondents for this study. One is a panel of fifteen experts, purposively chosen, to provide ratings on the relative importance of the different indicators of adaptive capacity. The ratings were elicited using the pairwise comparison questionnaire, which comes with the method of Analytic Hierarchy Process. These experts' ratings were then used to generate the weights of each indicator using analytic hierarchy process (AHP).

The second set of respondents consisted of 520 farming households selected through stratified random sampling. The characteristics of these households formed the adaptive capacity index formulated in this study. A survey, with the aid of an interview guide, was conducted on these respondents to gather data on farming and household characteristics for the adaptive capacity indicators.

Method of Analysis

The adaptive capacity to climate change and variability of farming households was measured using a composite index. The index consists of various indicators of adaptive capacity following the sustainable livelihoods framework. Based on this approach, adaptive capacity is determined by ownership and access to resources, information and technology, and ability to diversify livelihoods to cope with climate-related stresses.

The adaptive capacity index in this study followed closely the variables included in the vulnerability index of *Eakin and Bojorquez-Tapia* (*2009*). Each farming household was analyzed using five indicators of adaptive capacity namely physical, human, financial, information and livelihood diversity (**Table 1**).

Index Construction

The composite index was constructed to come up with adaptive capacity scores for each household. The first step was the scoring of categorical data using Analytic Hierarchy Process (AHP) based on the ratings/judgements of key informant/experts.

The Analytic hierarchy process is a multiple criteria decision-making tool introduced by *Thomas Saaty* (*1980*) that uses an Eigenvalue approach to the pair-wise comparisons (*Vaidya and Kumar 2006*). Following the AHP procedure, the components, indicators, and sub-indicators of adaptive capacity were turned into a multi-level hierarchical structure to facilitate pairwise comparisons using expert judgment at each level. The instrument for the pairwise comparisons used AHP's 9-point scale format (**Table 2**) wherein the relative importance of indicators and sub-indicators were compared and assessed based on expert ratings. The weights were computed using the Analytical Network Process (ANP) software, Super Decisions version 2.0.8 and the trial version of the software Expert Choice.

The calculation of priorities adopted the procedure of *Beritella et al. 2007* which converts the responses of experts into a judgmental matrix:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

Where:

aij = the expert's comparison rating between element i and element j of a given level with respect to the upper level of the hierarchy with

$$a_{ij} > 0; a_{ij} = \frac{1}{a_{ji}}; a_{ii} = 1 \ for\ all\ i.$$

The priorities or weights of the elements were estimated by finding the principal eigenvector w of the matrix A which is: $AW=\lambda_{max} W$, λ_{max} is the largest eigenvector of the

Table 1: Indicators and sub-indicators of adaptive capacity.

Indicators	Sub-indicators	Description/Measure
Human Resources	Farming experience	The number of years that the respondent has been in farming
	Educational attainment of household head	The number of years spent in school by the household head
	Percentage of adults with primary education	The number of adults in the household that had some elementary education expressed as percentage of the total number of adults in the household
	Percentage of adults in the household	The number of adults in the household expressed as percentage of the total number of household members
Physical Resources	Farm size	The farm size in hectares
	Irrigation	Source of irrigation
	Ownership of farm implements/machines	The number of useful farm machines owned by the farming household
	Farm tenure	Type of farm occupancy
Financial resources	Remittances from family members	The amount of remittances/regular monetary assistance received by the household
	Value of animal units	The estimated total value of animals owned and raised by the household
	Receives financial assistance/subsidy from the government	If the respondent has regularly availed of financial assistance or subsidy for farming from the government
	Has access to credit	If the respondent knows a source of credit (formal or informal) or if he/she has availed of credit to finance farming from 2006-2010
Information	Type of trainings on farming	The type of training undergone by the farmer in the last 5 years from 2006-2010
	Receives technical assistance	If the farmer has been visited by or has consulted an agricultural technician from 2006-2010
	Participates in farm organization	If the respondent is a member of a farmers' organization
	Sources of climate information	The number of sources of climate data accessed by the farmer
Livelihood diversity	Number of livelihoods/sources of income	The number of all sources of income and employment of all household members
	Percentage of land not in crops	The percentage of land not devoted to crop production
	Number of crops planted	The number of crops planted per year

Table 2. Saaty's AHP fundamental scale for pairwise comparisons.

Numerical Values	Verbal Scale	Explanation
1	Equal importance of both elements	Two elements contribute equally
3	Moderate importance of one element over the other	Experience and judgment favour one element over another
5	Strong importance of one element over the other	An element is strongly favoured
7	Very strong importance of one element over the other	An element is strongly dominant
9	Extreme importance of one element over the other	An element is favoured by at least an order of magnitude
2,4,6,8	Intermediate values	Used to compromise between two judgments

Source: *Berittella et al. 2007*

matrix A. The vector *W* is then normalized to get the vector of priorities of elements of one level with respect to the upper level. The priorities served as weights of the elements at each hierarchic level.

The next step in the construction of the index was aggregating or combining all indicator scores with their corresponding weights to come up with one single index value/scores ranging from zero to one for adaptive capacity. The final step was classification of the scores into three levels – low, moderate and high adaptive capacity. Since there is no general rule for classifying adaptive capacity levels, cut points were based on previous studies (for example, *Eakin et al. 2008* and *Gbetibouo 2010*) based on the dispersion of data by setting three intervals for the three categories of adaptive capacity.

RESULTS AND DISCUSSION

Description of the study site

Dumangas is a coastal municipality located in Panay Island, Central Philippines (**Figure 1**). It has a total land area of 12,870.8 hectares with a population of 56, 291 indviduals and 12,443 households. The municipality is primarily agricultural devoting 56% of its land to crops. Rice is the town's major agricultural output contributing about 6% of the province's total output.

Dumangas faces a number of climate related challenges which have been affecting a lot of residents particularly farmers. These challenges have contributed to the vulnerability of farmers to climate change in the area. Being a coastal town, it is threatened by sea level rise and coastal erosion. It is also flood-prone during wet season due of its low elevation and the extensive river network within its territory. During dry season, it is at risk of drought because of lack of irrigation.

Socio-Economic Profile of Respondents

Majority of the farmers (62.3%) included in the study are male. Most of them (60%) belong to the 51-100 year-old age bracket, of which 188 (36%) are elderly or 60 years of age and above. The mean age of respondents is 54 years old, the youngest is 20 and the oldest is 95 years old.

Figure 1. Map of the study site. (Source: www.worldatlas.com/webimage/countrys/asia/ciamaps/ph.htm)

Some of them became full-time farmers after retiring from their jobs and continue to work actively in their farms even in old age.

Seventy-nine percent of the respondents are married. The rest are single, widowed, or separated. The average household size is four. The smallest household has only one member while the largest has eleven. Majority of these households are nuclear families consisting only of parents and children.

The primary crop planted by respondents is rice except for five farmers who plant watermelon, sugarcane, and vegetables. The smallest farm size is 0.02 ha and the biggest is 18 ha. Most respondents however, are small-scale farmers, cultivating an average farm size of 1.65 ha.

Monthly household earnings vary extensively. The lowest reported is PhP 300.00 and the highest is PhP 189,005. More than half (53%) of them, however, have relatively low incomes that range only from PhP 300 to PhP 10,000 per month and about two-thirds (79%) percent earn only PhP 300 to PhP 20,000. The average monthly household income is PhP 14,804 or PhP 3,701 per capita. Despite the disparities, most of the households are considered non-poor based on the poverty threshold of PhP 16,584 or PhP 1,382 per month for the region.

Adaptive Capacity and Asset Ownership of respondents

The adaptive capacity to climate change of the farming households is influenced by the diversity of their livelihood and by the physical, human, financial and information resources that they own and have access to. These indicators are important factors that determine resiliency to shocks such as climate variability or change. They comprise the assets or activities that reduce risks, smoothen consumption and maintain standard of living in the event of catastrophes or disruptions in farming (*Ellis 2000*). All other things being the same, farming households with more resources and higher livelihood diversity will most likely be able to adapt better to climate change.

Physical resources

Physical resources include natural assets such as land, produced capital like machines and farm infrastructure. The physical resources sub-indicators include farm size, farm ownership, irrigation source, and number of farm implements/machines owned.

Farm ownership is the most secure land tenurial status and allows owners some privileges to farm infrastructure such as construction of shallow tube wells which is not allowed for non-owners. In this sense, farm ownership functions as farm material wealth rather than financial wealth (*Eakin and Bojorquez-Tapia 2008*). This enables farm owners to combine a set of physical resources such as irrigation and farm tenure to carry out strategies to adapt to climate change.

Fifty-two percent of the respondents are owners of their farms, the rest are either leaseholders (36%) or shareworkers (12%). Leaseholders till the land under a renewable lease contract and pay rent in cash or the equivalent value in rice.

Out of 520 respondents, 62 (12%) are shareworkers or farmers who cultivate others' farms for a fee. The shareworker-owner arrangement is a common practice in the study site and many farm owners maintain a regular shareworking family to work for them. Owners finance/decide the whole farming operation but fully entrust the cultivation to shareworkers. Together with their family, the shareworkers perform all farming activities from land preparation to harvesting. They are usually paid 10% of the gross production every cropping season.

The sources of farm irrigation in Dumangas are the National Irrigation Authority (NIA), shallow tube wells and rivers. About one third (37%) of the farms have access to NIA irrigation. Still some of these farmers have their own shallow tube well as supplementary irrigation. While those who do not have access to NIA irrigation use shallow tube well, pump water from the river, or rely on the rain.

Ownership of farm machines enables farmers to exploit better farming technology, hence enhances adaptive capacity. More than half (54%) of the respondents have farm equipment. These are mostly thresher, blower or power tiller.

Farm size is also considered as a physical resource in this study. Farmers with bigger farm sizes have higher adaptive capacity, all other things being equal. Majority (90%) of the households are small farm holders with only less than a hectare to three hectares of land. Average farm size of the respondents is 1.65 ha.

Human resources

Human resources pertain to the quality of labor, skills and number of productive household members (*Ellis 2000*). High human resources such as longer experience, more education and better health means more knowledge and skills to adapt to risks posed by climate change, which redounds to higher adaptive capacity. The sub-indicators of human resources are farming experience, level of education of household head, percentage of adults in the household with primary education, and percentage of adults in the family.

More educated farmers have better access to information and technologies and are better able to exploit these resources in adapting to climate change. Farmers are

Table 3. Number and percentage distribution of farmers by physical resource sub-indicators, Dumangas, Iloilo, Philippines, 2011.

Physical Resource Sub-indicators	Number	Percentage
A. Farm tenure		
Owner	273	52.0
Leaseholder	185	36.0
Share worker	62	12.0
Total	520	100
B. Source of Irrigation		
NIA Irrigation only	145	28.0
NIA Irrigation and shallow tube well	46	9.0
Shallow tube well only	176	34.0
River and shallow tube well	2	0.4
River only	50	9.6
Rain	101	19.0
Total	520	100
C. Number of farm machines owned		
0	239	46.0
1-2	185	36.0
3-4	74	14.0
5-6	20	3.8
7-10	2	0.4
Total	520	100
D. Farm Size		
1 hectare and below	297	57.0
1.01 – 3.0	173	33.0
3.01 – 5.0	32	6.0
5.01 - 10	13	3.0
10.01 and above	5	1.0
Total	520	100
E. Average farm size	1.65 ha	

generally literate with 99% of them having some formal education except for two who had not attended school at all. Majority (365 or 70%) had at least high school education. On the average, respondents had nine years of formal schooling equivalent to third year of secondary education in the country.

The percentage of adults in the household refers to the number of people in the family who can support themselves. It is the opposite of dependency ratio, which implies that households with higher percentage of adults have higher adaptive capacity because they have more available labor, and less dependent persons to support. Many of the farming households in the sample have few dependents because majority (81%) of these comprised more than 50 percent working adults.

The percentage of adults with primary education captures the literacy rate of the entire household. Generally, more literate households have better quality labor and hence better human resources compared to households with less literate members. The percentage of adults with primary education is high with 442 (82%) of the households having 76-100% adult members with elementary education. On the average, 91% of adults in the family had primary education. These result reflect that high literacy rate is not limited to household head alone but extends to the whole farming household too.

The last sub-indicator of human resource is farming experience. Farmers with more farming experience are expected to adapt better to climate change. The respondents in this study are relatively well-experienced farmers. Many of them started at a young age by assisting their parents in farm work. Out of the 520 interviewees, only 98 (19%) had farming experience of less than 10 years. The rest have been farmers for 11 to 65 years with an average of 26 years. Because of their long farming experience, most respondents (64%) base their farming decisions primarily on experience.

Financial resources

Financial resource as an indicator of adaptive capacity represents the households' ownership of and access to financial wealth. Better financial standing signifies higher ability to finance adaptation/coping measures and recovery mechanisms to climate change risks. The sub-indicators of financial resource are the amount of remittances from family members, value of animal units, financial assistance from the government, and access to credit.

Table 4. Number and percentage distribution of farmers by human resource sub-indicators, Dumangas, Iloilo, Philippines, 2011.

Human Resource Sub-indicators	Number	Percentage
A. Formal education of household head		
None (0)	2	0.4
Elementary level (1-5 years)	53	10.0
Elementary graduate (6 years)	100	19.0
High school level (7-9 years)	66	12.6
High school graduate (10 years)	124	24.0
College level/vocational (11-13 years)	103	20.0
College and post graduate (14 years & above)	72	14.0
Total	520	100.0
B. Percentage of adults in household		
0% - 25%	6	1
26% - 50%	95	18
51% - 75%	114	22
76% - 100%	305	59
Total	520	100
C. Percentage of adults with primary education		
0% - 25%	6	1
26% - 50%	37	7
51% - 75%	43	8
76% - 100%	434	84
Total	520	100
D. Farming experience (years)		
10 and less	98	19
11 - 20	120	23
21 - 30	137	26
31 - 40	93	18
41 - 50	44	8
51 - 60	25	5
61 - 70	3	1
Total	520	100

Only a few (20%) respondents receive remittances from their family members. The average remittance amounted to PhP 8,830 mo^{-1} contributed usually by immediate family members (e.g., children, spouses) working in other cities in the country or abroad.

The value of animal units owned by households is also an important financial resource. Animals are form of savings for farming households and hence indicative of the amount of financial resources available to them to finance adaptation strategies. Majority (73%) of the farmers raise animals for consumption, for commercial purposes, or plowing the field. The average value of existing animal units owned by farmers is PhP 9,815.

Financial assistance from the government is usually in the form of discounts on seeds and fertilizer. Few farmers (16%) avail of the government subsidy because they need to make purchases to benefit from it. Hence, only those who procure seeds from the government through the Municipal Agricultural Office (MAO) was able to avail of the subsidy. Most farmers either exchange or allot a portion of their produce for seeds, which does not entail any cash out.

Majority of the farmers have access to both formal and informal credit. Some of them have been regularly availing of loans to finance their farming expenses. Their sources of formal credit are rural banks, NGOs, and other institutions offering small- denominated loans. Sources of informal credit are friends, relatives, other farmers, and loan sharks. About 39% of the respondents, however did not have access to credit due to lack of knowledge of existing credit institutions and/or inability to avail of credit due to the lack of capacity to pay.

Information resources

The sub-indicators of information resources include training on farming, technical assistance from the government, participation in farmers' organization, and number of sources of climate information. These are the avenues by which farmers can derive pertinent information that strengthen their ability to adapt to climate change, either directly from training, sources of climate information, or indirectly through interactions and knowledge-sharing with other farmers.

There are three types of training regularly conducted

Table 5. Number and percentage distribution of farmers by financial resource sub-indicators, Dumangas, Iloilo, Philippines, 2011.

Financial Resources Sub-indicators	Number	Percentage
A. Monthly remittances received from family members		
None	425	82
5,000 and below	49	9
5,001 – 10,000	18	3
10,001 – 20,000	18	3
20,000 – 50,000	8	1
Above 50,000	2	0.4
Total	520	100
B. Value of animal units		
0	142	27
1,000 and below	98	19
1,001 – 5,000	135	26
5,001 – 10, 000	37	7
10,001 – 20,000	41	8
20,001 – 50,000	39	8
50,001 – 100,000	18	3
Above 100,000	10	2
Total	520	100
C. Access to credit		
No	204	39
Yes	316	61
Total	520	100
D. Receives government financial assistance		
No	435	84
Yes	85	16
Total	520	100

for farmers. One is Climate Field School (CFS), a 12-week comprehensive training program of the MAO that incorporates climate knowledge into farming techniques. The MAO also conducts other trainings on farm techniques but shorter and less detailed than the CFS. Chemical companies likewise sponsor farm trainings but these are even shorter than those given by the MAO and more often deal only with topics being addressed by their products such as pest and disease control.

One hundred eighty (34.6%) of the 520 respondents attended some form of training on farming from 2006 to 2010. Very few farmers (35 or 6.7%) had undergone CFS, 89 (17%) and 56 (11%) farmers were able to avail of MAO and Chemical Companies' sponsored trainings, respectively. The remaining 340 (65.4%) did not have any training at all.

Technical assistance serves as an important information resource to farmers particularly on agronomic practices and climate (*Hassan and Nhemachena 2008*). In Dumangas, technical assistance is extended to farmers by MAO technicians or extension workers through farm visits and/or direct provision of farming advice. Unfortunately, only100 out of 520 farmers in the span of five years (2006-2010) were able to avail of MAO technical services due to the lack of extension workers.

Membership to a farmers' organization is another sub-indicator of information resource. Affiliations to social groups provide farmers access to useful information for climate change adaptation that may be exclusively available only to group members. Group membership can also be a significant avenue for knowledge sharing among farmers about effective adaptation practices.

Very few respondents (18%) are members of a farmers' organization. Some of them raised that many farmers' organizations in Dumangas were unsuccessful and had to stop operations. Other respondents, on the other hand, admitted to being inactive for a long time and no longer consider themselves as members of the organizations.

Farmers view weather information as an important input in making farm decisions and almost all of them monitor the weather/climate regularly. The most useful climate information for them is on rainfall, temperature, schedule of rainy/dry season and advisory on typhoon, drought and water level.

Many respondents (93%) have at least one source of weather/climate information while for the majority, monitoring is daily, others would be three to five times a week or only at the start of every planting season. Some respondents (7%) do not monitor the weather regularly due to lack of access to popular sources of climate information such as the radio or television. These respondents either do not have electricity or television or radio.

The most common sources of climate information among farmers are television (79%) and radio (39%). The agrometeorological station in the municipality also provides the barangays with daily weather advisory and recommends favorable farming activities based on that advisory. The agromet station, however, is not a popular source of climate/weather information among farmers. Only 20 (4%) respondents cited it as their source of climate/weather information. Access to the weather information from the agromet is a problem for those who live far from the barangay hall where the weather advisory is posted daily.

There were also 11 farmers (2%) who relied only on their own experience and observation and a few (0.6%) who obtained it from their neighbors.

Diversity in livelihood

Diversity in crops and income sources enable farmers to create a portfolio of livelihoods with different risk attributes so that risks, such as those posed by climate chang can be managed, making recovery easier and faster (*Reardon and Vosti, 1995 as cited in Paavola 2008*). The sub-indicators of livelihood diversity are the number of livelihoods/sources of income, percentage of land not used in growing crops, and number of crops planted.

Farming households in general, have seven sources of income namely crop production, employment, off-farm employment, animals, aquaculture, business, rentals, and remittances. Almost all of them (96%) however, rely only on one or two sources, farming and one additional livelihood. The three most common supplementary sources of income are animal raising, non-farm employment, and remittances. Non-farm occupations consist of work in the formal and informal sector such as public transport driving, construction work, teaching, community leadership, housekeeping and employment in offices and business establishments.

The diversity level in terms of number of crops planted is also very low. Most (68%) farmers plant only one crop, about 31 percent plant two and only about 2% plant three to five crops. Moreover, 99% of the farmer respondents specialize in rice farming. Although some (31%) of them plant other crops, these are just add-ons to rice.

Percentage of land not used in growing crops is also very low at an average of 1.3% of the total farm area as almost all farmers (95%) devote 100 percent of their land to crop production. This is because nearly all of them are small farm holders and therefore would tend to maximize the use of their plots for crops.

Weights of adaptive capacity indicators

Based on experts' opinion, the most important indicator for adaptive capacity is financial resource. Financial resource scored the biggest weight from experts because adaptation requires monetary expenditures. Moreover, higher financial resources make possible the acquisition of physical and information resources vital in carrying out adaptations. Information was ranked second as experts

Table 6. Number and percentage distribution of farmers by information resource sub-indicators, Dumangas, Iloilo, Philippines, 2011.

Information Resources Sub-indicators	Number	Percentage
A. Type of training		
Climate Field School	35	7
Municipal Agricultural Office's training	89	17
Chemical companies' training	56	11
None	340	65
Total	520	100
B. Receives technical assistance		
Yes	100	19
No	420	81
Total	520	100
C. Participates in farmers' organization		
Yes	92	18
No	428	12
Total	520	100
D. Number of sources of climate/weather information		
0	37	7
1	334	64
2	149	29
Total	520	100

Table 7. Number and percentage distribution of farmers by livelihood diversity sub-indicators, Dumangas, Iloilo, Philippines, 2011.

Livelihood Diversity Sub-indicators	Number	Percentage
A. Number of sources of household income including farming		
1	197	38
2 - 3	301	58
4 - 5	22	4
Total	520	100
B. Other sources of household income		
Non-farm employment	122	23
Off farm employment*	8	2
Animals	129	25
Aquaculture	13	2
Business	52	10
Rental	13	2
Remittances	95	18

*Employment in other farms.

believe that pertinent knowledge is important for farmers to come up with effective adaptation strategies.

Adaptive capacity scores and levels of adaptive capacity

The classification of scores in three adaptive capacity levels shows that majority of the respondents (60%) have low adaptive capacity, 36% have moderate adaptive capacity and only 4% have high adaptive capacity. The low adaptive capacity ratings of most farming households is explained by their low scores in four out of of five indicators of adaptive capacity. Except for human resources, majority of the respondents fared relatively low in physical, financial, information resources and livelihood diversity.

Farmers' physical resources are generally few because of their small farm size, inadequate farming machinery and lack of access to steady and reliable irrigation facilities.

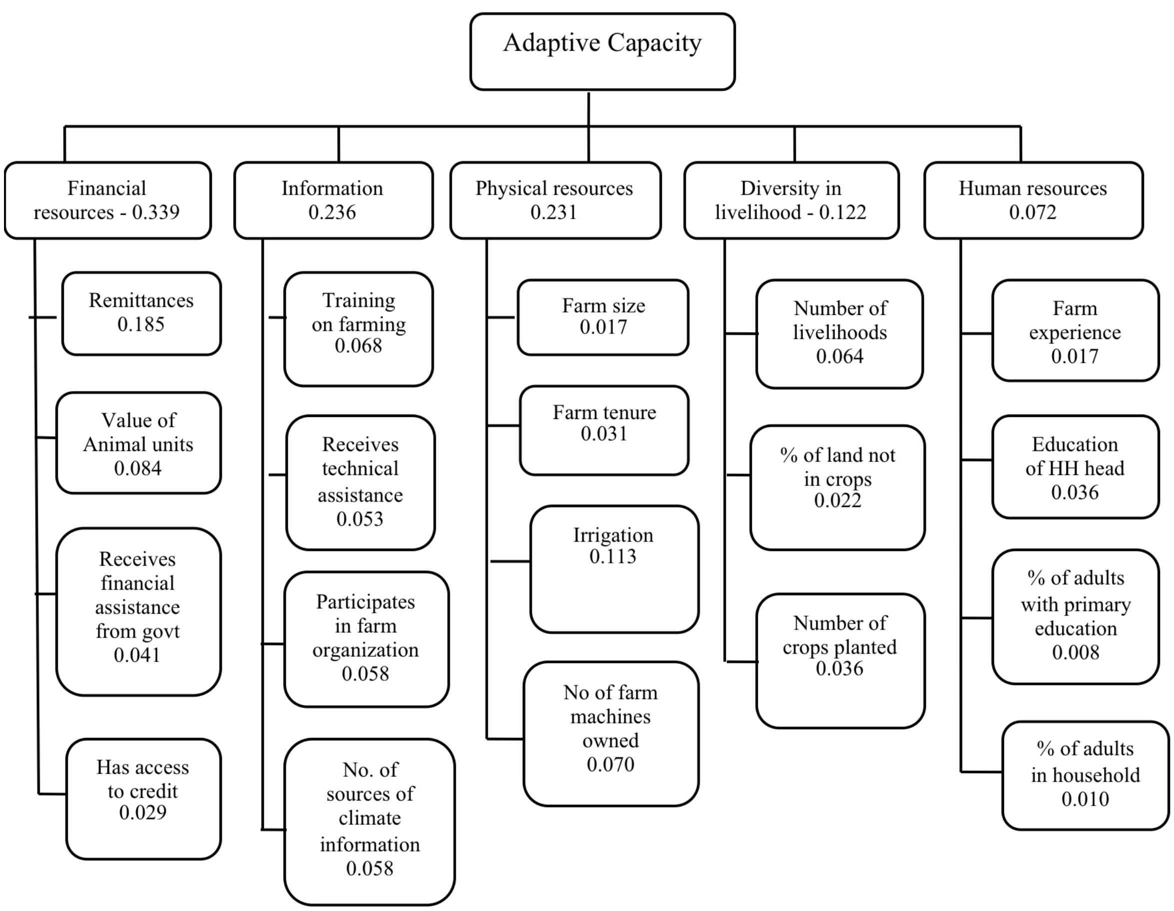

Figure 2. Weights of adaptive capacity indicators and corresponding sub-indicators.

Financial resources are also inadequate because most of them do not receive remittances, do not avail of financial assistance from the government, have low value animal units and lack access to credit. Similarly there is dearth of information resources due to lack of training, technical assistance and non-participation in organizations. They also have low livelihood diversity because of too much concentration on farming as indicated by few alternative income sources, specialization in a single crop and high percentage of land allotted for crop production.

On the average, farming households scored highest in information resources and lowest in diversity (**Table 8**). Differences in adaptive capacity were caused by large disparities in information, physical and financial resources (**Figure 3**). These were also the most important indicators based on expert judgement. The differences among households as far as human resources and diversity scores are concerned were not as high. There is little disparity among the average scores because farmers have similar characteristics in terms of the number of livelihoods, number of crops planted, and fraction of land devoted to crops.

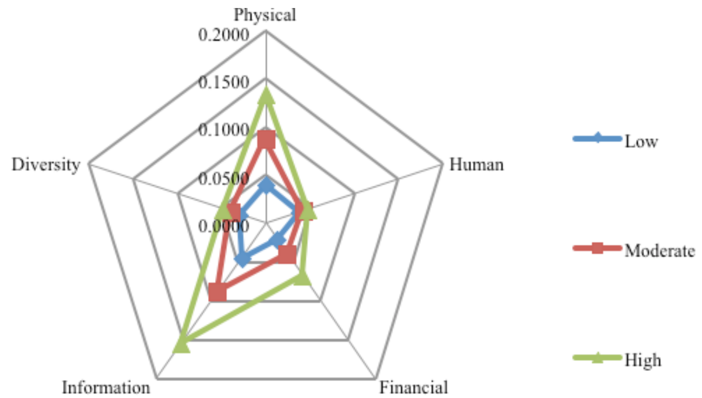

Figure 3. Average scores of farmers in the five indicators of adaptive capacity.

Adaptive capacity and adaptation

This paper also aims to find out whether adaptive capacity translates to adaptation. It is important to know whether farmers are able to realize their potentials (adaptive capacity) into concrete adaptations actions or strategies. Adaptation of individual farmers are equivalent to autonomous or spontaneous adaptation defined by *IPCC* (*2001*) to be "those that take place—invariably in reactive response (after initial impacts are manifest) to climatic stimuli—as a matter of course, without the directed intervention of a public agency".

Most farmers (324 or 62%) employ adaptation measures, while the remaining 196 (38%) did not report any adaptation measure. They claimed that they have been doing the same farming strategies through the years and do not see the need for adaptation because they cannot do anything against climate change which they consider as an act of God.

The most common strategies employed by those who consciously adapt to climate change are additional irrigation, change in fertilizer, adjustment in planting schedule, change in seed variety/crop rotation, maintenance of farm structure, increased pesticide application and change in planting method.

Notwithstanding levels of adaptive capacity, majority of respondents adapt to climate change. In levels of adaptive capacity, most farmers chose to employ adaptation measures. Notably, however, as the level of adaptive capacity increases, the percentage of adapters also increases.

Although most farmers adapt to climate change despite their levels of adaptive capacity, high and moderate adaptive capacity farmers employed more adaptation strategies compared to those of low adaptive capacity. This implies that better adaptive capacity translates to more adaptation measures. Farmers with relatively higher adaptive capacity are able to adapt better to climate change by shifting from one adaptation method to another in response to the different

Table 8. Number and percentage of farmers by levels of adaptive capacity, Dumangas, Iloilo, Philippines, 2011.

Level of adaptive capacity	Number	Percentage	Average Adaptive Capacity Scores
Low	312	60	0.173
Moderate	185	36	0.297
High	23	4	0.452
Total	520	100	

Table 9. Farming households' average scores in five indicators of adaptive capacity by level of adaptive capacity, Dumangas, Iloilo, Philippines, 2011.

Level of adaptive capacity	Average indicator scores				
	Physical	Human	Financial	Information	Livelihood Diversity
Low	0.0404	0.0382	0.0200	0.0439	0.0303
Moderate	0.0879	0.0427	0.0399	0.0874	0.0392
High	0.1340	0.0479	0.0674	0.1548	0.0480

Table 10. Number and percentage distribution of farmers by adaptive capacity action and level of adaptive capacity, Dumangas, Iloilo, Philippines, 2011.

Course of action	Adaptive capacity level					
	Low	%	Moderate	%	High	%
Adapts	189	61	119	64	16	70
Does not adapt	123	39	66	36	7	30
Total	312	100	185	100	23	100

climate risks they face.

The most commonly used adaptation methods were additional irrigation, change in fertilizer, adjustment in planting schedule, change in seed variety/crop rotation, maintenance of farm structure, pesticide application, and change in planting method. Change in seed variety/crop rotation was used by 157 (48.5%) farmers. Water application was employed by 104 (32.1%) farmers, and 78 (24.1%) adjusted their planting schedule. There were 50 (15.4%) farmers who maintained farm structure, 37 (11.42%) who changed fertilizer, 36 (11.2%) who changed pesticide, and 17 (5.2%) who changed their method of planting.

Employing different adaptation techniques enabled farmers to cope differently with the varying climate stresses being experienced. According to the farmers, they often change seed variety because these are higher yielding, heat/water tolerant, more resistant to pests and diseases, have shorterperiod of maturity and enable them to conserve soil. The respondents believe that by changing the seed variety, they are able to prevent soil acidity and maintain soil fertility.

Farmers prefer early-maturing varieties for three main reasons- these require less time to manage, cost recovery is shorter, and risk exposure to changing weather is lower. They also practice crop rotation as an adaptation measure.

This strategy is a form of diversification that enables them to reduce risk brought about by the changing climate. Mung bean is the most common crop rotated or supplemented to rice during the dry season. Crop rotation enables them to earn income during the dry months when rice farming is not viable due to lack of water.

Farmers increase irrigation in their farms during periods of prolonged dry season, during droughts, or when the canal irrigation system fails to supply water. They pump underground water through shallow tube wells to provide additional irrigation to their farms. The use of shallow tube wells, however, is expensive because it requires not only labor but also crude oil for the water pump. Due to high fuel prices in the country, it is just a supplementary or fallback irrigation source.

Adjustment in planting schedule is another adaptation technique of farmers. This method is practiced because they observed that the onset of the wet and dry seasons has been erratic over the years. In response to the changing climate, farmers adjust their planting schedule depending on the start of the rainy season.

Construction of canals/drainage system is also one of the climate-induced adaptation measures of farmer-respondents. This involves building of canals/drains to

Table 11. Frequency and percentage distribution of farmer-adapters under three levels of adaptive capacity by number of adaptation strategies employed, Dumangas, Iloilo, Philippines, 2011.

Number of adaptation strategies	Low	%	Moderate	%	High	%
1	132	69.8	59	49.6	5	31.25
2	50	26.5	41	34.4	9	56.25
3	7	3.7	18	15.1	2	12.50
4	0	0.0	1	0.8	0	0.00
Total	189	100.0	119	100.0	16	100.00

Table 12. Number of farmers reporting type of adaptation methods.

Coping Strategies	Number	Percentage
Irrigation	103	32
Increased fertilizer/pesticide	73	22
Change in planting schedule	79	24.1
Change in seed variety/crop rotation	157	48.5
Farm structures	50	15.4
Change in planting method	17	5.2

prevent water run-off during prolonged or heavy rains. The main purpose of constructing field drains is to avoid flooding in the field and protect the crop. Farmers use either family or hired labor to construct the drains.

Another type of adaptation to climate change practiced by farmers is modifying fertilizer and pesticide use. The main objective of farmers who employed this method was to protect crops and enhance soil fertility for better crop survival amidst changing climate. Specific practices include increasing the use of pesticides and fertilizers and shift to botanical pest control methods and organic fertilizer.

Some farmer-respondents change their rice planting method to adapt to climate change. They shift from transplanting to direct seeding and vice versa depending on the amount of rainfall during the planting period. Farmers think that transplanted rice has a higher survival rate during heat stresses compared to directly seeded rice, which makes this method popular among them. The belief led to the perception that direct seeding is the more appropriate planting method during periods of La Niña when water is plentiful and rice easily survives. Direct seeding requires less cost, time, and labor from farmers compared to the transplanting method, the very reasons why they find La Niña favorable to farming.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The objectives of the study were to determine the levels of adaptive capacity of farming households to climate change, identify the factors that cause the differences in adaptive capacity and find out whether adaptive capacity translates to adaptation. To answer these objectives, a composite index of adaptive capacity based on the sustainable livelihoods framework was constructed.

Majority of the farmers are relatively older adults with ages fifty years old and above. About 36% of them are elderly but are still active farmers. All, except for one, had formal education for an average of seven years.

Farming households, on the average, consist of four members. Based on the poverty line, the households are generally non-poor because their mean household income per month of PhP 14, 804 lie above the poverty threshold. farmers cultivating only an average of 1.62 ha of farmland.

Sixty percent of the farming households have low adaptive capacity, 36% scored had moderate and only 4% have high adaptive capacity. The farming households got the highest scores in information resources and lowest in diversity. Differences in adaptive capacity were caused by large disparities in information, physical and financial resources.

There are 324 farmers who employ autonomous adaptation strategies to lessen the impacts of climate change. Most of these farmers carry out only one adaptation method but others employ up to four. The adaptation methods they resort to were additional irrigation, change in fertilizer, adjustment in planting schedule, change in seed variety/ crop rotation, maintenance of farm structures, pesticide application, and change in planting method. Among these methods, more respondents carry out change in variety/ crop rotation, additional irrigation, and change in planting schedule.

Farmers in general adapt to climate change despite levels of adaptive capacity in order to survive and maintain consumption but those with higher asset standing are able to adapt better because they can employ more adaptation strategies. Better adaptive capacity therefore translates to more adaptation strategies.

High adaptive capacity farmers respond to more climate risks by shifting from one adaptation strategy to another. Low adaptive capacity farmers, due to lack of resources, either respond only to the risk that affects them most and/or employ the cheapest adaptation measure.

Poverty incidence alone is not a good and sufficient indicator of adaptive capacity. Majority of the respondents are generally non-poor based on the poverty threshold, despite this, most of them still have low adaptive capacity. A comprehensive measure such as the composite index used in this study is important to predict adaptive capacity. Also, an adaptive capacity index at the household level provides a good insight on the specific needs of farming household and is useful guide to enhance and support adaptation.

This paper recommends that adaptive capacity of farming households must be increased in order for them to employ more adaptation measures by increasing the provision of information, financial, and physical resources by: conducting educational campaign and training on climate change and farming adaptation techniques; support farm organizations in the municipality; making accessible to all farmers the climate and weather information generated by the local agromet station; encouraging farmers to avail of the existing subsidies (on seed and fertilizer) provided by the government; making credit more accessible to small farmers through small-denominated loans; developing/encouraging effective crop insurance for small-scale farmers.

It is also recommended that further studies on the factors that link/facilitate adaptive capacity to adaptation must be pursued. This is important in carrying out policies and programs for adaptation and useful in the targeting of beneficiaries for support services. Further studies on methodology and validity of adaptive capacity indices at the household level would also be significant for improvement of existing indices.

REFERENCES

Adger, W.N. 2006. Vulnerability. *Global Environmental Change* 16: 268-281.

Asian Development bank (ADB). 2009. The Economics of Climate Change in Southeast Asia: A Regional Review. Asian Development Bank, Mandaluyong City, Philippines.

Berrittella, M., A Certa, M. Enea, P. Zito. 2007. An Analytic Hierarchy Process for the Evaluation of Transport Policies to Reduce Climate Change Impacts. Fondazione ENI Enrico Mattei (FEEM) working paper 12.2007.

Blaikie, P., T. Cannon, I. Davis and B. Wisner. 1994. At Risk: Natural Hazards, People's Vulnerability, and Disasters. London, Routledge.

Brooks, N. 2003. Vulnerability, Risk, and Adaptation: A Conceptual Framework. Tyndall Center Working Paper No. 38. Tyndall Center for Climate Research And Center for Social and Economic Research on Global Environment University of East Anglia, Norwich.

Bureau of Agricultural Statistics (BAR). 2010. Selected Statistics on Agriculture 2010. Department of Agriculture: Philippines.

Bryan, E., T.T. Deressa, G.A. Gbetibouo, and C. Ringler. 2009. Adaptation to Climate Change in Ethiopia and South Africa: Options and Constraints. *Environmental Science and Policy* 12: 413-426.

Bryant, C., B. Smit, M. Brklacich, T. Johnston, J. Smithers, Q. Chiotti, and B. Singh. 2000. Adaptation in Canadian Agriculture to Climatic Variability and Change. *Climatic Change* 45: 181-201.

Cochran, W.G. 1977. Sampling Techniques. John Wiley and Sons, Inc. USA.

Deressa. T., R. M. Hassan, C. Ringler, T. Alemu and M. Yesuf. 2009. Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change* 19: 248–255.

Department of Environment and Natural Resources. 2010. Philippine Strategy for Climate Change Adaptation 2010-2022. DENR, Philippines.

Department for International Development. 1999. Sustainable Livelihoods Guidance Sheets. London.

Dumangas Municpal Planning and Development Office. 2005. Municipality of Dumangas: Socio-Economic Profile. Dumangas, Iloilo, Philippines.

Dumangas Municipal Agricultural Office. 2010. Climate Field School:A Key to Climate Change Adaptation and Disaster Risks Reduction Towards Agricultural Productivity. A Report Prepared by the Municipal Agriculturist Office, Dumangas, Iloilo, Philippines.

Eakin, H., and L. A. Bojorquez-Tapia. 2008. Insights into the Composition of Household Vulnerability from Multicriteria Decision Analysis. *Global Environmental Change* 18: 112–127.

Ellis, F. 2000. Rural Livelihoods and Diversity in Developing Countries. Oxford University Press, New York.

Expert Choice. (trial version). Retrieved: July 8, 2011 from http://www.expertchoice.com/.

Frankhauser, F., R.S.J. TOL and D.W. PEARCE. 1997. The Aggregation of Climate Change Damages: A Welfare Theoretic Approach. *Environmental and Resource Economics* 10: 249–266.

Food and Agriculture Organization. 2011. Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Security Framework Programme FAO, Rome.

Fussel, H.M. and R.J.T. Klein. 2006. Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change* 75: 301-329.

Gbetibouo, G.A., C. Ringler and R. Hassan. 2010. Vulnerability of the South African Farming Sector to Climate Change and Variability: An Indicator Approach. *Natural Resources Forum* 34: 175–187.

Hahn, M., A.M. Riederer and S.O. Foster. 2009. The Livelihood Vulnerability Index: A Pragmatic Approach to Assessing Risks from Climate Variability and Change -A Case Study in Mozambique. *Global Environmental Change* 19: 74–88.

Hassan, R. and C. Nhemachena. 2008. Determinants of African Farmers' Strategies for Adapting to Climate Change: Multinomial Choice Analysis. *AfJARE* Vol 2 No 1: p.83-104.

Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: Impacts, Adaptation and Vulnerability. A Contribution of the WorkingGroup II to the Third Assessment Report of the Intergovernmental Panel on Climate Change Edited by McCarthy, J.J., O.F.Canziani, N.A. Leary, D.J. Dokken, and K.S. White. Cambridge: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). 2007. Fourth Assessment Report. Intergovernmental Panel on Climate Change Secretariat. Geneva, Switzerland.

International Fund for Food Development Website. www.ifad.org, accessed 20 July 2010.

Israel, D. and R. Briones. 2012. Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and

Environment in the Philippines. Philippine Institute for Development Studies Discussion Paper Series No. 2012-36. Philippine Institute For Development Studies. Philippines.

Luers, A., D.B. Lobell, L. S. Sklar, C. Lee Addams, and P.A. Matson. 2003. A Method for Quantifying Vulnerability, Applied to the Agricultural System of the Yaqui Valley, Mexico. *Global Environmental Change* 13: 255–267.

Molua, E., 2002. Climate Variability, Vulnerability and Effectiveness of Farm-Level Adaptation Options: The Challenges and Implications for Food Security inSouthwestern Cameroon. Environment and Development Economics 7: 529–545.

National Statistics Office. 2008. Philippines in Figures 2008. National Statistics Office: Philippines.

Paavola, J. 2008. Livelihoods, Vulnerability and Adaptation to Climate Change in Morogoro, Tanzania. *Environmental Science and Policy* 11: 642-654.

Saaty, T. 1994. Fundamentals of Decision Making and Priority Theory with AnalyticHierarchy Process. RWS Publications, Pittsburgh, USA.

Saaty T. L., 1980. The analytic hierarchy process: planning, priority setting and resource allocation. McGraw-Hill, New York

Scoones, I. 1998. Sustainable Rural Livelihoods: A Framework for Analysis. IDS Working Paper No. 72, Institute of Development Studies: Brighton, Sussex, England.

Smit, B. and J. Wandel. 2006. "Adaptation, Adaptive Capacity, and Vulnerability".*Global Environmental Change* 16(3): 282-292.

Stern, N. 2006. The Economics of Climate Change: The Stern Review. Cambridge: Cambridge University Press

Super Decisions, ANP 2.0.8. 2009. Retrieved August 20, 2011 from http://www.superdecisions.com/ download.php3.

The Energy Resources Institute. (undated). Adaptation to Climate Change in the Context of Sustainable Development. (background paper). The Energy Resources Institute, New Delhi.

United Nations Framework Convention on Climate Chance (UNFCCC). 2009. Climate Change: Impacts, Vulnerabilities And Adaptation In Developing Countries. United Nations Framework Convention on Climate Change. Bonn, Germany.

United Nations University-Intitute for Environment and Human Security. 2012. WorldRisk Report 2012: Environmental Degradation and Disasters. United Nations.

Vaidya, O. and S. Kumar. 2006. Analytic Hierarchy Process: An Overview Of Applications. *European Journal of Operational Research* Volume 169, Issue 1, 16:1–29

Vincent, K. and T. Cull. 2010. A Household Social Vulnerability Index (HSVI) for Evaluating Adaptation Projects in Developing Countries. A paper presented during the PEGNet Conference, Midrand, 2010.

www.worldatlas.com/webimage/countrys/asia/ciamaps/ph.htm, accessed 25 July 2010.

Yusuf, A. and H. Francisco. 2009. Climate Change Vulnerability Mapping for Southeast Asia. Economy and Environment Program for Southeast Asia: Singapore.