Agriculture and Climate Change: Perceptions of Provincial Officials in Vietnam

Son Tran Van[1,*], William Bill Boyd[1], Peter Slavich[2] and Trinh Mai Van[3]

[1]*School of Environment, Science & Engineering, Southern Cross University, PO Box 157, Lismore, New South Wales 2480, Australia*

[2]*Coastal Agricultural Landscapes Centre, Southern Cross University, Lismore, New South Wales 2480, Australia*

[3]*Rural Environment Division, Institute for Agricultural Environment (IAE), Phu Do, Me Tri, Tu Liem, Hanoi Vietnam*

Abstract: Climate change is expected to have serious impacts on developing countries, including Vietnam. The central government of Vietnam has launched programs to study climate change trends and impacts on natural resources, environment and socio-economic development, and adaptation strategies. These programs have the active involvement of many ministries, sectors, research institutions and local governments. This paper addresses the perceptions of provincial officers in Vietnam regarding climate change, its impacts on agricultural activities, and adaptation options. It examines the current knowledge and understanding capacity of provincial officials in implementing the National Target Program to Respond to Climate Change, and the Action Plan to Response to Climate Change of the Agriculture and Rural Development Sector. The results from the study provide insight into the perceptions on climate change and climate change adaptation measures held by Vietnamese government officials working in environmental and agricultural sectors. The survey data indicate that Vietnamese government officials are aware of climate change and its potential impacts, but have relatively poor understanding of some aspects, given the key role of government officials in implementing Vietnamese adaptation policies and mitigation measures. These new findings are important to Vietnamese and international organizations involved in assisting agricultural research and extension agencies with identifying and implementing strategies to adapt Vietnamese farming systems to a changing climate.

Keywords: Climate change, perception, adaptation, agriculture, Vietnam, National Target Program to Respond to Climate Change.

INTRODUCTION

Global climate change and its potential impacts on human activities, such as agricultural production and land use, has been a subject of concern both within the academic community and among politicians and the general public. There is now clear evidence for an observed increase in global average temperatures and change in rainfall rates during the 20th century around the world [1, 2]. Climate is the primary determinant of agricultural productivity and climate change is expected to have an influence on crops and livestock production, hydrological balances, input supplies and other components of agricultural systems and land uses [1]. However, the nature of the bio-physical effects and human responses to them are complex, uncertain and variable between countries, regions and continents [3].

Vietnam has a long coastline with more than 3,000 islands, and has a high population and intensive agricultural activity along the coast. In terms of impacts of climate change on population, GDP (Gross Domestic Product), urban extent, and wetland areas, Vietnam is ranked first globally, and ranked second in terms of impacts of sea level rise on land area and agriculture [4]. The Vietnamese government considers climate change and sea level rise impacts to be serious, and since 2006, has increasingly focussed on the issues of climate change and disaster management in national strategies and policy development. The central government of Vietnam, together with its ministries, sectors and regions, has launched programs to study trends and impacts of climate change on natural resources, environment, socio-economic development, and adaptation strategies [5]. These programs are expected to have critical influence on the organizational capacity of institutions which support rural communities to adapt to negative impacts of climate change. In the area of agriculture and rural development, *the Action Plan Framework for Adaptation and Mitigation of Climate Change in the Agriculture and Rural Development Sector period 2008-2020*, which was developed and is being implemented by the Ministry of Agriculture and Rural Development, is the umbrella program which guides actions to address climate change. This program establishes priorities on climate change responses nationwide in the area of agriculture and rural development. The scope and content of the

*Address correspondence to this author at the School of Environment, Science & Engineering, Southern Cross University, Lismore, New South Wales 2480, Australia; Tel: +61266203569; Fax: +61266212669;
E-mail: transonbiovasi@yahoo.com, sonnewcastle@yahoo.com

ISSN: 1814-8085 / E-ISSN: 1927-5129/15

program includes; increasing awareness of climate change in the agriculture and rural sector through a communication program, capacity building on adaptation and mitigation solutions, and integrating climate change into sector policy systems and increasing international cooperation [6]. Effective implementation of adaptation strategies requires the government to have suitable policies, management practices and political capacity. Previous studies in Vietnam have highlighted that local action plans and policies surrounding adaptation to climate change are being compromised as local staff do not have sufficient experience, knowledge or expertise [7, 8].

Many past studies of the perceptions of climate change have focused on understanding perceptions among the general public [9, 10] and how these vary from those of scientific experts and among farmers [11, 12]. Perceptions about the environment and natural resources have been recorded as differing between individuals, a difference that may be influenced by social factors such as workplace, education or other socio-economic conditions [1-15]. Little research, however, has been devoted to exploring how farmers and local government officials perceive climate change and how their perceptions link to adaptive response and policy implementation. Dang *et al.* [16] found that farmers and agriculture officers in the Mekong Delta are becoming increasingly conscious of local climate change issues, while their understanding of the role of adaptation measures is limited. There remains a need for better understanding of the perception of people who play direct roles in the formulation and implementation of climate change policy, especially in countries such as Vietnam [7, 17].

We hypothesize that the ability of an agency to address climate change issues relies on the attitudes of its members. It is essential to have a full understanding of the perceptions of those people who play direct roles in the formulation and implementation of climate change policy at the provincial level in Vietnam. This allows a realistic assessment of the government's capacity to respond to climate change. Such information has not been previously available in Vietnam. In order to address this gap in knowledge, a survey was conducted to gauge the perceptions about climate change held by provincial officers in departments for which climate change is likely to have particular salience: the Department of Agriculture and Rural Development and the Department of Environment and Natural Resources Management in eight agricultural ecological regions of Vietnam.

MATERIALS AND METHODS

Study Site

Vietnam is located on the eastern section of the Indochinese Peninsula of Southeast Asia and stretches over 15 degrees of latitude from 8°15'N to 23°22'N, and from longitudes 102°8'E to 109°30'E. The country covers an area of 331,051km^2 and has a 3,260km long coastline. There are significant variations in climatic conditions between regions in Vietnam due to the diverse topography and the length of the country [18]. Based on these differences, the country is divided into eight agro-ecological regions (Figure **1**): the North West, the North East, the Red River Delta, the North Central Coast, the South Central Coast, the Central Highlands and the South East and the Mekong River Delta [19].

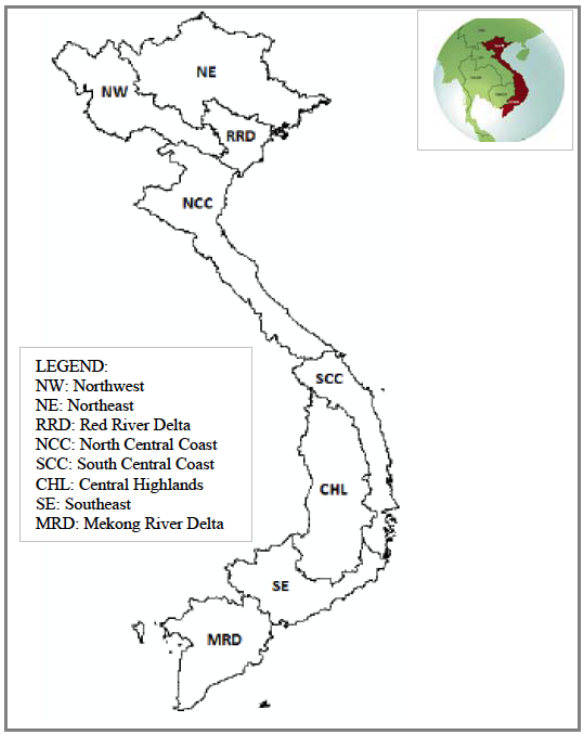

Figure 1: Agro-ecological regions of Vietnam.

Agriculture is a key sector of Vietnam's economy and social structure, contributing 18.4% of Vietnam's GDP (Gross Domestic Product), and employing 54% of the working population. The areas under cultivation account for approximately 17% of total land area, with rice, coffee, tea and pepper being the main crops [20].

Survey Methodology

The analyses of this study used data from an ongoing Vietnam Ministry of Natural Resources and

Environment project entitled *National Target Program to Respond to Climate Change.* Under that project, structured interviews based around questionnaire were designed and conducted by the Vietnamese Agricultural Environment Institute in 2010 in six agro-ecological regions of Vietnam including the North West, the North East, the Red River Delta, the North Central Coast, the South Central Coast, and the Central Highlands (Figure **1**), with the original purpose of constructing vulnerability indices for climate change in different ecological regions of Vietnam. Additional surveys in the two remaining regions of Vietnam, namely the South East and the Mekong River Delta (Figure **1**), and were conducted by the first author in 2011, using the same questionnaire and survey method. In total, 160 surveys were completed in eight agro-ecological regions of Vietnam. In this study, the term climate change refers either to effects of climate disasters, hazards such as typhoons, hailstorms, droughts and sudden flood or new conditions of climate such as higher temperatures, sea level rise, saline intrusions, subsiding water tables, more or less rainfall, and less predictable seasons [6].

The structured interviews research progressed in three stages:

1. Design Questionnaire

Based on a literature review, fifty-four closed-end questions were designed in the questionnaire to examine provincial government officials' understanding of climate change topics. The topics cover the perceptions of the change of climate elements, impacts of those changes on agriculture production, and the necessary adaptation measures. The questionnaire was written in Vietnamese and was peer-reviewed by Vietnamese officials to ensure clarity and relevance. The questionnaire assessed provincial officers' perceptions and beliefs about three major topics: change of local climatic factors under the effects of global climate change, the role and impacts of these changes on the agriculture sector; and the effectiveness of central and provincial government responses to climate change.

2. Provincial Official Interviewee Recruitment

Eight provincial Departments of Agriculture and Rural Development and Natural Resources and Environment were contacted to do the survey. In each region, 18 to 24 senior officials who have at least five years of professional working experience in the environment and agriculture industries, including the director of each Department, the heads of crop production, head of water resources, land resources, aquaculture, and agriculture extension divisions, and senior staff members were selected.

3. Implementation

The interviews were conducted by two groups of five researchers from Vietnamese Agricultural Environment Institute who have knowledge and experience with research topics, and by the author. All interviews were conducted in Vietnamese by the same group of interviewers, and a specific sequence of questions was followed in each interview.

Meteorological data, used to contextualise the survey responses, were extracted from previous studies regarding long term change and variability of climatic factors in Vietnam conducted by the Ministry of Natural Resources and Environment and the Institute of Meteorology, Hydrology and Environment [19], and the other researchers.

Responses to the questions related to perceptions on factors of climatic change, interviewees answered questions on a five points scale comprised of 2 for 'complete agreement', 1 for 'agreement', -1 for 'disagreement' and -2 for 'complete disagreement'. The 0 value was assigned to the responses of 'don't know' or 'no effect'. This is because the answers of 'don't know' or 'no effect' can be understood that respondents are not confident to predict an effect as a result of lacking information, or they do not expect an effect.

This scale was then used to calculate a degree of agreement index (DA). For the questions related to belief in adverse effects of climate change on local climatic factors, agriculture, and the importance of responding measures, the importance level (IL) index was constructed, ranging from 5 (strong belief that the change of climate factors, effects on agriculture and responding measures are very important) to 1 (strong belief that those changes, potential effects and responding measures are not important at all [21].

The data were analysed using the Statistical Package for the Social Sciences (SPSS), by running descriptive frequencies, and then calculating the Tukeys' HSD test and Z- test to analyse the differences, in relation to data themes, as follows.

- Perception regarding general beliefs on climate change and changes in weather patterns and sea level.

- Perception regarding impacts of these changes on agriculture.
- Perception regarding necessary response measures to climate change and sea level rise.

To assess the respondents' perceptions of changes in climate, their responses were compared against published data from the Vietnam Institute of Strategy and Policy for Natural Resources regarding climate change and variability in Vietnam over the past five decades, and other studies of farmers' perceptions of climate change [16, 22, 23]. Similar studies elsewhere [24, 25] have indicated varying correlation between levels of farmers' beliefs and climatic and meteorological records.

To test the effect of workplace on respondents' perceptions of climate change, the responses of 83 Agricultural and Rural Development Department (DARD) officers and 77 Department of Natural Resources and Environment (DONRE) officers were compared. Since these departments have different strategic purposes, it may be expected that their approaches to implementing natural policy on climate change response may differ. It is possible, therefore, that departmental understanding and/or perception of this issue differ, and that difference may filter through to individual staff perceptions.

RESULTS

Assessing Provincial Officials' Perception to Climate Change

General Beliefs Associated with Climate Change

When asked, "What climatic factors have been changed under the impact of climate change phenomenon in Vietnam?", more than half strongly agreed or partly agreed that climate change has changed the nature and frequency of climatic factors including temperature (73%), rainfall (77%), climatic extreme events (61%), and sea level rise (54%). Responses varied between the climatic elements and between the agro-ecology regions (Table **1**). All North Central Coast region respondents agreed that annual temperature has changed (Mean DA (degree of agreement) = 1.4), whereas only 47% of those in the North West region did. Perception of sea level change was similar with all interviewees in the Mekong River Delta region perceiving that sea level has risen (Mean DA = 1.3), but only 23% of North West respondents think so (Mean DA = 0.4). In general, the level of perceptions of respondents are consistent with analysis of scientific observations in the regions [6, 20], indicating that climatic factors and sea level have changed significantly in Vietnam during the last decades under the impact of global warming, although varying from region to region.

The survey results also show that about 30% of interviewees did not know or had no idea whether climate factors have changed (Figure **2**). It is unclear whether respondents do not think there was any change or whether they do not have enough information to confirm a change confidently. Furthermore, slightly fewer than 10% of respondents expressed other views about the nature of climate change and its impacts on climate system, making statements, for example that climate change has depleted the ozone layer or that climatic factors change from year to year without any influence from global warming phenomenon.

Beliefs on the Relative Importance of Sea Level and Weather Pattern Changes on Agricultural Production

Question 2 of the survey explored the perception of potential effects of climatic change and sea level rise on agriculture. While temperature change is perceived to be important to agricultural production in the Central Highlands, South Central Coast and North Central Coast regions (Mean importance level = 2.1-2.5), North East and Mekong River Delta interviewees thought it was of little importance (Mean importance level = 1.4). In terms of sea level rise, respondents of the North Central Coast, South Central Coast and Mekong River Delta believe that sea level rise is important with regard to potential effects on agricultural production (Table **1**, Mean importance level ≥ 3).

A number of provincial officers did not believe that the change in climate factors are important to the agricultural sector (15.8% of low importance and 0.2% of not important at all) (Figure **2**).

Perceptions of Changes in Climate Versus Evidence from Climate Data

Long-term changes in temperature were perceived by more than 50% of the provincial officials: in which 73% believed that annual mean temperatures in Vietnam have increased. The Central Highland, Red River Delta and North Central Coast regions had the highest number of officials stating that annual temperature has increased in recent years (80 and 100% of respondents). Between 49-74% of

Table 1: Vietnamese Provincial Government Officials' Perceptions of Impacts of Climate Change Phenomenon on Climatic Factors and Sea Level, and the Belief on the Importance of those Changes on Agricultural Production

Climatic factors	Regions	Mean degree of agreement	Mean importance level	Respondent agreement distribution (%)				
				Strongly disagree	Partly disagree	Do not know	Partly agree	Strongly agree
Temperature	Central Highlands	1.1	2.5	0.0	10.0	10.0	40.0	40.0
	South East	0.6	2.0	4.8	4.8	23.8	57.1	9.5
	Mekong River Delta	0.7	1.4	0.0	9.1	18.2	68.2	4.5
	Red River Delta	1.1	1.8	0.0	4.0	16.0	48.0	32.0
	North West	0.3	1.3	0.0	17.6	35.3	47.1	0.0
	North Central Coast	1.4	2.1	0.0	0.0	0.0	57.9	42.1
	South Central Coast	0.8	2.1	0.0	0.0	35.0	65.0	0.0
	North East	0.5	1.5	0.6	6.9	18.8	55.0	18.8
	Average	***0.8***	***1.8***	***0.7***	***6.6***	***19.6***	***54.8***	***18.4***
Rainfall	Central Highlands	0.7	2.3	0.0	0.0	35.0	60.0	5.0
	South East	0.9	2.5	0.0	0.0	19.0	66.7	14.3
	Mekong River Delta	0.5	1.8	0.0	13.6	27.3	59.1	0.0
	Red River Delta	0.8	2.8	4.0	8.0	8.0	68.0	12.0
	North West	1.1	1.6	0.00	0.00	23.50	41.20	35.30
	North Central Coast	1.1	2.1	0.0	0.0	26.3	36.8	36.8
	South Central Coast	1.0	1.8	0.0	0.0	12.5	75.0	12.5
	North East	1.2	2.0	0.0	0.0	10.0	65.0	25.0
	Average	***0.9***	***2.1***	***0.5***	***2.7***	***20.2***	***59.0***	***17.6***
Sea level change	Central Highlands	0.2	1.5	0.0	0.0	80.0	20.0	0.0
	South East	0.9	2.9	0.0	0.0	14.3	85.7	0.0
	Mekong River Delta	1.3	3.4	0.0	0.0	0.0	68.2	31.8
	Red River Delta	0.5	3	0.0	8.0	40.0	48.0	4.0
	North West	0.4	1.2	5.9	0.0	70.6	23.5	0.0
	North Central Coast	0.4	3.2	0.0	0.0	63.2	36.8	0.0
	South Central Coast	0.9	2.7	0.0	0.0	18.8	75.0	6.3
	North East	0.4	2.5	0.0	0.0	65.0	25.0	10.0
	Average	***0.6***	***2.6***	***0.7***	***1.0***	***44.0***	***47.8***	***6.5***
Climatic extreme events	Central Highlands	1.5	2.2	0.0	0.0	40.0	60.0	0.0
	South East	0.6	2.7	0.0	0.0	38.1	61.9	0.0
	Mekong River Delta	0.7	2.5	0.0	0.0	31.8	68.2	0.0
	Red River Delta	0.9	2.5	0.0	0.0	12.0	88.0	0.0
	North West	0.5	2.8	5.9	0.0	70.6	23.5	0.0
	North Central Coast	0.5	2.6	0.0	0.0	47.4	47.4	5.3
	South Central Coast	0.6	2.9	0.0	6.3	37.5	56.3	0.0
	North East	0.8	2.9	0.0	0.0	20.0	80.0	0.0
	Average	***0.8***	***2.6***	***0.7***	***0.8***	***37.2***	***60.7***	***0.7***

Mean degree of agreement (-2 = strongly disagree to 2 = strongly agree).
Mean importance level (1 = not important to 5 = very important).

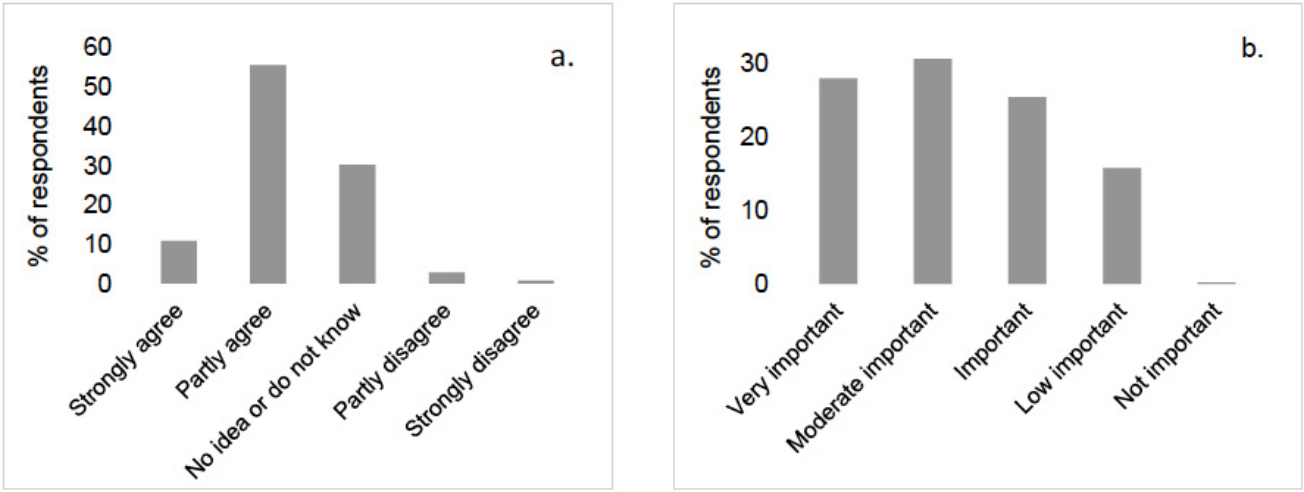

Figure 2: Respondents' agreement distribution on **a**) the changes of climate pattern and **b**) the beliefs of the importance of those changes to agricultural production.

interviewees agreed that temperature accumulation and temperature amplitude have increased. This compares with 19-28% who believed that these temperature parameters had decreased and 14-19% who thought there had been no change or did not know.

The published annual surface temperature trends of Vietnam between 1957 and 2007 indicate an increasing trend. The trend is quite obvious and consistent in the Central Highlands, the Red River Delta, the North West, the Central Coast, and the North East with the rates of change of 0.0111 - 0.0177°C per year, but less so in the South East, the South Central Coast and the Mekong River Delta. Overall, therefore, the respondents' perceptions appear to be largely in accordance with the published data for Vietnam, except the perception of respondents in the North East where annual temperature was identified as having changed significantly [19] but only 65% of interviewees perceived it. In terms of perceptions of rainfall change, 72% of respondents believed that they had observed changes in the annual rainfall pattern, of which 38% noticed an increase, 34% noticed a decreased, and 28% did not know or no idea. The Central Highlands and South Central Coast are regions which have highest number of interviewees who perceived an annual rainfall increase (50%), whereas only 24% of respondents in North West and 29% in the South East responded that annual rainfall has increased in their regions. A very similar pattern is evident with regards to the number of rainy days per year and heavy rains, with average of 22% and 16% respondents respectively noticing an increase, and 37% and 26% noting a decrease.

The recorded data on rainfall from 1957 to 2007 shows that there was no significant increasing or decreasing trends in rainfall in the five main agro-ecology regions of Vietnam. Indeed, there is significant inter-decadal variability in the amount of rainfall and some significant inter-regional variability over the recording period [19]. In terms of perception of changes in climatic extreme events, 40-55% of respondents perceived changes in climate extreme events such as floods, droughts and typhoons. The South Central Coast and the North Central Coast have the highest percentage of respondents (53-68%) noting an increase in the frequency and intensity of these phenomena, whereas the North East has the lowest percentage of officials perceiving change of climate extreme events (44%). Drought is the most noted climate extreme event in the North East region (55%). The officials' perceptions of climate extreme events changes in the Mekong River Delta and the North Central Coast are consistent with those of farmers in these regions. Dang *et al.* and LE THP [16, 22] indicated that farmers in these areas also noted changes in the severity of climate extreme events such as floods, typhoons and drought.

Association between Respondents' Workplace and Perception of Climate Change in Vietnam

The results of chi squared analysis indicated that, in general, there was no significant difference in perceptions between officials of DARD and DONRE regarding changes in climatic patterns (Table **2**). The exceptions were in the perceptions of changes in annual temperature and flood duration, where there were significant differences between the two departments in perceptions over whether the annual

Table 2: Difference in Perception of Weather Patterns Change between Officials of DARD and DONRE

	Temperature and Rainfall						
X^2 (α = 0.05)	Annual Temperature	Temperature Accumulation	Temperature Amplitude	Extremely Cold Days	Annual Rainfall	Annual Rainy Days	Heavy Rains
Increased	0.007*	0.512	0.054	0. 849	0.496	0.948	0.600
Decreased	0.027*	0.446	0.493	0.626	0.897	0.219	0.823
	Extreme events						
X^2 (α = 0.05)	Flood Intensity	Flood Frequency	Flood Duration	Drought	Typhoon Intensity	Typhoon Frequency	Typhoon Season
Increased	0.969	0.477	0.408	0.468	0.350	0.126	**Earlier** 0.556
Decreased	0.057	0.225	0.034*	0.626	0.223	0.194	**Later** 0.856

*Significant difference at α = 0.05 (Tukeys' HSD test).

temperature had increased or decreased recently. There was also a significant difference between the two departments in the percentages who perceived that flood duration had decreased.

Assessing Provincial Authorities' Perception of Sea Level Rise

With regards to the specific questions about their perceptions of impacts of sea level rise, respondents were first asked to indicate whether they agree or disagree with the statement that sea level rise has impacts on their local agricultural production. Most respondents in coastal regions including the South Central Coast and North Central Coast (69-74%), Red River Delta, Mekong River Delta (80-91%), and South East (76%) agreed that sea level rise has caused some impacts on their agricultural sector. On the other hand, 80-91% from two inland regions (the North West and the Central Highlands) are uncertain (do not know or no idea) about the impact of sea level rise on their agricultural sector (Figure **3**).

Respondents were also asked about how they thought sea level rise would impact on their regions. There is significant difference in perception between regions. While all interviewees in the Mekong River Delta believe that sea level rise will damage dike and irrigation systems, salinize soils and water resources, and change the agriculture production environment, in the Central Highlands only 10-25 % support this view. In the North West region, only 0-29% agreed with statements that sea level rise will damage sea dikes and irrigation systems, reduce agricultural land area, and change crop patterns, 24% believe that sea level rise will increase crops yield, and 5.9% believe water resource availability for agriculture activities will increase as a result of sea level rise (Table **3**).

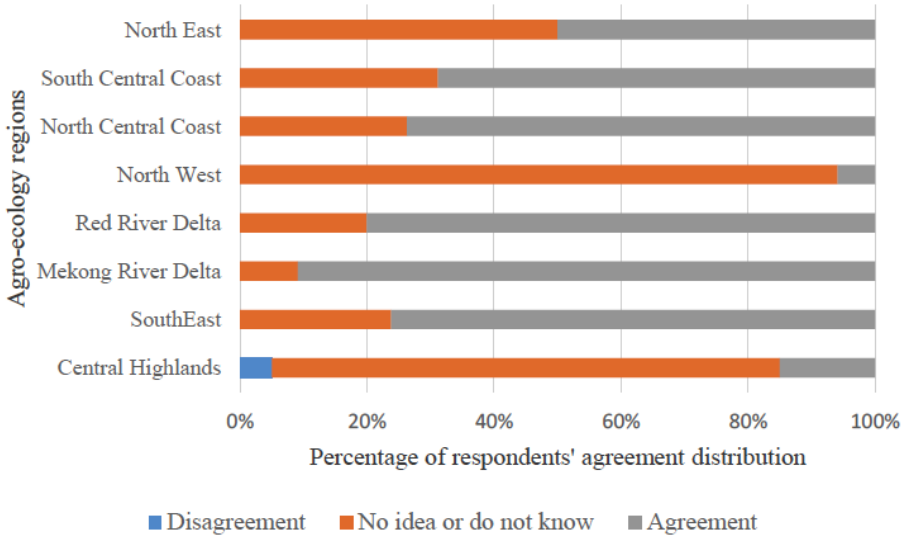

Figure 3: Percentage of respondents' agreement distribution on the impacts of sea level rise on the agricultural sector.

Table 3: Beliefs on Impacts of Sea Level Rise

Impacts of sea level rise	Respondent agreement (%)							
	Central Highlands	South East	Mekong River Delta	Red River Delta	North West	North Central Coast	South Central Coast	North East
Damage dike system	20.0^{a}	90.5$^{b, c}$	100.0^{c}	84.0^{b}	5.9^{a}	78.9^{b}	68.8^{b}	70.0^{b}
Damage irrigation system	10.0^{a}	52.4^{b}	100.0^{c}	80.0^{d,e}	0.0^{a}	84.2^{c,e}	75.0^{b,e,e}	55.0^{b,d}
Cause salt marsh	0.0^{a}	47.6^{b,c}	90.9^{d}	84.0^{d}	23.5^{c}	84.2^{d}	74.7^{b,d}	70.0^{b,d}
Salinize soil/water resources	10.0^{a}	57.1^{b,c}	100.0^{d}	88.0^{d,e}	0.0^{a}	42.1^{c}	81.3^{b,e}	60.0^{b,c}
Change crop pattern	25.0^{a}	76.2^{b,c}	95.5^{c}	68.0^{b}	29.4^{a,d}	57.9^{b,d}	62.5^{b,d}	65.0^{b}
Increase crop yield	20.0^{a}	0.0^{b}	0.0^{b}	0.0^{b}	23.5^{a}	0.0^{b}	6.3^{a,b}	0.0^{b}
Decrease crop yield	15.0^{a,b,c}	76.2^{d,e}	90.9^{e}	40.0^{c,f}	11.8^{b}	63.2^{d,f}	43.8^{a,c,f}	50.0^{b,f}
Increase water resources for irrigation	9.8^{a}	0.0^{a}	0.0^{a}	0.0^{a}	5.9^{a}	0.0^{a}	0.0^{a}	0.0^{a}
Decrease water resources for irrigation	10.0^{a}	76.2^{b,c}	63.6^{b,c}	80.0^{c}	23.5^{a,d}	73.7^{b,c}	50.0^{b,d}	75.0^{b,c}
Change production environment	25.0^{a,b}	81.0^{c}	100.0^{d}	56.0^{c}	11.8^{b}	63.2^{c,e}	50.0^{a,e}	55.0^{a,c,e}
Cause agriculture land lost	15.0^{a}	71.4^{b}	95.5^{c}	68.0^{b}	23.5^{a}	63.2^{b}	68.8c	80.0^{b,c}
Affect local government's plans	14.9^{a}	57.1^{b}	72.7^{b}	23.8^{a,c}	23.5^{a,c}	68.4^{b}	50.0^{b,c}	50.0^{b,c}
Affect farmers' livelihood	0.0^{a}	61.9^{b,c}	72.7^{c}	24.0^{d,e}	11.8^{a,e}	52.6^{b,c,d}	43.8^{b,c,d}	35.0^{b,d,e}

Items with different superscripts are significantly different at p <0.05 (Z test).

Data from tidal gauges along the Vietnamese coast show that sea level has risen at a rate of about 3mm/year during the period of 1993-2008, which is comparable with the global trend [6].

Response Strategies

General Beliefs of Response

When respondents were asked what they thought the Vietnamese central government could do to respond to climate change impacts, most indicated that it is necessary to develop adaptation plans (86%), and other plans to minimize impacts of climate change and sea level rise (73% and 76%, respectively). Only 14% believed that central government needs to take action in addition to these three measures. To examine respondents' perceptions of the role of these adaptation and mitigation measures, respondents were asked to rank the importance of these measures. The results indicate that developing plans to adapt to the change in climate condition is considered to be the most important approach (Mean importance level = 3.4), followed by developing plans to minimize impacts of climate change (Mean importance level = 3.1) and developing plans to minimize impact of sea level rise (Mean importance level = 2.9). Adaptation is perceived as the most important approach in the North Central Coast, the Central Highlands and the Mekong River Delta (Mean importance levels of 3.8 and 3.6 respectively), whereas measures to minimize impacts of climate change and sea level rise are considered as important for Red River Delta, Mekong River Delta and Central Coast regions.

Adaptation Methods to Climate Change

In response to a question about what respondents thought are the most effective adaptive actions that the central government could take, most stated that government should develop adaptive scenarios (89%, Mean degree of agreement = 1.1), develop coping plans (82%, Mean degree of agreement = 0.8), change crop/livestock varieties to be more suitable with the changing climatic patterns (80%, Mean degree of agreement =0.8), and change crop season pattern (82%, Mean degree of agreement = 1.0). Among four of those adaptation measures, changing crop season pattern is considered as the most important (Mean importance level = 3.4), and developing adaptive

Table 4: Perceptions on the Significance of Government Investments to Reduce Negative Impacts of Climate Change

Investment	Regions	Mean degree of agreement (-2 = strongly disagree to 2 = strongly agree)	Mean importance level (1 = not important to 5 = very important)	Respondent agreement distribution (%)				
				Strongly dis agree	Partly disagree	No Opinion or do not know	Partly Agree	Strongly Agree
Infrastructure to protect crops production		***0.7***	***3.4***	***0.0***	***11.3***	***19.4***	***58.1***	***11.3***
Irrigation system	Central Highlands	1.2	3.3	0.0	5.0	15.0	40.0	40.0
	South East	0.5	2.7	0.0	9.5	33.3	57.1	0.0
	Mekong River Delta	0.6	2.6	0.0	9.1	22.7	68.2	0.0
	Red River Delta	0.7	3.1	0.0	8.0	16.0	72.0	4.0
	North West	1.2	3.2	0.0	0.0	17.6	47.1	35.3
	North Central Coast	1.0	3.3	0.0	0.0	15.8	68.4	15.8
	South Central Coast	1.3	3.2	0.0	0.0	0.0	75.0	25.0
	North East	1.0	3.4	0.0	5.0	0.0	90.0	5.0
	Average	***0.9***	***3.1***	***0.0***	***5.0***	***15.6***	***65.0***	***14.4***
Research on crops/livestock varieties	Central Highlands	0.8	3.1	0.0	5.0	25.0	60.0	10.0
	South East	0.8	2.9	0.0	9.5	9.5	71.4	9.5
	Mekong River Delta	1.0	3.0	0.0	4.5	9.1	72.7	13.6
	Red River Delta	0.9	2.6	0.0	4.0	12.0	72.0	12.0
	North West	1.0	3.3	0.0	0.0	17.6	64.7	17.6
	North Central Coast	1.1	2.9	0.0	5.3	5.3	68.4	21.1
	South Central Coast	0.9	2.9	0.0	0.0	12.5	81.3	6.3
	North East	0.8	2.9	0.0	10.0	10.0	70.0	10.0
	Average	***0.9***	***2.9***	***0.0***	***5.0***	***12.5***	***70.0***	***12.5***
Have good plans and programs sustainable agriculture and rural development	Central Highlands	1.1	3.1	0.0	0.0	5.0	85.0	10.0
	South East	1.0	3.0	0.0	4.8	4.8	81.0	9.5
	Mekong River Delta	0.9	2.8	0.0	4.5	4.5	86.4	4.5
	Red River Delta	0.8	3.0	0.0	4.0	20.0	68.0	8.0
	North West	0.9	3.0	0.0	0.0	17.6	76.5	5.9
	North Central Coast	0.8	3.1	0.0	5.3	26.3	52.6	15.8
	South Central Coast	0.9	3.1	0.0	6.7	6.7	73.3	13.3
	North East	1.0	3.0	0.0	0.0	10.0	80.0	10.0
	Average	***0.9***	***3.0***	***0.0***	***3.1***	***11.9***	***75.5***	***9.4***
Enhance communities awareness of climate change	Central Highlands	0.9	3.3	0.0	0.0	20.0	70.0	10.0	100.0
	South East	1.1	3.2	0.0	0.0	4.8	81.0	14.3	100.0
	Mekong River Delta	1.1	3.1	0.0	0.0	4.5	86.4	9.1	100.0
	Red River Delta	1.0	3.1	0.0	0.0	12.0	72.0	16.0	100.0
	North West	0.9	2.8	0.0	0.0	11.8	82.4	5.9	100.0
	North Central Coast	1.1	3.3	0.0	0.0	15.8	63.2	21.1	100.0
	South Central Coast	1.3	3.4	0.0	0.0	0.0	75.0	25.0	100.0
	North East	1.0	3.1	0.0	0.0	15.0	70.0	15.0	100.0
	Average	***1.0***	***3.2***	***0.0***	***0.0***	***10.6***	***75.0***	***14.4***	100.0

scenarios and develop coping plans ranked as second (Mean importance level = 3.3); and changing the crops/livestock varieties is the least important measure (Mean importance level = 2.8).

Ranking the Importance of Vietnamese Government's Investment to Address Climate Change

Investment in infrastructure to protect crops was identified as the major preferred adaptation strategy (Table **4**); 70% agreed this is highly important (Mean importance level = 3.4). Investing in irrigation systems and enhancing community awareness of climate change were ranked second (Mean importance level = 3.1, and 3.2 respectively), while investing in research on crops/livestock varieties suitable to changing climate conditions was perceived to be the lowest priority for the government (Mean importance level = 2.9).

These perceptions are inconsistent with Vietnamese government priorities such as the National Target Program to Respond to Climate Change, in which the central government of Vietnam considers investment in research to be more significant than investment in infrastructure. Research receives about seven times more funding than infrastructure under this program (20% versus 3%) [6].

Climate Change Mitigation Perception

In response to a question on what respondents thought that central government could do to mitigate climate change, 37% agreed that the government should enhance community awareness of climate change by organizing education programs regarding causes and effects of climate change, and develop a carbon market as well as to find methods to reduce carbon emissions. However, up to 61% have no idea about whether the government should take any action to mitigate climate change. This high percentage may indicate that respondents undervalue mitigation measures or do not have enough information. Mitigation is one of the important measures of many governments in response to climate change, and accounts for 46% of total fund allocation for climate change activities in Vietnam over the twenty five years to 2007 (Figure **4**).

Sea Level Rise Adaptation Options

The final section of the survey examined respondents' perceptions to sea level rise adaptation, by posing the question, "Do you think the current adaptation strategies of Vietnamese government are necessary?"; Respondents were given a list of current adaptation strategies in Vietnam to comment on: enhancing protection systems for agricultural production (e.g. by building more sea dikes); investing more in irrigation systems for coastal areas; enhancing coastal management capacity of authorities in the coastal provinces; investing more in infrastructure, developing warning systems; and changing crop patterns. Most of the respondents (83%) agreed that enhanced coastal management capacity is a good method to adapt to climate change. On the other hand, when asked to rank the importance of those adaptation measures, enhanced protection systems for agriculture production and investment in irrigation systems were perceived as the most important (Mean importance

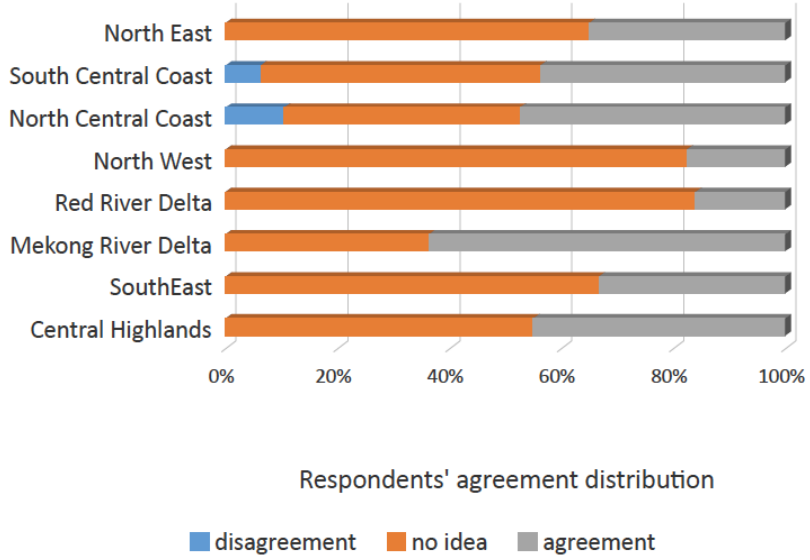

Figure 4: Respondents' agreement distribution on climate change mitigation options.

Table 5: Provincial Officials' Perception of the Significance of Adaptation Measures to Sea Level Rise, as Determined by Ranking of Options

Investment	Mean degree of agreement	Mean importance level	Respondent agreement distribution (%)				
			Strongly dis agree	Partly disagree	No Idea or do not know	Partly Agree	Strongly Agree
Protection systems for agriculture production	0.9	3.2	0.0	1.3	22.5	64.4	11.9
Irrigation	0.8	3.2	0.0	4.4	18.8	72.5	4.4
Enhance coastal management capacity	0.8	2.9	0.0	0.6	16.3	81.9	1.3
Infrastructure	0.7	2.8	0.0	0.0	40.0	49.4	10.6
Develop alert system	0.8	3.0	0.0	0.6	23.8	75.6	0.0
Change crop patterns	0.7	2.9	0.0	3.1	19.4	77.5	0.0

Mean degree of agreement (-2 = strongly disagree to 2 = strongly agree).
Mean importance level (1 = not important to 5 = very important).

level = 3.2) (Table **5**). Those two measures were even more important for Red River Delta as they were ranked by respondents in this region at 3.8 and 3.7 point respectively.

DISCUSSION

Results from this study provide insight into Vietnamese government officials' perceptions of climate change and sea level rise in several aspects, their beliefs and understanding of the effects of climate change and sea level change on agricultural production, and of potential adaption methods to climate and sea level change. Understanding the perceptions held by provincial government environmental and agricultural management officials is important, since it is these people who play a direct role in the implementation of Vietnam's climate change policy and management of on-ground programs to deliver on this policy.

The results from surveys indicate that respondents seem to have a clear understanding of climate change and its impacts on their local agricultural activities, with a high percentage of respondents expressing their beliefs that climate change involves changes of temperature, rainfall, sea level and extreme natural events. This perception is consistent with the IPPC's [1] definition of climate change. There is a small but considerable percentage of the respondents, however, whose understanding of climate change does not align with these views: about 10% suggest that climate change is equivalent to changes within the ozone layer or salinization, and about 16% do not believe that climate change will impact on the agricultural sector.

Comparison of the officials' recall of climatic changes can be used as a benchmark against which to provide some evaluation with the officials' responses. Respondents' perceptions are largely consistent with climatic data records. They are also aligned with the perceptions of farmers in the region, generally acknowledging recent increases in temperature and rainfall, and significant changes in the nature of natural extreme climate events. The high proportion of respondents noting an increase in rainfall could be explained by the fact that there was a slight increase in the amount of rainfall in the period between 2001-2007, at least in the south and central regions, compared with 1991-2000, reflecting a likelihood that respondents may place more weight on recent information than on longer-term trends [25]. Change in annual rainfall was perceived as minimal by the farmers in Mekong River Delta, although, timing and distribution of rainfall was seen as abnormal in this region [16].

The perceptions of provincial officials in the Mekong River Delta, North Central Coast, and Red River Delta are in line with farmers in these regions. Farmers noticing unusual increases in temperature have been

previously recorded in the Mekong River Delta [16], in the North Central Coast [22], and in the Red River Delta [23]. The higher ranking from respondents in the Central Coast and Central Highlands areas for temperature change can be understood from the results of studies [22, 26] which indicate that crops in the Central Coast area of Vietnam are more sensitive to temperature than in the other regions because they are growing at the higher end of their optimum temperature range (22 to 27^{o} C) and any increase in temperature may therefore result in decreased yields. The data indicate that local officials were using information about regional climate change to make inferences about the national scale climate change.

The potential impact of sea level rise on the agricultural sector was ranked highly by respondents in some coastal regions most probably because of the natural and social characteristics of these regions, especially the low lying land surface and high reliance on agriculture. This perception accords with that of MONRE [6], who report the Mekong River Delta and the coastal areas of Vietnam to be the main areas affected by sea level rise. However, 16% overall of the surveyed Vietnamese provincial officials believed that climate change will not affect agriculture. These attitudes are inconsistent with statements in the main reports and programs of the Vietnamese government [5, 6, 19], which confirm that the change of climate factors, sea level, and climatic extreme events will have significant potential impacts on rural and agricultural sectors.

Importantly, the workplace environment of the respondents does not appear to have influenced their perception of climate change; no significant differences were recorded between the perceptions of staff in the two major government departments responsible for implementing relevant policy, DARD and DONRE, except the perception of annual temperature and flood duration. This finding is inconsistent with those of [13], who found that environmental policy professionals tend to espouse definitions of environmental problems and risk consistent with a more entrenched world view associated with the organizations to which they belong. It is important, however, to note that perceptions of the respondents in this study were misaligned with the official view of central and provincial government authorities with regard to impacts caused by sea level rise. Among the interviewees, 43% stated that sea level rise does not seriously affect the agricultural sector within their province, whereas the Ministry of Environmental and Natural Resources Management [6] has indicated that Vietnam will be heavily affected by sea level rise, especially in the two biggest river deltas, the Red River and the Mekong River Deltas. There are significant differences between the two deltas in the beliefs on 8 of the 13 impacts of sea level rise and the Red River Delta officials gave much lower estimates in many aspects. This may suggest that officials in the Red River Delta region may be less knowledgeable about the predicted impacts of sea level rise in their region. These two areas have intensive agricultural activities and produce most of Vietnam's rice crop. The analysis also reveals that, while most of the respondents from coastal provinces have a clear understanding of potential impacts of sea level rise in their areas, some respondents from inland provinces have less certain views regarding if and how sea level rise will affect local agricultural activities. This indicates that the information channels and connections between central government and provincial government are perhaps ineffective so provincial officials are not well informed of the findings of the central government's research institutions. Review of the literature indicates that there have been no previous publications on the impacts of sea level rise on the inland regions in Vietnam, despite the possibility that sea level rise may cause some impact on agricultural production through increasing salinity of ground water resources.

Adaptation is widely recognized as an important component of any policy response to climate change, as it helps people living in the vulnerable areas achieve their food, income and livelihood security objectives in the face of changing climatic patterns. Climate change adaptation is the process by which ecological, social, or economic systems adjust to actual or expected climatic stimulus and their effects or impacts [27]. The importance of adaptation plans in response to climate change and sea level rise is reflected in the fund allocation for climate change activities in Vietnam by Vietnamese government and international donors in the last two decades. According to The World Bank [28], in 25 years (from 1992 to 2017) USD 1.37 billion has been invested in climate change activities in Vietnam, 51% allocated to climate change adaptation, 46% to mitigation, and 3% to institutional support, raising awareness and capacity. The survey results indicated that respondents had a sound understanding of response strategies, with a high proportion of respondents commenting that it is necessary to develop adaptation plans to cope with climate change and sea level rise. Most respondents believed that central government should invest more in crop

research, change crop patterns, invest in infrastructure and irrigation, and modify crop planting seasons. While this may be unsurprising, given the focus on surveying respondents responsible for environmental and agricultural management, it should be noted that most respondents identified investment in infrastructure to protect crops as the most significant adaptation method. This differs from results of research elsewhere, such as Africa, where the main adaptation strategies favoured by farmers are changing crop varieties, changing crop season, and increasing irrigation [29], it also differs from the point of view of the Vietnamese central government in allocating funding for climate change activities through the National Target Program to Respond to Climate Change.

While respondents appear to be well aware of sea level rise and its impacts on their local agricultural activities, they generally appear to underestimate the value of mitigation methods, such as fossil fuel replacement, emission targets or specific incentives, with most stating that they have no idea about whether government should take any mitigation measure. This result is consistent with the findings of Phan [30] who argued that although climate change issues are beginning to receive more attention in the Vietnamese media, programs dedicated to these topics were poor and inappropriate as they largely focus on impacts and adaptions with little emphasis on mitigation or climate sciences.

The implication of this finding is that, to enhance provincial agricultural and environmental management officials' capacity to implement climate change agricultural policy efficiently in Vietnam, there is further need to disseminate information and increase awareness regarding climate change, sea level rise and its impacts, and response strategies, especially the role of adaptation and mitigation methods. The awareness programs for provincial officers could be done through training courses to be run by Vietnamese government organizations, non-government organizations or media programs.

While much care has been exercised in examining perceptions of Vietnamese government officials to climate change, there are limitations to the survey. Future research should give sufficient consideration on the variations of interviewees' living location. Furthermore, this study is collecting information of officials' views and perceptions on climate change, but does not delve deeply into the underlying processes of these perceptions. So, future studies could do this, using, for example, theory of planned behaviour to examine underlying values and beliefs that may be influencing official's perceptions.

CONCLUSION

The Vietnamese government and agricultural management officials surveyed seem to have a clear and knowledgeable understanding of climate change and its impacts on agricultural production as well as response strategies for this phenomenon at their local scale. Their responses align well with records of climate and meteorological change in Vietnam and farmers' perceptions in these regions. These officials may be considered, therefore, to be capable of implementing the activities of National Target Program to Respond to Climate Change or any climate change related activities in their local area. However, respondents have weaknesses with regard to understanding adaptation and mitigation measures. In particular, there appears to be a general underestimation of the negative impacts of sea level rise on agriculture, and of the role of mitigation measures to address these impacts. The results from this study provide information that will be valuable to Vietnamese and international organizations involved in assisting agricultural research and extension agencies with identifying and implementing strategies to adapt farming systems to climate change. However, caution should be used by any policy makers who would like to use the results of national survey to make inferences for their decisions related to climate change issues as local officials tend to use the local climate change information to make statements about general climate change.

ACKNOWLEDGEMENTS

This paper is part of Son Tran Van PhD research at Southern Cross University under the sponsorship of Australia Centre for International Agriculture Research (ACIAR). We are very grateful to ACIAR and the School of Environment, Science and Engineering for funding data collection. We would like to thank the Ministry of Agriculture and Rural Development and Institute of Agriculture Environment of Vietnam for sharing valuable survey data. We also thank Dr Lyndon Brookes, Dr. Brad Keen, Mrs. Kathryn and other reviewers for the excellent statistical support and constructive comments.

REFERENCES

[1] IPCC. Working Group 2. Impacts, adaptation and vulnerability. The Fourth assessment Report of the

Intergovernmental Panel on Climate Change. Annex 1. Cambridge University Press. Cambridge, UK 2007.

[2] IPCC. Summary for policymakers. In: Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA 2013.

[3] Ejembi EP, Alfa GB. Perception of climate change in Africa: Regional agricultural perspectives. Research on Humanity and Social Sciences 2012; 2.

[4] Dasgupta LS, Meisner B, Wheeler C, Yan J. The impact of sea level rise on developing countries: A comparative analysis. World Bank Policy Research Working Paper 2007; 4136.

[5] MONRE. Vietnam's second national communication to the United Nations framework convention on climate change. Hanoi 2010.

[6] MONRE. National Target Program to Respond to Climate Change 2008 (Implementing the Government's Resolution No.60/2007 dated 3rd December, 2007.

[7] Climate Change and Disaster Management Working Group of Vietnam. Climate change and disaster management policy in Vietnam. Asian Management and Development Institute, Pressure Group Consultancy, UK 2011.

[8] Mickwitz P, Aix F, Beck S, *et al*. Climate policy integration, coherence and governance. PEER Report No 2. Partnership for European Environmental Research (PEER), Helsinki 2009.

[9] Kempton W. Will public environmental concern lead to action on global warming? Annual Review of Energy and the Environment 1993; 18.

[10] Bord RJ, Fisher A, O'connor R. Public perception of global warming: United States and international perspectives. Climate Research 1998; 11: 75-84. http://dx.doi.org/10.3354/cr011075

[11] Lazo JK, Kenel J, Fisher A. Expert and layperson perception of ecosystem risk. Risk Analysis 2000; 20: 179-193. http://dx.doi.org/10.1111/0272-4332.202019

[12] Maddison D. The Perception of and adaptation to climate change in Africa. Policy Research Working Paper Series 4308, the World Bank 2007.

[13] Dentz T, Stern PC, Rycroft RW. Definitions of conflict and the legitimation of resources: The case of environmental risk. Sociological Forum 1989; 4: 47-70. http://dx.doi.org/10.1007/BF01112616

[14] Feijoo C, Momo F. Socio-economic levels and environmental perception in a small town in Argentina. The Environmentalist 1991; 11: 163-170. http://dx.doi.org/10.1007/BF01263229

[15] Filip J, Funtes E, Donso S, Martini S. Environmental perception of mountain ecosystems in Central Chile: An Exploratory Study. Hum Ecol 1983; 11. http://dx.doi.org/10.1007/bf00891380

[16] Dang LT, Elton L, Johan B, Ian N. Farmers' perceptions of climate variability and barriers to adaptation: lessons learned from an exploratory study in Vietnam. Mitigation and Adaption Strategies for Global Change 2012; 19: 531-548.

[17] Stedman RC, Davidson DJ, Wellstead A. Risk and climate change: Perceptions of key policy actors in Canada. Risk Analysis 2004; 24.

[18] Chaudhry P, Ruysschaert G. Climate change and human development in Vietnam. UNDP -Human Development Report Office 2007; p. 18.

[19] Vietnam Institute of Strategy and Policy on Natural Resources and Environment. Vietnam assessment report on climate change. Hanoi 2009.

[20] Vietnam General Statistics Office. Statistical Yearbook 2011. Hanoi 2012.

[21] Bostrum A, Morgan MG, Fischoff B, Read D. What do people know about global climate change? 1. Mental models. Risk Analysis 1994; 14: 959-970. http://dx.doi.org/10.1111/j.1539-6924.1994.tb00065.x

[22] LE THP. Climate change and farmer's adaptation. Master Swedish University of Agricultural Sciences 2011.

[23] Miguel DG. Identifying institutional factors that are barriers to climate change adaptation in Vietnam, Master thesis, Uppsala University, Sweden 2013.

[24] Hageback J, Sundberg J, Ostwald M, *et al*. Climate variability and land-use change in Danangou Watershed, China—Examples of small-scale farmers' adaptation. Climatic Change 2005; 72: 189-212. http://dx.doi.org/10.1007/s10584-005-5384-7

[25] Maddison D. The Perception of and adaptation to climate change in Africa. Special Series on Climate Change and Agriculture in Africa. CEEPA Discussion 2006. Paper No. 10 Discussion Paper.

[26] Quan HN, Hoang MH, Oborn I, Van Nordwijk M. Multipurpose agro forestry as a climate change adaptation option for farmers: An example of local adaptation in Vietnam. Climate Change 2012; 117: 241-257.

[27] De Chavez R, Auli-Corpuz V, Eds. Guide on climate change & indigenous peoples, Philippines: Tebtebba Foundation 2008.

[28] World Bank. Climate-resilient development in Vietnam: Strategic directions for the World Bank. Sustainable development department, Vietnam Country Office. The World Bank 2011.

[29] Gbetibouo GA Understanding farmers' perceptions to climate change and variability: the case of the Limpopo Basin, South Africa. International Food Policy Research Institute 2009. Discussion paper 00849. http://books.google.com.au/. Cited 11 September 2012.

[30] Pham H. Climate change coverage by the Vietnamese media: four-year trends 2006–2009. Institute of Health, Environment and Development, Hanoi, in association with the Vietnam Forum of Environmental Journalists and Internews' Earth Journalism Network, 5 Dec 2009; p. 8.

Received on 18-06-2015 Accepted on 03-08-2015 Published on 02-09-2015

http://dx.doi.org/10.6000/1927-5129.2015.11.66