Adaptation to Climate Change in Agricultural Sector for Achieving Green Growth

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ADAPTATION TO CLIMATE CHANGE IN AGRICULTURAL SECTOR FOR ACHIEVING GREEN GROWTH

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ABSTRACT

The potential for future economic growth and development is put at risk, as a result of environmental degradation, climate change, and other environmental risks which are driven by internal and external factors. The impact of climate change in agricultural sector, especially on food crop sub-sector, are threat of floods and drought, plant pest organism attack resulting in decreased quantity and quality of agricultural product. Therefore, it is necessary to adopt strategies and efforts to anticipate the impacts of climate change. Farmers need to adapt climate change in the form of a tolerant agricultural adaptation (resilience) to climate change.

This study investigated farmers' willingness to pay (WTP) for adapting climate change in agricultural sector. Contingent valuation method was employed to elicit the WTP of farmers for adapting to climate change. The farmers as respondents were offered a yes/no option to select their WTP for adapting the climate change. Therefore, this study use logit regression to estimate the determinants of the WTP's farmers. The data were obtained by direct face to face interviews in order to get reliable responses from respondents. The structured questionnaires consisted of four sections which included household characteristics, household assets, social capital, and location characteristics. The last section consisted of CVM question to estimate farmer's WTP for adapting the climate change. The study area was located in Daerah Istimewa Yogyakarta Province where identified as agricultural area with any plant pest organism attack due to the climate change. This kind of climate change effect selected as the object of this study because it had been experienced by the most of the agricultural land identified by Geographic Information System.

The study result as 73.8 % of respondents were willing to pay of IDR 26,500 for adapting climate change. The socio-economic factors were found influence to the WTP. The result reveals that age, number of family members, trust, participation in farmer community and number of relatives live in other region influence to the farmers' WTP for adapting climate change. This study could support policy makers to design an efficient adaptation framework to the adverse impacts of climate change especially in agricultural sector.

Keywords: contingent valuation method; adapting climate change; logistic regression; willingness to pay; climate change

INTRODUCTION

Climate change has brought extreme weather, unexpected temperature and fluctuating rainfall. Studies showed that this situation causes a reduction on agro-economy performance in several countries (Georgescu et al., 2011; Lobell et al. 2011; Fischer et al. 2005). In this situation, Stern et al. (2006) argue that poor countries are more vulnerable concerning climate change exposure, economic and social sensitivity. In Southern Africa, for example, Lobell et al. (2008) found that maize harvest dropped up to 30% due to climate change. In South East Asia, climate vulnerability cause grain and maize product decrease

approximately by 10% (IPCC, 2007). A growing quail due to climate change could significantly affect the productivity of rice crop in China (Tao et al. 2008). In Malaysia, agricultural productivity is decreasing due to climate vulnerability and other related issues (Siwar et al. 2009). In some agricultural areas in Yogyakarta Indonesia, based on a mapping using Geographic Information Systems, Saptutyningsih & Ma'ruf (2016) found various impacts of climate change exist including flood or even drought that hit agricultural land, and pest attack, that cause farmers experience crop failure.

Related disciplines, in particular, the risk management literature, often use the term mitigation (rather than adaptation) to describe actions that reduce climatic risks. The Intergovernmental Panel on Climate Change (IPCC) defines resilience as the ability of a system to anticipate, absorb, accommodate or recover from a hazardous event (Field et al. 2012). The adaptation researches has now become an area of academic interest. Studies conducted by Dell et al. (2014) and Carleton and Hsiang (2016) confirm that there is a strong connection between economic studies of adaptation and literature on the economic impacts of climate change. The fifth assessment report of the IPCC devoted an entire chapter to the economics of adaptation, which includes over 500 references (Chambwera et al. 2014), including Markandya et al. (2014), Kahn (2016) and Massetti and Mendelsohn (2015).

Regarding the impact of climate change, among a society members, farmers are often less concern on climate change due to their weakness on institutional capacity including lack of confirmation of local knowledge that might lead to restriction on adaptation and environmental engagement (SPORE 2008; BNRCC 2008; Royal Society 2005; Adams et al. 1988). Climate change directly or indirectly affects the social and economic sustainability of farmers. Climate change causes crop failures, low productivity and high production costs and results in loss of income for farmers, while also raising the seasonal unemployment rate (Siwar et al. 2009; Alam et al. 2011).

Concerning the above circumstances, a new economic model that value environmental endowment would be necessary to address the impact of climate change to achieve sustainable development. Various efforts need to be made for adapting climate change, such as in the form of a tolerant agricultural adaptation (resilience) to climate change. The adaptation to climate change could be made by strengthening social capital in essential community roles, as mentioned by Siregar (2011).

This study aimed to measure the willingness to pay of farmers to adapt and identify the role of social capital in adaptation to climate change. The willingness to pay measurement will determine the pattern of adaptation of farmers in facing the climate change. Study of climate change that has been conducted mainly employed descriptive study (Ngigi, 2009) and choice experiment (Chaisemartin & Mahe, 2009). Meanwhile, this study uses a contingent valuation method to measure the willingness to pay of farmers in adapting to

climate change and identify the factors affecting the willingness to pay of farmers for adapting climate change. Based on the mapping that has been conducted previously by Saptutyningsih & Ma'ruf (2016), this study focused on the location of farmland that is impacted by climate change especially pest attack, in Yogyakarta Indonesia.

This study is expected to help policymakers and government to address the challenge of climate change better and meet expected growth targets by providing them with data about the awareness levels of farmers towards climate change and their WTP for adapting the climate change. To this end, the study of the WTP of farmers is necessary, especially given the fact that, to date, no such research has been conducted in the Indonesian context. There is, therefore, a pressing need to survey the behaviour and WTP of farmers for adapting climate change in this country.

RESEARCH METHODOLOGY

Description of the study area

This study was conducted in Yogyakarta, Indonesia, since climate change has had an impact on the agricultural sector in this province. A mapping of climate change impact on agricultural land using geographic information system shows that most agricultural lands in the province were affected by pest attacks as presented in Figure 1 (Saptutyningsih & Ma'ruf, 2016).

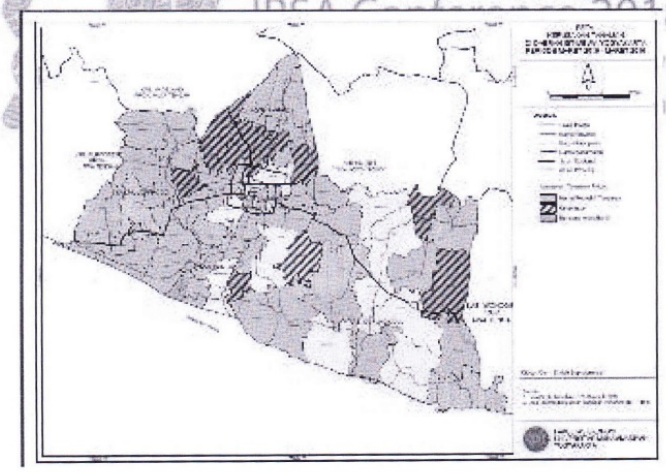

Figure 1. Impact of climate change on agricultural land in Yogyakarta

Sampling procedure

Subjects in this study were farmers and owners of agricultural land in Yogyakarta whose land was affected by climate change. The mapping of climate change impact mentioned above indicates that there are three types of climate change impacts in this province: flood, pest attack, and drought (Saptutyningsih & Ma'ruf, 2016). This study focuses on pest attack

since this impact was the one that mostly incurred in the area. 191 samples were selected using a non-probability technique with systematic random sampling. This number was determined using Slovin formula. This study employed logit regression model. It was assumed that adaptation to ecological technology that chosen by farmers would maximize their utility.

Design of the questionnaire

The questionnaire consisted of 4 sections. Section A collected information on the farmers' socioeconomic characteristics (i.e. family size, age, sex). Section B enquired the farmers' household endowment asset (i.e. land size, land tenure). Section C collected information on social capital characteristics (i.e. trust, community participation, number of relatives outside the village, etc.) and location characteristic (i.e. distance from home to farm). Finally, section D consisted of CVM questions to estimate farmers' WTP for adapting climate change. This methodological approach conforms to research carried out by Loomis et al. (2000), Zhongmin et al. (2003), and Herrera et al. (2004), who contended that a clear explanation of CV variables to be studied is crucial in valuation studies. This method gives a better understanding of the variables that affect the household's WTP, which is an important key to identify the hypothetical situation. It also helps to elicit the range of amount/values of WTP through binary (close-ended) choice questions. Furthermore, this method ensuring accurate benefit estimates of the studied ecosystem good and services. In this regard, we set questions in the form of binary/ dichotomous, i.e. respondents had two options (1 = Yes and 0 = No). We designed bids amount ranging from 5,000 where respondents were required to mention or circle the amount they were willing to pay. These bids were finally set after a careful pre-testing and feedback from farmers. In the CV questionnaire, we selected a payment vehicle as the adaptation fees. Based on the respondent's previous answer, we ask follow-up questions for lower or upper amounts of adaptation fees.

Data analysis

This study employed the Contingent Valuation Method (CVM) which is a hypothetical value based method used to estimate farmers' WTP for adapting climate change. CVM is a survey technique that constructs a hypothetical market to measure willingness to pay (WTP) or willingness to accept (WTA) compensation for different levels of non-market natural and environmental resources (Loomis, 2002). The approach was selected for this study because of its ability to assign a market value of ecosystem services in the agricultural sector that do not have market values or cannot be assessed through market mechanisms (Bateman et al., 2002; Amponin et al., 2007; Haab and McConnell, 2002).

The estimation model in this study was:

WTP Adaptation = f (household characteristics, household asset endowment characteristics, social capital characteristics, location characteristic)

Table 1. The definition of explanatory variables

Variables		Definitions
Dependent variable		
WTP Adaptation		Willingness to pay (WTP) for adapting climate change
Independent variables		
Household characteristics	AGE	Age of household head
	SEX	Sex of household head (=1 if male)
	FAM_SIZE	Average number of family size
Household asset endowment characteristics	SQUARE	Average total farm area in hectare
	LAND TENURE	dummy land tenure 1 if farm area owner; 0 if otherwise
Social capital characteristics	TRUST	Trust in people (=1 if respondent believes people are trust worthy)
	COMMUNITY	The household participation in community (=1 if participate)
	FAM_OUT	Number of relatives outside this village
Location characteristic	DIS_HOME	Distance to home from farm area (km)

VARIABLES AND DATA DESCRIPTION

The survey involved 191 farm households that were randomly selected in 7 villages, located in Kulonprogo district of Yogyakarta, Indonesia. The dataset includes detailed information on the socioeconomic characteristics of the households, asset endowment characteristics of the household, social capital characteristics, and location characteristics.

The dependent variable is the willingness to pay for adapting to climate change. The respondents stated that they adopt adaptation technologies to reduce the risk of climate change especially plant pest organism attack that causes a decreased quantity and quality of their agricultural production.

Table 2. Willingness to pay for adapting climate change

WTP	Yes	No
Amount (person)	141	50
Percentage (%)	74	26

Table 3 presents descriptive statistics of variables considered in the analysis. The willingness to pay for adapting to climate change in the agricultural sector was a dummy variable with a value of 1 if the farm household head willing to pay IDR 26,500. The household characteristics of this study are sex of household head (= 1 if male); the age of household head which had an average of 58.2 years old; and the average number of family size of the sample was two people. The average total farm area as the household asset endowment was 1861 hectares on average. The farm area owner captured as a dummy variable with a value of 1 if respondents were the owner of the farm area.

Table 3. Descriptive statistics of explanatory variables

Description of variables	Mean	Minimum	Maximum	SD
Willingness to pay for adapting climate change	.738	.00	1.00	.441
Household characteristics				
Sex of household head (=1 if male)	.753	.00	1.00	.431
Age of household head	58.200	34	88	10.360
Average number of family size	2.308	.00	8.00	1.798
Household asset endowment characteristics				
Average total farm area in hectare	1861.360	35.00	20000.00	2221.840
Dummy land tenure (=1 if farm area owner)	.654	.00	1.00	.476
Social capital characteristics				
Trust in people (=1 if respondent believes people are trust worthy)	.884	.00	1.00	.320
The household participation in community (=1 if participate)	.628	.00	1.00	.484
Number of relatives outside this village	5.125	.00	150.00	14.731
Location characteristics				
Distance to home from farm area	901.267	5.00	22000.00	2175.990

The determinant of adapting to climate change in this paper, social capital, refers to trust in people and household participation in the community. The trust variables are formed from trust in people and trust in institutions. Trust in people is captured as a dummy variable with a value of 1 if respondents think that people are trustworthy and 0 if otherwise. The household participation had a value of 1 if respondents participate in a community. The number of relatives outside this village was five people on average. The characteristic of location in this study was the distance to home from farm area was about 901.267 metres on average.

RESULTS DAN DISCUSSION

Among the household characteristic variables, sex of household head has no significant effect on willingness to pay (WTP) for adapting climate change included in this study (Model 1 and 2) but affects WTP in Model 3 and 4. Sex of household head positively correlated with the WTP for adapting climate change since the model has the interaction between sex of household head and trust in people. It means that male household head with trust in people has a significant effect on WTP for adapting climate change. The household size has a significant effect on WTP of adaptation to climate change. This was expected given that the adoptions of the ecological adaptation technology require labour.

The household endowment variables have no effect on WTP for adapting climate change. The land size was positively associated with WTP of adaptation to climate change in the study area but does not significantly correlated with WTP. Our results also show that land tenure has no significant effect on WTP for adapting climate change considered in this study. But by including interaction between age of household head and trust in people, land tenure became significantly correlated with WTP of adaptation to climate change. Land

tenure also had no significant effect on WTP for adapting climate change. By including interaction between age of household head and trust in people and interaction between sex of household head and community participation, land tenure became significantly correlated with WTP of adaptation to climate change. It means that an older household head with trust in people and male household head who participate in the community caused the land tenure positively correlated with WTP for adapting climate change.

Table 4. Regression results

Variables	Odds ratio (SE)			
	1	2	3	4
Constant	.009	.000	.001	.000
	(1.627)	(2.994)	(3.034)	(8.665)
SEX	1.019	1.015	.090**	.005**
	(.465)	(.472)	(1.179)	(2.768)
AGE	1.044**	1.111**	1.118**	1.551***
	(.022)	(.048)	(.049)	(.150)
FAM_SIZE	1.346**	1.379**	1.339**	1.442**
	(.143)	(.144)	(.148)	(.170)
SQUARE	1.000	1.000	1.000	1.000
	(.000)	(.000)	(.000)	(.000)
LAND TENURE	.631	51.502	63.089	206.867*
	(.315)	(2.887)	(2.940)	(3.166)
TRUST	19.169***	21.456***	3.354	278394173
	(.601)	(.616)	(.962)	.6**
				(7.824)
COMMUNITY	2.192*	2.242*	2.163*	9.854**
	(.449)	(.452)	(.458)	(1.027)
FAM_OUT	.954**	.956**	.955**	.959*
	(.024)	(.023)	(.023)	(.023)
DIST_HOME	1.000	1.000	1.000	1.000
	(.000)	(.000)	(.000)	(.000)
AGE*OWN		.925	.923	.904*
		(.051)	(.052)	(.056)
SEX*TRUST			16.984**	676.005**
			(1.257)	(2.777)
AGE*TRUST				.723**
				(.136)
SEX*COM				.101**
				(1.161)

Dependent variable : WTP for adapting climate change
*significant at level 10%; **significant at level 5%; ***significant at level 1%

On the other hand, household head trust in people has a positive and significant effect on WTP for adapting climate change. Our findings of the effect of social capital on WTP for adapting climate change are in line with other similar studies. As described in the previous section, there is some literature on the link between social capital and technology adoption on adapting climate change. For example, based on analysis from different African countries, van Rijn et al. (2012) argue that an aggregate measure of social capital and the adoption of agricultural innovations by farmers are highly correlated. But they further argue

that different dimensions of social capital are associated with agricultural innovation in a variety of ways: some are positively related while others are negatively related. Also, Bouma et al. (2008) found that social capital is not a significant determinant for household investment in soil and water conservation when such investments are subsidized. Similarly, Gebremedhin and Swinton (2003) examined the effect of community influence (social capital) in inducing adoption of soil conservation in the northern part of Ethiopia. They found that it had no significant effect on adoption of both soil and stone bund terraces.

Another dimension of social capital considered in this paper was trust in people has a significant effect on WTP for adapting climate change. The participation of respondents in a community has a significant effect on WTP of adaptation to climate change in level 10%. The total number of relatives of the household living outside of the respondent's village. This is positively and significantly correlated with the WTP of adapting climate change. As a measure of location characteristics, distance to home is also included in the analysis. But it has no effect on WTP for adapting climate change.

CONCLUSION

This study assesses farmers' willingness to pay for adaptation to climate change in agricultural sector. Specifically, this study focuses on pest attack as the impact of climate change on the agricultural sector, ecological adaptation technology for adapting climate change and alternative social capital measurement.

This study found that farmers in Yogyakarta are willing to pay for climate change adaptation. Their WTP is influenced by sex, age, land size, and social capital. A different forms of social capital have different relationships with the farmers' WTP. Trust, as a main social capital measurement in this study, has significant influence on the WTP of the farmers to adapt their agricultural practice due to climate change.

There is remain challenges that limit the explanatory power of social capital as a tool in climate change adaptation. Further studies may extend the current study by including other kinds of sustainable land management practices such as agroforestry, maintenance of soil fertility such as manure application and the use of chemicals etc., to understand and provide a complete picture on the role of social capital, climate change and other household characteristic variables.

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