Does social capital matter in climate change adaptation? A lesson from agricultural sector in Yogyakarta, Indonesia

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Does social capital matter in climate change adaptation? A lesson from agricultural sector in Yogyakarta, Indonesia

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ABSTRACT

Climate change increases the vulnerability of agricultural sector due to the increasing threat from pest attacks. Mitigation of a threat that results from climate change requires adaptation strategies. This study investigates farmers' willingness to participate in the process of climate change adaptation in Yogyakarta, Indonesia; particularly in facing the increasing risk of pest attacks. Using a logistic regression model, we tested the impacts of social capital on farmers' willingness to participate. The results showed that 70% of farmers were willing to contribute financially to the adaptation process. This participation was positively correlated with high social capital, which consists of high level of trust, community engagement, and personal relations with people in other villages. This study contributes to the literature by highlighting the potential roles of social capital in the process of climate change adaptation in agricultural sector.

1. Introduction

Climate change is indicated by extreme weather, unpredictable temperature, and fluctuating rainfall. Studies have shown that climate change may reduce a country's overall agro-economy performance (Fischer et al., 2005; Georgescu et al., 2011; Lobell et al., 2008); hence may threaten food security (Krishnamurthy et al., 2009, 2014; Richardson et al., 2018). In South East Asia, climate vulnerability may decrease the production of grains and maize by approximately 10% (IPCC-TGICA, 2007). In Indonesia, climate change causes water shortage, lowers soil moisture, decreases soil fertility, and increases evaporation and precipitation (Measey, 2010). Overall, this poses a threat to food security. Research shows that Indonesian paddy production was reduced by about 25% due to climate change in 2014 (Fadhliani, 2016). Climate change could also increase sea levels and flood rice and shrimp farms (Measey, 2010). Saptutyningsih and Ma'ruf (2016) have shown that farms in Yogyakarta, Indonesia, were highly affected by climate change e.g. flood and drought that could damage agricultural lands and pest attacks on crops (Baehaki and Widiarta, 2009; Romadhon, 2007; BBPOPT, 2015; Deptan, 2009) that may have a major cause of production failure (see Fig. 1). Climate change affects social and economic sustainability of the agricultural sector, both directly and indirectly. Crop failures, low productivity, and high production costs resulting from climate change lead to farmers' income loss and an increase of seasonal unemployment rates (Alam et al., 2011; Siwar et al., 2009). Unfortunately, farmers' understanding of climate change is limited because they lack institutional capacity and knowledge on adaptation and environmental engagement (Adams et al., 1988; CTA, 2008; Watts, 2005).

Mitigation of climate change impacts requires effective strategies, one of which is strengthening the roles of social capital in communities (Bezabih et al., 2013; Siregar and Crane, 2011) because of its potential in influencing economic performance (Bourdieu, 1986; Coleman, 1988; Putnam, 1993). Social capital is defined as trust and norms in a community that enable its members to act collectively (Bowles and Gintis, 2001; Woolcock and Narayan, 2000). Trust, which could be defined as "the expectation that arises within a community of regular, honest and cooperative behaviours based on commonly shared norms on the part of other members of that society" (Fukuyama, 1995), plays a key role in social capital. People's behaviours and attitudes can be influenced by the established social norms in the community, and this could lead to higher economic efficiency because it may reduce transaction costs and gap of information, and increase support to address social problems. This is often referred to as 'cognitive social capital' (Grootaert and Bastelaer, 2002).

Social capital could enhance farmers' livelihood by changing their farming practices such as when they need to embrace innovation and new agricultural technologies (Bandiera and Rasul, 2006a, 2006b;

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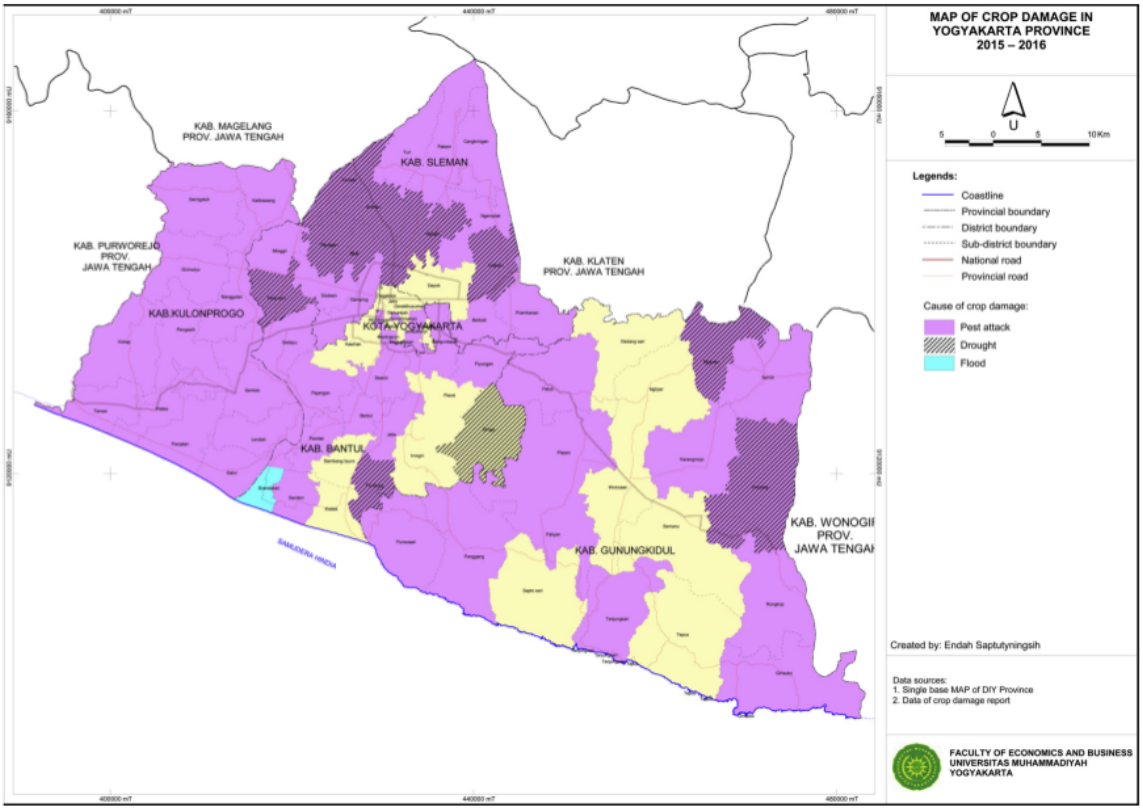

Fig. 1. Map of crop damage from climate change in Yogyakarta.
Source: Saptutyningsih & Ma'ruf (2016)

Isham, 2002; Narayan and Pritchett, 1999). Social networks such as friends and family could affect farmers' attitude about climate change adaptation (Nam et al., 2012), enrich their knowledge on the adaptation (Fankhauser et al., 1999), modulate their willingness to pay for adaptation costs, and increase their capacity for estimating potential risks and damages caused by climate change (Kane and Shogren, 2000). For this reason, the Indonesian Climate Change Sectoral Roadmap (ICCSR) recommended the involvement of social capital when opening new plantation and introducing technologies to farmers.

Several studies have found that social capital and natural resource management are interconnected. For instance, Adhikari and Goldey (2010) argue that social capital can negatively or positively affect collective actions. Ishihara and Pascual (2009) suggest that social capital could facilitate collective actions in natural resource management. In China, social capital is an important factor determining the success or failure of forest management as an effort to mitigate climate change. Low level of social capital leads to ill-management of forests (Gong et al., 2010). Social capital is also vital in determining the willingness to pay for water quality improvement among members of society in Greece (Polyzou et al., 2011). However, a study focusing on the impacts of social capital on farmer's behaviours remains inconclusive.

To fill in this knowledge gap, this study examines farmers' participation in the process of climate change adaptation and the extent to which social capital has an impact. We surveyed farmers in villages in Yogyakarta, Indonesia, where chances of pest attack were high (Saptutyningsih and Ma'ruf, 2016). Using a logistic regression model, we examined the impacts of social capital and sociodemographic factors on the farmers' willingness to pay for climate change mitigation in agricultural sector. This study contributes to the literature by identifying the role of social capital in the process of climate change adaptation.

2. Materials and methods

2.1. Study site

This study was conducted in Yogyakarta, Indonesia, where agricultural sector was severely impacted by climate change. Food security in the province was threatened by the low agricultural productivity (Kharisma, 2016). Agricultural land in the province was highly vulnerable to pest attacks, as well as flood and drought resulting from climate change (Fig. 1) (Saptutyningsih and Ma'ruf, 2016). For example, more than 15,000 ha of land in Kulon Progo Regency was damaged by pest attacks; and in 2016, rice production decreased by 35–40%, which was mainly caused by pest attack (Kharisma, 2016). In 2016, the total rice production in Kulon Progo Regency was only 116,452.20 tons, decreasing by 8.30% compared to that of in 2015 (BPS, 2016), which eventually decreased the aggregated production of rice commodities in Yogyakarta. An integrated ecological solution to control pests was then proposed by the Kulon Progo Regency Government (Sutarmi, 2014), and this required active participation from farmers.

2.2. Survey design and administration

We surveyed farmers in the study site to discover their willingness to participate in the process of climate change adaptation and the extent to which social capital has an impact. Their support was measured based on their agreement or disagreement to assist climate change mitigation by paying a certain amount of money: a referendum for an environmental tax. This inquiry was conducted to identify farmers who were invested in climate change adaptation. In order to determine the benchmark, we conducted a focus group discussion with 22 well-

informed farmers. These farmers were selected from 22 villages with severe pest damages. In the discussion, we used contingent valuation method to elicit participants' willingness to pay or willingness to accept a certain change in natural resources (Bateman et al., 2002; Cruz, 2007; Haab and McConnell, 2002; Zhongmin et al., 2003). Started with the lowest bid of IDR 5,000 (USD 0.36), the double bound study resulted in farmers' willingness to pay of IDR 26,500 (USD 1.88) for climate change adaptation. Needless to say, this estimation did not represent the willingness to pay of the entire population in the study site. Rather, this result served as an indicator to determine potential economic value of climate change adaptation from the point of view of well-informed farmers. This estimate was then used to identify which farmers had sufficient finance and were willing to participate in the adaptation. To do so, we asked participants whether they would agree or disagree to pay IDR 26,500 (USD 1.88) monthly for climate change adaptation.

The concept of social capital has been identified in previous studies (e.g. Dakhli and De Clercq, 2004; Jin and Shriar, 2013; Jones et al., 2009, 2010; Macias and Williams, 2014; Narayan and Cassidy, 2001; Polyzou et al., 2011; Schaik, 2002). Social capital characteristics include trust, community participation, and personal relations with people outside one's village. Such characteristics are very much embedded in Indonesians' traditions and communities.

The final survey questionnaire consists of seven sections (see Appendix). Section A maps out the farmers' sociodemographic characteristics (i.e. family size, age, sex). Section B uncovers the farmers' assets (i.e. land size, land ownership); Section C the social capital (i.e. trust, community participation, and the number of relatives outside the village); Section D the farmers' risk perception and adaptation strategies; Section E the farm land characteristics (i.e. distance from home to farm); Section F the climate change indicators (e.g. rainfall and temperature); and Section G the farmers' willingness to pay the monthly payment of IDR 26,500 (USD 1.88) for the climate change adaptation.

We surveyed 286 farm households selected from 22 villages in Yogyakarta where pest attack was prevalent (Saptutyningsih and Ma'ruf, 2016). The required sample size for the surveys was determined by the Slovin formula. The surveys were conducted using two-stage sampling. The mode was face-to-face on-site survey (Le Goffe, 1995; Lee and Han, 2002; Lee, 1997; Togridou et al., 2006). At the first stage, stratified sampling was used to obtain a representative sample from the areas with pest attacks. At the second stage, we used random selections of 13 household-head farmers per village. Seventeen respondents did not complete the surveys, so the final total number of respondents was 269.

2.3. Data analysis

We employed a logistic regression (Wang and Elhag, 2007) to identity the correlation between social capital and farmers' willingness to participate in climate change adaptation. The dependent variable of the model is the farmer's willingness, where 1 indicates agreement and 0 disagreement. The independent variables of the model are the sociodemographic, asset, social capital, adaptation, and location characteristics, as well as the climate change indicators (Table 1).

The basic model of the logit estimation is as follows:

$$Log_e\left[\frac{\{p(y=1)|x_1...x_p\}}{\{1-p(y=1|x_1...x_p\}}\right] = Log_e\left[\frac{\pi}{1-\pi}\right] = \alpha + \beta_1 x_1 + ... + \beta_p x_{p1} = \alpha + \sum_{j=1}^{p}\beta_j x_j \quad (1)$$

where π is a conditional probability of the form $P(Y = 1|\ X_1 ... X_p)$. The above log odd is known as the logit transformation of π, and the analytical approach described here is also known as logit analysis. The logistic function followed:

$$\langle P(Y=1|X_1...X_p)\rangle = \frac{\exp(\alpha + \sum_{j=1}^{p}\beta_j x_j)}{1+\exp(\alpha + \sum_{j=1}^{p}\beta_j x_j)} \quad (2)$$

Table 1
The definition of explanatory variables.

Categories	Variables
Support for climate change adaptation	Support for the monthly payment (USD 1.88) for climate change adaptation (1: yes, 0: no)
Sociodemographic characteristics	Age of household head (year)
	Gender of a household head (1: male, 0: female)
	Average number of family size (no.)
	Literacy of the household head (1: yes, 0: no)
Asset characteristics	Total farm size (hectare)
	Farm ownership or land tenure (1: yes, 0: no)
	Farm distance from house (kilometres)
Social capital characteristics	Trust in people (1: yes, 0: no)
	Household participation in community (1: yes, 0: no)
	Number of relatives outside the village (no.)
Adaptation characteristics	Perception on climate change risk to farms (1: strongly disagree, 4: strongly agree)
	Existence of household strategy for climate change adaptation (1: yes, 0: no)
Climate change indicators	Average annual rainfall (millimetre)
	Average annual temperature (Celsius)

This could also be transformed into:

$$\langle P(Y=1|X_1...X_p)\rangle = \frac{1}{1+\exp(-\alpha - \sum_{j=1}^{p}\beta_j x_j)} \quad (3)$$

The nonresponse probability is:

$$P = (Y=0|X_1...X_p) = 1 - p(Y=1|X_1...X_p) = \frac{1}{1+\exp(-\alpha - \sum_{j=1}^{p}\beta_j x_j)} \quad (4)$$

where $Y = 1$ (or yes) if the respondents are willing to pay IDR 26,500 (USD 1.88), and $Y = 0$ (or no) if otherwise. Using the set of predictors, the logistic regression equation for the log odds in favour of support for climate change adaptation is estimated as:

$$log\left[\frac{p}{1-p}\right] = b_0 + b_l x_j + \varepsilon_t \quad (5)$$

The above log equation demonstrates a log-odd ratio which is also the logarithm of the odds that a choice to support for climate change will be made by the farmers. The signs of parameter and their statistical significance indicate the direction of the farmers' response (Gujarati, 2009).

3. Results and discussion

The study results indicated that 70% of the respondents (n = 188) were willing to pay a lump sum of money to assist climate change adaptation and the remaining 30% (n = 81) were not willing to do so. The social capital variables were significant in determining their support. Their trust in people, participation in community, and the number of relatives outside their villages had a positive and significant influence on their support (Table 2).

Among the sociodemographic characteristics, the variables of age, family size, and literacy had positive and significant impacts, while gender had no significant impacts. The older the farmers, the more they support climate change adaptation. The larger the family size, the more they are willing to participate. Also, the more literate the farmers, the higher their willingness to participate.

Among the characteristics of farm assets, farm size had slightly positive impacts on farmers' support for climate change adaption. The larger the farm size, the more the farmers are willing to participate. Meanwhile, land ownership and close proximity to home had no significant impacts.

Of the adaptation characteristics, farmers' perception of a climate change risk to their farm and the use of adaptation strategy had a positive and significant impact. If farmers think that climate change poses

Table 2
Results of a logistic regression model.

Variables	Odds ratio	Stand. error
Constant	0.000	6.756
Age	1.070**	0.026
Gender	0.648	0.508
Family size	1.610***	0.174
Literacy	6.958***	0.577
Total farm size	1.000*	0.000
Farm ownership	1.137	0.456
Trust in people	3.972**	0.585
Community participation	2.525**	0.483
No. of relatives outside the village	0.936**	0.031
Perception on climate change risk	1.236**	0.103
Adaptation strategy	6.970**	0.507
Farm distance from house	1.000	0.000
Average annual rainfall	0.995	0.005
Average annual temperature	1.672**	0.198
Nagelkerke R^2	0.633	
Wald	40.969	0.000

Dependent variable: support for climate change adaptation.
* significant at α = 10%.
** significant at α = 5%.
*** significant at α = 1%.

a risk to their farm, they are more willing to participate. The same is true if an adaptation strategy is used in the process.

Among the climate change indicators, only temperature had a significant effect on the farmers' support. The higher the temperature, the more they are willing to support the climate change adaptation. Meanwhile, the average annual rainfall had no significant effect.

From the analysis of individual variables, about 50.7% of respondents considered that climate change was a risk to their agricultural production. About 85% of respondents used ecological inventions to respond to pest attacks by using light traps, planting sesame flowers, planting secondary crops, and/or applying organic fertilizers.

Regarding the focus of this study—the influence of social capital on farmers' willingness to pay to assist climate change adaptation, this study suggests that social capital factors, measured by trust, community engagement, and the number of relatives outside the village, had positive and significant impacts on farmers' support. It implies that farmers who trust others are more receptive to recommendation for using new technologies in response to climate change. These results were in line with a study by Duffy and Wong (2000), stating that trust is needed in order to establish interpersonal relationships and adaptation. Trust is a reflection of personal expectations, assumptions or beliefs about the possibility that one's actions in the future will be beneficial, good, and not damaging his interests. Lewicki and Wiethoff (2000) describe beliefs as willingness to act on the basis of words, actions, and decisions of others. A person's trust is determined by the development of a belief system through their life experience, established rules or norms in the institution or community and the experience of having a relationship.

Farmers' engagement in farmer groups is likely to increase their knowledge on the importance of mitigation to prevent further damage form pest attacks. These results confirm the argument made by Bezabih, Beyene, and Borga (2013) that trust, as a social capital formation in institutions, influences the choice of respondents' adaptation strategies. The results are also in line with the argument by Hidayati and Suryanto (2015), asserting that farmers' participation in a farmer group has a significant influence on the reduction of crop failure caused by drought. Participation in the community could enrich one's knowledge, including the new agricultural technology, planting methods, pest attack handling, and climate change mitigation. Farmer community usually becomes a mediator between farmers in general and relevant government agencies. Various programs and assistance from outside the community are usually delivered through the community.

Farmers who have a greater number of relatives outside the village are more willing to pay for climate change adaptation. This social capital increases the farmers' access to information about the potential impacts of climate change. Encouragement from relatives may have a positive influence on farmers' willingness to adopt new technology, hence the willingness to pay.

The study findings were both consistent and inconsistent with the previous studies that analyse the link between social capital and technology adoption in response to climate change. For instance, Van Rijn et al. (2012) demonstrate a significant correlation between social capital and farmers' innovations on agriculture. However, our findings differ from the view presented by Bouma et al. (2008) which states that social capital has little impacts on household investment in subsidized agriculture activities, such as soil and water conservation. This study is also in opposition to a study by Gebremedhin and Swinton (2003), which found that in Ethiopia, the adoption of soil and stone bund terrace was not determined by social capital.

Regarding wealth, this study showed that well-off farmers, measured from farm land size, were willing to pay a certain amount of money to assist climate change adaptation. This result confirms Jianjun et al. (2015) asserting that farm size and household income determine farmer's decision on climate change adaptation. As regards land ownership, the finding was counterintuitive. Naturally, farmer who own farm land must concern about their property so that they should be more willing to support climate change adaptation. The study results suggested otherwise. Farmers' willingness was not influenced by their land ownership.

This study confirms that social capital could be an alternative approach in environmental management, especially in a country where social capital is an integral part of the community. For instance, Indonesian Climate Change Sectoral Roadmap (ICCSR) utilized social capital successfully to introduce new technologies to farmers.

Success rate of environmental management programs is higher if they are implemented based on the interests of local communities—including their social capital, for example by adhering to the local wisdom. As argued by Agrawal (1996) and Ostrom (1999), local communities create more contextualized and effective rules and are able to enforce these rules successfully owing to the knowledge accumulated from past experiences. Thus, social capital approach is useful in supporting environmental management programs, including climate change adaptation.

4. Conclusion

This study examines the impacts of social capital on farmers' support for climate change adaptation. We surveyed farmers in Yogyakarta, Indonesia, who were facing increased risks to pest attacks that result from climate change. The findings showed that 70% of these farmers were willing pay to assist climate change adaptation. This support was stronger from farmers with better social capital, i.e. higher trust in people, higher participation in community, and having relatives outside their village. These results imply that a social capital approach should be integrated in the strategies to cope with climate change in a country such as Indonesia, where social capital is embedded in its communities. The results also imply that a social capital approach may be applicable in the improvement of national action plan on climate change adaptation (RAN-API) and Indonesian Climate Change Sectoral Roadmap (ICCSR), and in the promotion of new agricultural technologies among farmers. That being said, future research is still needed to confirm the roles of social capital on farmers' support for climate change adaptation in other provinces of Indonesia, as well as other countries because results may vary in different social and cultural contexts.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2019.104189.

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