Is social capital important in coping with climate change? A case of agriculture sector in Gunungkidul, Indonesia

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Abstract. Agricultural producing fields in Yogyakarta, Indonesia, are suffering as a result of climate change. Drought is becoming more often as a result of climate change, making the agricultural sector more vulnerable. Adaptation methods are needed to mitigate a hazard posed by climate change. Farmers' willingness to participate in the climate change adaptation process in Yogyakarta, Indonesia, is investigated in this study, particularly in light of the increasing risk of drought. Contingent valuation method (CVM) was used to determine the farmer's WTP. We investigated the effects of social capital on farmers' willingness to participate using a logistic regression model. This study involved 268 respondents. According to the findings, 68% of farmers are willing to financially contribute to the adaptation process. This involvement was linked to a high degree of social capital which proxied by community engagement. Apart from social capital, this study also uses socio-demographic characteristics, knowledge of climate change, assets, and farming experience. This study adds to the body of knowledge by addressing the possible importance of social capital in the agricultural sector's climate change adaptation process.

1 Introduction

Growing public awareness of global climate change has sparked widespread anxiety about the issue's potential effects and implications. Despite the lack of clear evidence on the precise implications of climate change on regional water resources, many scientists believe that climate change will increase the frequency and intensity of extreme climate events like drought [1]. In addition to the threat of climate change to future water supplies, population increase, urban expansion, and environmental protection laws have put strain on local water supplies in many locations, intensifying competition for already scarce water resources.

Drought can strike everywhere on the planet. In general, it is referred to as a climate-related state that differs from what is considered 'normal.' The particular definition of drought is more a matter of where the water comes from and how it is used, because normal precipitation and water use expectations vary. Drought develops slowly and quietly, lacking highly visible and structural repercussions, unlike other natural catastrophes such as floods, hurricanes, tornadoes, and earthquakes, which occur within finite periods of time and result

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in visually obvious destruction. Drought conditions may go unrecognized until severe precipitation shortages arise, and consequences occur. Droughts are notorious for being difficult to assess because of their slow pace and long duration.

Natural disasters, such as drought, can have both direct and indirect effects. In the literature, direct and indirect impacts are also referred to as primary and secondary (or higher order) effects. The breadth of impacts that may or may not be included in economic impact assessments is dictated by the limitations provided by such definitions. One problem is that there is no clear and consistent categorization of these two sorts of effects. The previous study [2] examined various cost ideas utilized in disaster economics research. Direct costs were confined to land, dwellings, and machinery [3], whereas indirect costs included business interruption and backward and forward multiplier impacts in the economy.

In the agricultural sector, the effects of drought are most visible. Drought manifests itself in the form of dried crops, abandoned farmland, and withered and yellow pastureland. Crops and pastures are harmed by prolonged soil moisture shortages caused by drought. Drought has the most direct economic impact on agriculture, with crop failures and pasture losses being the most common. Drought-induced production losses result in negative supply shocks, but the magnitude and distribution of losses are determined by the market structure and interaction of agricultural supply and demand.

Drought-related losses are not entirely absorbed by farmers; rather, some of the losses are passed on to consumers in the form of higher prices. Consumers will suffer more losses as prices rise. Farmers may even be better off as a result of the drought because prices are rising faster than supply. Furthermore, farmers that purchase crop insurance will have a portion of their losses covered by insurance firms, and other farmers who qualify may receive direct government disaster assistance. Farmers' eventual losses may differ significantly from the drought's real effects. Farmers' revenue losses are frequently conflated with drought's economic effects. As a result, it's critical to assess the entire impact of the drought as well as the losses suffered by various stakeholders.

Drought has complicated economic consequences because it also produces winners. Drought-induced price increases would draw items from other locations into the local market, easing the supply deficit and limiting the price increase. Producers outside of the drought-stricken area profit from lower prices in this instance. When measuring the drought's effects, it's crucial to determine the geographic coverage or accounting position. When drought consequences are assessed at a regional or national level, they may be cancelled out. Impact assessments should not include zero-sum transfers of losses or gains [4]. Drought has a long-term influence on perennial crops and livestock production, which is another key concern. In certain circumstances, the detrimental consequences could last for years. Because of the delayed effects of drought, it is critical to establish a time period for measuring the economic consequences of drought.

Despite the importance of understanding drought economic repercussions, few research have been conducted in a systematic or consistent manner. The media frequently quotes, and decision makers misunderstand the combination of production losses, indemnity payments, and relief costs. Furthermore, many evaluations have been limited to agricultural losses and do not account for the whole range of drought-related effects.

Because of its capacity to influence economic performance [5,6,7], one strategy for mitigating climate change consequences is to increase the functions of social capital in communities [8,9]. Some studies describe social capital as the trust and standards that enable members of a community to act collectively [10,11]. Grootaert and Bastelaer [12] coined the term "cognitive social capital. "Several studies have discovered a link between social capital and natural resource management. For example, believe that social capital can have a beneficial or negative impact on collective action [13]. According to [14], social capital can help people work together to manage natural resources.

In China, social capital is a key component in determining whether forest management efforts to prevent climate change succeed or fail. Forest mismanagement is linked to a lack of social capital [15]. In Greece, social capital is also important in determining people's willingness to pay for improved water quality [16]. However, a study that looked at the effects of social capital on farmer behavior came up empty.

To close this information gap, this study investigates farmers' participation in the climate change adaptation process and the impact of social capital. We conducted a study of farmers in Yogyakarta, Indonesia, villages where drought were likely [17]. We investigated the effects of social capital and sociodemographic characteristics on farmers' willingness to pay for climate change adaptation in the agriculture sector using a logistic regression model. This study adds to the body of knowledge by identifying the significance of social capital in climate change adaptation.

2 Methodology

2.1 Study site

This research was undertaken in Gunungkidul Regency, Yogyakarta Special Region Province, Indonesia, where climate change has had a significant impact on the agriculture industry. The province's food security was threatened by low agricultural productivity [31]. Climate change has made agricultural land in the province more vulnerable to drought, flooding, and pest assaults [17]. The productivity of rice plants in Gunungkidul Regency in 2019 and 2020 mostly decreased [32].

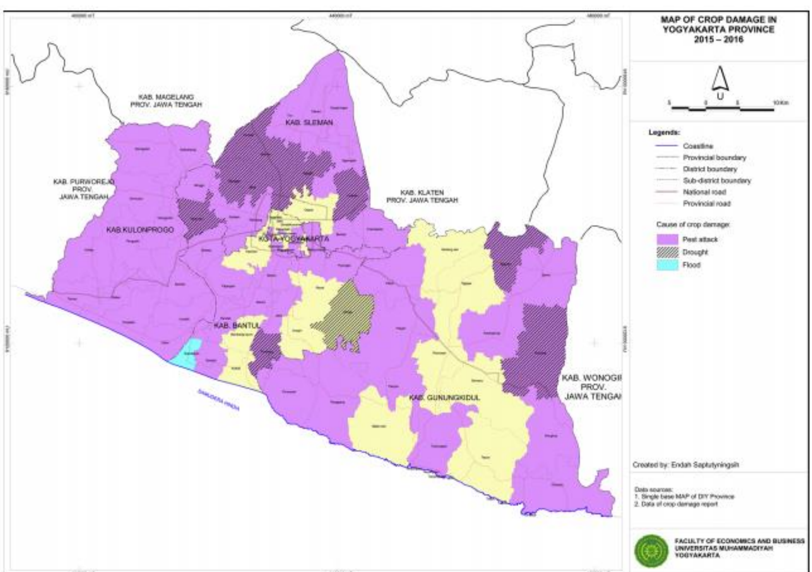

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Fig. 1. Map of drought in agriculture from climate change in Yogyakarta Special Region Province, Indonesia
Source: [32]

Due to the vast number of people in Gunungkidul Regency who work in agriculture using a rain-fed system, the regency is also affected by climate change in the form of drought. Agricultural productivity in rainfed systems is still reliant on rainfall. Sub-districts in Gunungkidul Regency frequently experience variable rainfall intensity.

Table 1. References of Climate Change Adaptation.

Independent Variables	Sign	References
Gender	+	Ibrahim et al. [18], Oktaviani et al. [19]
Age	+	Arshad et al. [20], Saptutyningsih et al., [21] Fonta et al. [22], Plain et al. [23]
Years of schooling	+	Suryanto et al. [24], Plain et al. [23], Ellis, [25] Oktaviani et al.[19]
Income	+	Hakim et al. [26], Arshad et al. [20] Suryanto et al. [24], Oktaviani et al., [19], Fonta et al. [22], Yussif et al. [27], Abugri et al. [28]
Land square	+	Yussif et al. [27], Ellis, [25]
Years as farmer	-	Priyanto et al. [29], Ellis, [25], Yussif et al., [27]
Participation in community	+	Priyanto et al., [29] Hidayati & Suryanto, [30]

Dependent variable: WTP for climate change adaptation

2.2 Survey design and administration

The population of farmer households in the three districts of Semin District, Gedangsari District, and Ngawen District, all located in Gunungkidul Regency, made up the sample for this study. In all, there are 30,034 people living in the three districts. The study's sample size was 268 respondents, according to the Isaac and Michael formula. The purposive sampling was utilized as the sample approach in this investigation. People who reside in drought-prone areas and work as farmers in Gunungkidul Regency, Special Region of Yogyakarta, made up the study's sample. We conducted a survey of farmers in the research area to determine their readiness to participate in the climate change adaptation process, as well as the impact of social capital. Their support was gauged by their willingness (or unwillingness) to contribute to climate change adaptation by paying a set sum of money: an environmental tax referendum. The purpose of this investigation was to find farmers who were committed to climate change adaptation. We held a focus group discussion with 20 well-known people to select the benchmark. We used the contingent valuation method to interview farmers in Gunungkidul Regency to determine their willingness to pay for climate change adaptation [33,34,35,36]. The results of the contingent valuation were used as a proxy for evaluating the possible economic advantages to farmers from supporting climate change adaptation. A payment mechanism for an environmental tax referendum was used to develop the contingent valuation survey. Our poll questioned, "Would you agree or disagree if the Indonesian government-imposed x amount of environmental tax to execute climate change adaptation?" The double bound study began with the lowest offer of IDR 20,000 (USD 1.36), and farmers' willingness to pay for climate change adaptation reached IDR 23,000 (USD 1.55). Needless to say, this estimate did not represent the willingness to pay of the full research population. Rather, from the perspective of well-informed farmers, this result functioned as an indicator of the potential economic worth of climate change adaptation. This figure was then used to determine which farmers could afford to engage in the adaptation and were willing to do so. To do so, we asked participants if they would be willing to pay IDR 23,000 (USD 1.55) per month to help with climate change adaptation.

Previous studies [37,38,39,40,41,16,42] have highlighted the idea of social capital. Community participation is the example of social capital traits. Such characteristics are deeply ingrained in Indonesian culture and societies.

The final survey questionnaire (see Appendix) is divided into four sections. The sociodemographic features of the farmers are mapped out in Section A. (i.e. gender, age, sex). Section B reveals the farmers' assets (i.e. land size, land ownership); Section C reveals the farmers' social capital (i.e. trust, community participation, and the number of relatives outside the village); Section D reveals the farmers' risk perceptions and adaptation strategies; Section E reveals the farm land characteristics (i.e. distance from home to farm); Section F reveals the climate change indicators (e.g. rainfall and temperature); and Section G reveals the farmers' willingness to pay the monthly payment of IDR 23,000 (USD 1.55) for the climate change adaptation.

Table 2. Descriptive statistics of the survey participants (n = 268).

Variables	Mean	Std.
Willingness to pay for climate change adaptation (IDR)	0.68	0.47
Gender of household head (1: male; 0: female)	0.56	0.49
Age of household head (year)	49.95	11.54
Years of schooling of the household head (years)	8.37	2.69
Income of household head per month (IDR)	870,503.73	524,685.05
Land square (m^2)	6,903.73	3,751.71
Years as farmers (years)	19.71	11.62
Household participation in community (1: yes, 0: no)	0.69	0.46

Note: Std: Standard deviation; IDR: Indonesian rupiah

The final survey questionnaire consisted of third sections. The first section of the questionnaire mapped out the socio-demographic characteristics of the farmers, such as gender, age, years of schooling, income, and knowledge about climate change. The second section identified the farmers' assets proxied by land square and years as farmer. The third section asked the social capital characteristics including community participation. Characteristics of social capital include households' participation in community.

2.3 Data Analysis

To determine the relationship between social capital and farmers' willingness to take part in climate change adaptation, we used a logistic regression [43]. The farmer's willingness is the dependent variable in the model, where 1 denotes agreement and 0 denotes disagreement. The sociodemographic, asset, social capital, adaptability, and geographical characteristics, as well as the indicators of climate change, are the independent variables of the model (Table 1).

The following describes the logit estimation's fundamental model:

$$Log_e=\left[\frac{\{p(y=1)|x_1\ldots x_p\}}{\{1\text{-}p(y=1|x_1\ldots x_p\}}\right]=Log_e\left[\frac{\pi}{1\text{-}\pi}\right]=\alpha+\beta_1x_1+\ldots+\beta_px_{p1} \quad (1)$$

$$=\alpha+\sum_{j=1}^{p}\beta_jx_j$$

where is a conditional probability of the form P(Y = 1| X1... Xp).

The analytical process described here is also known as logit analysis. The above log odd is also known as the logit transformation of. Following was the logistic function:

$$\langle P\left(Y=1|X_1\ldots X_p\right)\rangle=\frac{exp\left(\alpha+\sum_{j=1}^{p}\beta_jx_j\right)}{1+exp\left(\alpha+\sum_{j=1}^{p}\beta_jx_j\right)} \quad (2)$$

Table 3. The definitions of explanatory variables.

Categories	Variables
Willingness to pay for climate change adaptation	Support for monthly payment for climate change adaptation (1 : yes ; 0 :no)
Sociodemographic characteristics	Gender of household head (1: male; 0: female)
	Age of household head (year)
	Years of schooling of the household head (years)
	Income of household head per month (IDR)
	Knowledge about climate change (1: have knowledge; 0: otherwise)
Asset characteristic	Land square (m^2)
	Years as farmers (years)
Social capital characteristic	Household participation in community (1: yes, 0: no)

This may also be changed into:

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

The non-response probability is:

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

where Y = 1 (or yes) if the respondents are willing to pay IDR 23,000 (USD 1.55), and Y = 0 (or no) otherwise. The logistic regression equation for the log odds in favor of support for climate change adaptation is calculated using the set of predictors as follows:

$$log\left[\frac{p}{1-p}\right]=b_0+b_i x_j+\varepsilon_t \tag{5}$$

The logarithm of the odds that farmers will decide to support climate change is shown in the aforementioned log equation, which also shows a log-odd ratio. The parameter's indications and statistical significance show the direction of the farmers' response [44].

3 Results and discussion

As research participants, 268 farmers took part in a study on farmers' willingness to pay to reduce climate change. A total of 89–90 respondents were collected from each of the three research sub-districts in Gunungkidul Regency. 150 men, or 56% of the participants in this study, were men. In contrast, 118 farmers, or 44%, were women. There were 28 respondents (or 10%) in the 25–35 age group. 77 respondents, or 29%, were between the ages of 36 and 45. A total of 84 responders, or 31%, were in the 45–55 age range. 50 respondents, or 19%, were between the ages of 56 and 65, while 29 respondents, or 11%, were between the ages of 66 and 75. There were 5 respondents, or 2%, who did not attend school, according to the most recent education level collected from 268 respondents. With a total of 111 respondents, or 42%, respondents are primarily concentrated at the primary education level. There are up to 84 respondents who have completed junior high school, and there are 68 respondents who have completed high school, which has a participation rate of 25%.

Based on the total amount of land they own, 39%, or 105 respondents, have a land area that is less than 5,000 m^2. 134 responders make up 50% of the 6,000–10,000 m^2 of the land area. There are 24 respondents who have an amount of agricultural land between 11,000 and 15,000 m^2, making up 9% of the total, and 5 respondents, or 2% of the total, who have an area of agricultural land over 16,000 m2. In this survey, respondents' annual incomes ranged from IDR 600,000 to IDR 1,000,000, with IDR 2,000,000 and beyond producing the least amount of income. With 120 respondents, the percentage of those who have worked as farmers for less than 15 years is 45%. With a total of 109 respondents, 41% of them had farming experience ranging from 16 to 30 years. Finally, there are 28 respondents with a percentage of 10% who have agricultural experience, with the age range of that experience being between 31 and 45 years. Of them, 11 respondents have a percentage of 4% and have farming experience exceeding 46 years.

There were 268 responses total, including both those who took part in farmer groups and those who did not. A total of 186 responders, or 69% of the total, joined the farmer groups. Meanwhile, 82 respondents, or 31%, did not participate in farmer groups. This lack of participation was impacted by a number of reasons, including respondents' age, their level of busyness or other employment outside of farming, and farmer groups' lack of activity. The study results showed that 68 percent (*n*=182) of the respondents were willing to pay a lump sum of money for climate change adaptation and the remaining 32 percent (n=86) were not willing to do so. The social capital variables played a key role in their willingness to support the government tax designed to support climate change adaptation. Their support was positively and significantly influenced by their participation in the community (Table 2). Age, Income, years of schooling, and knowledge about climate change were sociodemographic indicators that had favorable and significant effects, whereas gender had no such effects. Farmers support adaptation to climate change more as they age. Their willingness to participate increases with the higher income. Additionally, farmers are more inclined to join if they are longer years of schooling. These support the findings of earlier studies [45,46,47,48,49]. This study contradicts the assertion made [50] that age has no appreciable impact on WTP and actually has a negative impact [51,52] on WTP.

Table 4. Regression results.

Variables	Odd ratio (S.E)	Odd ratio (S.E)
Sociodemographic		
Gender	14.435** (1.127)	7.410 (1.506)
Age	1.548*** (0.153)	1.924** (0.254)
Income per month	1.000*** (0.000)	1.000* (0.000)
Years of schooling	2.769** (0.434)	6.708** (0.789)
Knowledge about climate change	26.147** (1.444)	127.420** (2.232)
Assets		
Land squares	1.002*** (0.000)	1.002*** (0.001)
Years as farmer	.634*** (0.171)	0.537** (0.256)
Social capital		
Participate to community		167.232** (2.615)
Constant	0.000 (9.875)	0.000*** (18.780)
Nagelkerke R Square	0.954	0.967

Note: ***significant at $\alpha = 1\%$; **significant at $\alpha = 5\%$; *significant at $\alpha = 10\%$
Dependent variable: willingness to pay for climate change adaptation

Farm size was one of the aspects of farm assets that somewhat influenced how supportive farmers were of climate change adaptation. Farmers are more likely to participate the bigger the farm is. The encouragement for adaptability is stronger for farmers with more experience. The number of years a farmer has been a farmer also has a big impact on their willingness to pay for climate change adaptation. This result confirms the findings of a prior study [53] that farm size and household wealth influence a farmer's assessment of the risk of climate change.

This study reveals that social capital, as assessed by community engagement, has a positive and significant impact on farmers' support with regard to the study's main focus—the influence of social capital on farmers' willingness to pay to support climate change adaptation. Farmers' participation in farmer organizations is likely to improve their understanding of the significance of mitigation to stop further drought damage. These findings support the claim [30] that farmer participation in a farmer organization significantly reduces crop loss brought on by drought. One's understanding of modern agricultural technology, planting techniques, dealing with droughts, and reducing the effects of climate change may be enriched by community involvement. Between farmers in general and the appropriate government agencies, the farmer community frequently acts as a mediator. Typically, the community serves as a conduit for a variety of outside services and help.

4 Conclusion

The effects of social capital on farmers' support for climate change adaptation are investigated in this study. We conducted a survey of farmers in Yogyakarta, Indonesia, who were more likely to experience droughts as a result of climate change. According to the results, 68% of these farmers were willing to pay for assistance with climate change adaptation. Farmers who had more social capital, or who participated more in the community, were more likely to offer this support. These findings suggest that in a nation like Indonesia, where social capital is deeply ingrained in its communities, solutions to address climate change should incorporate a social capital strategy. The findings also suggest that a social capital strategy may be useful for enhancing the Indonesian Climate Change Sectoral Roadmap (ICCSR) and the National Action Plan on Climate Change Adaptation (RAN-API), as well as for promoting innovative agricultural technologies among farmers. However, because results may differ in various social and cultural situations, additional study is still required to confirm the effects of social capital on farmers' support for climate change adaptation in other regions of Indonesia and other nations.

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