Crop insurance as farmers adaptation for climate change risk on agriculture in Surakarta residency-Indonesia

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Abstract: This paper aims to examine variables that influence willingness to adaptation, besides to estimate production loss due to climate change. Specific goals can be split into three parts: the first step was to do mapping by geographic information systems (GIS). The second step was to assess economic losses by using production loss tools. Finally, the last step was identify the factors that affect farmers' decisions to adapt the climate changes risk. The research method used was a quantitative method by surveying areas classified as vulnerable to crop failure. There were 380 householders involved in this research. The approach used was the contingent valuation method (CVM). The results indicated that 128,154 hectares of agricultural land were vulnerable to natural disasters; whereas 41,704 hectares were vulnerable to drought. The estimated loss in these areas was more than 207 billion IDR, derived from the vulnerable agricultural land area to flooding or drought, and then multiplied by the potential loss of production. One policy to overcome injuries included crop insurance. However, the results revealed that 93% of respondents were not willing to pay premium of crop insurance. The willingness to pay for premium rate was less than 50,000 IDR per harvest period. It implies that the implementation of crop insurance in Indonesia still requires government subsidies.

Keywords: climate change; adaptation; crop insurance; willingness to pay; WTP; vulnerability; risk management; flood; drought; farmer.

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1 Introduction

1.1 Background

The world has induced the phenomenon of global warming since 1950 (Treut et al., 2007). Global warming is characterised by an increase in carbon dioxide caused by accelerating economic activity in recent years. Unsustainable economic growth strategies that conduct most of the countries tend to ignore environmental problems. Based on study of Chouaïbi and Abdessalem (2011) reported that high consumption of electricity energy has affected positively to economic growth in Tunisia. The impact of high economic growth has adverse risks, such as climate change.

The risk of climate change will not only affect national food security but also farmers' welfare. Based on the research conducted by Gravitiani and Suryanto (2017), climate changes have caused 41,704 hectares field in Surakarta to be vulnerable to drought and 62,365 hectares field in Surakarta to be susceptible to flood. The potency of farmers' loss was 207 billion IDR for each planting period when harvest failure.

Ownership of land by farmers in Java are not broad significantly; most of them only have less than 500 m (BPS, 2019). Besides the physical characteristic, their level of education is still low actually and they do not have extensive knowledge consequently. Therefore, they do not have broad market access and the ability to avoid the adverse risks of climate change. Based on this condition, the risk reduction associated with farmers capability is still needed assistance and improvement.

The strategies undertaken by farmers in Indonesia include diversifying crops, such as rice and corn. The other plans are selling products periodically, making loans to the informal sector, or even selling assets that they already have, such as livestock of sale products (Wollenberg et al., 2016; Alam et al., 2017). According to Gravitiani and Suryanto (2017), the reduction in the risk of climate changes in Surakarta Residency was mostly made through shifting assets owned by farmers. Nearly 50% of recognise of farmers that they had to sell their assets to cover losses. Another interesting fact was that 94% of farmers refused to join in to participate in crop insurance. According to respondents, they did not understand crop insurance schemes, and even they did not know that the government provided subsidies for them to pay premiums.

Crop insurance is a type of disaster risk management by transferring risk to other parties. Strategy with portfolio management is still constrained by several factors such as limitation of understanding and knowledge about disaster risk management and climate change. The program to provide the crop insurance scheme is realised by partnering with insurance company. The Ministry of Agriculture conducted a pre-implementation test for crop insurance in October 2012 with an area of 1000 hectares in each area. The success of this program depends on the accurate market analysis, which consists of the report on the demand side (farmers) and the supply side (insurance company).

Based on the preliminary explanation, this research tried to analysis of how much IDR that farmers want and willing to pay premiums. This analysis is useful as basis for calculating how much subsidy is needed by the government. To increase farmers participation in insurance, an analysis of factors influencing willingness to pay (WTP) for adaptation is also needed. Based on this analysis it can be determined what kind of policies that needed by the government to increase awareness of farmers awareness and guaranty for sustainability of insurance programs.

1.2 Specific objectives

This research aimed to map vulnerable areas to flood and drought in Surakarta Residency. Based on the map, it will evaluate the impact of disaster such as flood also drought on agriculture land. After valuation has been finished, we tried to analyse the variables that determine farmers' choice to make an adaptation. The last objective was to determine the factors that affect to adaptation.

1.3 Urgency of research

Although it has been realised that climate change harms the agricultural sector, risk reduction efforts have not been optimal. Farmers are the most vulnerable because of climate change, so this research focuses on how farmers can reduce the risk.

Crop insurance is a form of adaptation that has been developed in several countries, such as Thailand, China, and Australia. Crop insurance is useful to promote community empowerment because this scheme involves participation of farmers. Thus the role of government will be reduced or even disappear in the long run. Farmers are also will be able to reduce the risk of decline in production and incomes, as well as to secure capital for the next planting season.

2 Literature review

The leading cause of climate change is increasing in the earth's average temperature on earth. It indicates by increasing in the amount of greenhouse gas (GHG) emissions in the atmosphere. Extreme events that can be encountered, for example, an area that is experiencing heating, but other regions experiencing significant cooling. Due to the irregularity of this climate phenomenon, the climate can be colder and hotter than usual. In addition, it can also create chaotic weather phenomena, including erratic rainfall, dramatic changes in wind direction, etc. (Ochieng et al., 2016).

Research on how to cope with changes made by Kang et al. (2017) and Alhassan and Hadwen (2017), both of Kang et al. (2017), Alhassan and Hadwen (2017) state that adaptation strategies develop adaptation strategies for climate change in infrastructure and other resources. Adaptation strategies through the following actions:

- create inventory and eliminate potential risks in land and air resources
- adjust and improve facilities and infrastructure focusing on changes in hydrological and air resource potential management
- enhance marketing systems and production management systems mainly cropping patterns, types and varieties of plants, and soil treatment systems.

Crop insurance products are generally categorised as micro-insurance schemes, which are called to serve small-scale farmers. Farmers with limited land are more vulnerable when they experience crop failure due to climate change. When crop failure, they are more susceptible to disease, accidents, disability, loss of property. Farmers are also vulnerable to unemployment due to limited skills outside the agricultural sector. Furthermore, poverty and vulnerability to risk can cause poor people to drown in worse conditions (Fosu-Mensah et al., 2012).

Peasant communities are considered unable to pay the premiums required in premiums of crop insurance. Fosu-Mensah et al. (2012) also stated that self-insurance is used to copy risks such as selling cattle or goats, jewellery, crop reserves, or doing other work outside the main job in developing countries. At least two research conducted by Ali and Erenstein (2017) and Abugri et al. (2017) showed a similar trend.

2.1 Agricultural insurance (crop insurance)

The agricultural insurance program in Indonesia is still in the initial stages of implementation. This program began in 2015 by Regulation of the Minister of Agriculture No. 40/Permentan/SR.230/7/2015 and it was operated in limited regions. Investigation about agricultural insurance, especially in Indonesia, has not been done much as in countries such as Japan and Thailand. The provision of subsidised insurance premiums in Indonesia is also still under evaluation to determine the optimal level.

As the agriculture sector in a developing country, in Indonesia, it is still traditionally carried out, and farmers' ability to avoid risk is still low. This statement is supported by Altieri and Nicholls (2017), Roco et al. (2015) and Reidsma et al. (2010).

2.2 Previous researches

Sumaryanto and Nurmanaf (2007) have stated that the government's role in the development of agricultural insurance is crucial. The development of crop insurance as influencing inflow requires commitments, policies, programs, reliable and consistent political support (Zaytsev, 2016). The principal pillars of agricultural insurance design include essential elements, primary structure, and necessary requirements. Meanwhile, Wang et al. (2015) stated that the role of the government is recommended to increase the number of agricultural insurance premiums. Part of government is needed because the people's interest in participating in insurance is still low.

The linkages between climate change and food production is very strength. Wheeler and Von Braun (2013) researched the relations of climate changes and crop productivity. Furthermore, Ruminta (2016) explained the negative trend quantity of production of farmers in Bandung regency. Their research indicated the development of adaptation and mitigation for climate changes and agricultural adaptation program have to be prepared until 2050. The results indicated that the changes in air temperature have a more significant potential of a negative impact than the differences in precipitation in affecting the surplus (deficit) of the Indonesian food supply.

Investigation of the probability between agricultural and non-agricultural households to adapt was done by Hazarika and Yasmin (2018). Likelihood or tendency of variables was used as predictive variables such as household variables, main domestic work, access to agricultural income, formal education, years of farming experience, distance to the nearest financial institution, total, total consumption expenditure, and full land ownership. The results of this research were significant financial problems for those who have access to non-agricultural income. Barkah and Raharja (2018) stated from supply side, product of crop insurance should have standardising of pricing and quality of services.

The researches related to the adaptation for natural disaster insurance have been conducted by Kousky et al. (2018) in USA; Quandt and Kimathi (2015, 2016) in Kenya and Wang et al. (2015) in China. Quanth and Kimathi (2015) focused on how the population could adapt because of climate changes and the importance of local knowledge. This research examined which was the most vulnerable whether the three livelihood options are keeping camels, business, or modern agriculture. The results showed that the three types could be maintained for many reasons. Keeping camels were taken because more resistant during the dry season. Business and modern agriculture were not too dependent on the weather, and they can improve food security and income. Local wisdom of the community must continue to be maintained because it makes the community stronger.

The variables used to estimate the WTP amount are carried out by Fahad and Jing (2018). Multiple linear regression models were used to the testing of construction validity and reliability of WTP estimates. These variables are severity, types of plants planted, income levels, education levels, length of farming, and levels of public awareness about climate changes. Previous researches used similar variables that used by Fahad and Jing (2018), they have been done by Suryanto et al. (2012) and Arshad et al. (2016).

3 Research method

3.1 Data

The spatial data is needed to figure out the areas that categorised as vulnerable to floods or droughts caused by extreme weather. The information is included: Regional map of Surakarta Residency with 1:25 000 scale based on RBI; geological map sheet of Surakarta Residency with 1:100,000 scale; data of high point areas in Surakarta Residency; information of roads; information of rivers; information of land use; flood inundation data for Surakarta Residency; river discharge data; data of rainfall in Surakarta Residency; and data of soil infiltration in Surakarta Residency.

This research utilise secondary data generated from various source such as Central Bureau of Statistics (BPS); The Bureau of Meteorology and Geophysics (BMKG); National Board of Planning (Bappenas), Public Work, Ministry of Agriculture, Local Government in Surakarta Regency, and other relevant institutions.

3.2 Sampling method

All farmer household of farmers (HH) who lived in vulnerable area due to climate change in Surakarta Residency are become population. Heads of household were chosen as the unit of analysis because they assumed to be the decision-maker in the family. The number of samples used was decided by following the tables compiled by Krejcie and Morgan (1970) in Sekaran (1992). Based on Krijcie and Morgan table, there were 380 respondents.

3.3 Analysis tools

This research employs several methods such as Economic Valuation using contingent valuation method (CVM) approach.

3.3.1 Geographic information systems

Geographic information system (GIS) method was chosen because in this research it did not try to explain temporal influences and did not require 3D images. GIS in this research was only needed to simulate areas that have a level of vulnerability based on influencing factors. Meanwhile, CVM is a stated preference approach to asking for willingness to pay for goods/services that have no market price (Abugri et al., 2017; Suryanto et al., 2017; Fahad and Jing, 2018).

3.3.2 Valuation of loss in production

Climate changes impact such as flood will affect to farmers negatively. The number of losses caused by natural disasters can be detected from the switch (decrease) in productivity. Previous study proved that flood and drought may cause total crop failure for farmers as they did in the Southern Kulonprogo, a regency in Yogyakarta Province (Saptutyningsih and Suryanto, 2011) and also in Ghana (Abugri et al., 2017).

The potential of losses that caused by climate change impact can be predicted using the following model:

$$LP = f(A \times K) \quad (1)$$

LP: agricultural harvest of potential loss due to climate change

A: land area that is potentially affected by flooding or drought

K: estimation of the expected loss per hectare.

After economic valuation of potential loss that suffered by farmers, the next step is to analyse the factors that affect to avoid the negative risk due to climate change. CVM is an approach to determine the WTP to reduce losses due to flood and drought. CVM is a method to estimate value; especially for respondents to provide the number they want to pay with certain obstacles.

According to discussing of previous research and theory, we tried to analyse to WTP's variables together with other variables. The independent variables include perceptions of disaster risk, income levels of respondents, education levels attained, types of disaster, and county of residence (dummy variables).

Model of WTP equation has been adapted from Arshad (2016). WTP could be predicted by some independents variables as follows:

$$WTP_i = a_0 \sum_{k=1}^{11} \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \beta_5 x_{i5} + e \quad (2)$$

Variables

WTP	=	The amount of IDR that the respondent received to pay the crop insurance premium that can be claimed when the crop fails due to flooding and drought
X_1 = Percept	=	Respondent's perception according to potential risk due to climate change (flood or drought).
X_2 = Education	=	Respondent's level of formal education that have been reached.
X_3 = Income	=	Respondent's total income that earned per month including by the earning member of households.
X_4 = Region	=	Dummy variables to distinguish the region vulnerable to drought and floods.
X_5 = Types	=	Dummy variables to distinguish the types of droughts and floods

4 Analysis and discussion

4.1 Descriptive analysis and GIS

Based on data Department of Public Works (2010), the total area of Bengawan Solo watershed is ±19,778 km^2; it can be divided into four subwatershed (Sub-DAS). The parts of subwatershed: the first part is Bengawan Solo watershed with a total area of ±16,100 km^2 and the second is Grindulu Lorog rivers and watershed in Pacitan with a total area respectively ±1517 km^2. The third is small basin in the north coast ±1441 km^2 approximately; The fourth is the smallest subwatershed, it namely, Kali Lamong catchment area, with a total area of ±720 km^2.

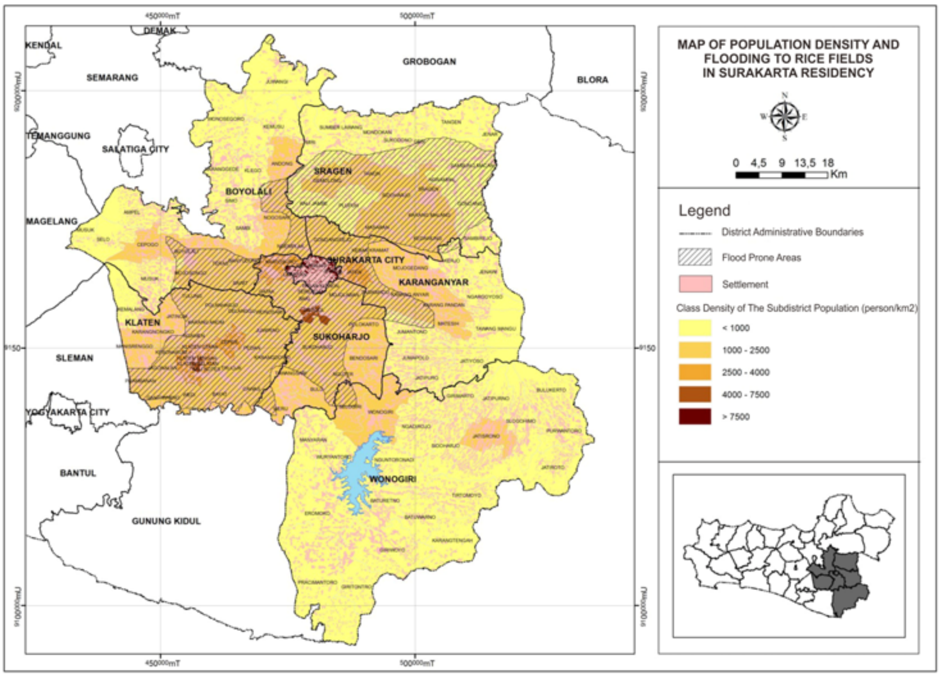
The Bengawan Solo watershed includes upstream region (Wonogiri, Karanganyar, Sukoharjo, Sragen) and the downstream area around Bojonegoro, Ngawi, and Madiun. The city of Bengawan Solo upstream area and Madiun river covers ±6072 km^2 and

3755 km^2 respectively. The upstream of Bengawan Solo and Madiun River from Merapi volcano (±2914 masl), Merbabu mountain (±3142 masl), and Lawu mountain (±3265 masl), while the downstream that covered by Bengawan Solo is ±6273 km^2. Administratively, the watershed of Bengawan Solo covers 17 regencies including Boyolali, Klaten, Sukoharjo, Wonogiri, Karanganyar, Sragen, Blora, Rembang, Ponorogo, Madiun, Magetan, Ngawi, Bojonegoro, Tuban, Lamongan, Gresik, and Pacitan, and three municipalities including Surakarta, Madiun, and Surabaya.

Bengawan Solo watershed is located in a tropical area dry season. It around May to October periodically while rainy season since November – April. The average of humidity is 80%, and the average temperature is 26.7°C monthly. The other characteristics are the monthly average of sunshine approximately 6.3 h, and the monthly average of wind speed is 1.2 m/s (Department of Public Works, 2010).

Based on GIS results in Figure 1, Boyolali and Karanganyar regency are known to have a lower level of risk than other areas in Surakarta Residency. In general, Wonogiri regency has a low-risk level, but some districts are vulnerable to drought and flood. Anticipation can be performed by people who live in the areas exposed to disasters by making adaptation or mitigation.

Figure 1 The map of vulnerable area and population density in Surakarta (see online version for colours)



Source: GIS estimation result

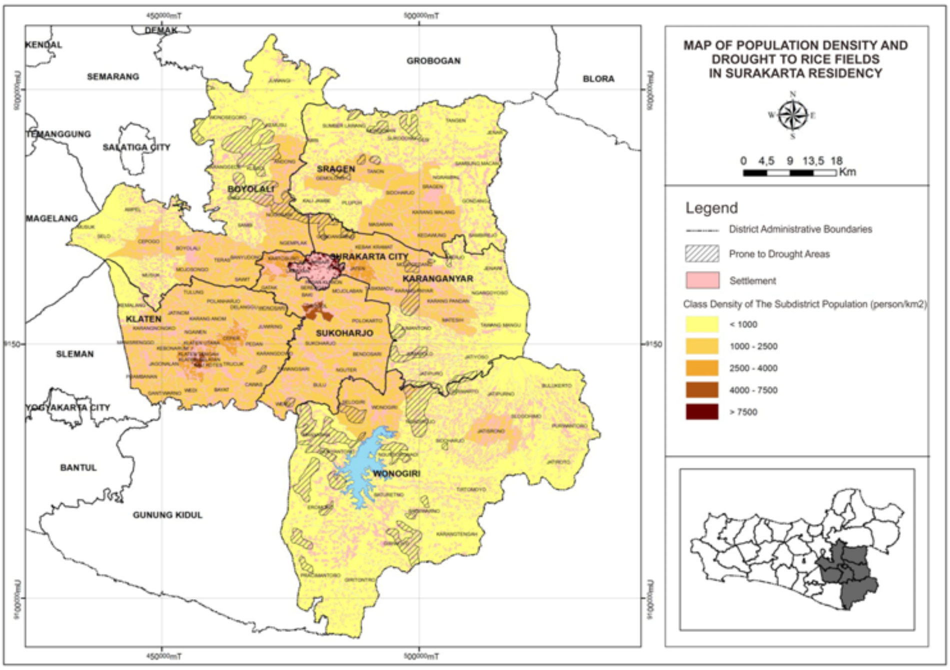
Based on Figure 1, although all regencies in the city of Surakarta have the potential to experience the risk of inundation during heavy rain, the riskiest located in Pasar Kliwon District. Most areas in Sukoharjo, Klaten, and Sragen Regency also have the potential to have flood-prone regions, mainly due to high rainfall and overflows from the Bengawan

Solo River. Sukoharjo and Sragen regencies are vulnerable to flooding because Bengawan Solo passes through these areas.

The vulnerable areas in Surakarta municipality mostly are residential and not paddy fields, area, different from Sukoharjo, Klaten, and Sragen mostly are paddy fields. Analyse of GIS result determine the area vulnerable to flood whether located in paddy fields or resettlement.

The areas with drought risk in Surakarta are presented in Figure 2. Result of GIS was showed that the regions with drought risk, although not as wide as the areas with flood risk, spread in almost all Surakarta areas. Most of the areas with drought risk are rice fields located in Wonogiri Regency, Karanganyar Regency, and Boyolali Regency. Wonogiri is a regency that has the widest area when affected by drought. Meanwhile, Klaten and Sukoharjo are two regency areas without drought risk.

Figure 2 The map vulnerable area for drought and the population in Surakarta Residency (see online version for colours)



Source: GIS estimation result

Crop insurance was offered to farmers as a scheme to decrease their risks due to climate change. When farmers experienced losses in their harvest caused by climate change, then they could claim the insurance company. The questionnaires were distributed to respondents to understand their willingness to pay a crop insurance premium. The analysis result can be seen in Table 1.

Based on Table 1, as almost the farmers in developing countries, willingness to pay premiums is still low. Majority of the respondents (93.29%) are not willing to purchase the premium of crop insurance and only 6.71% answer yes. Further analysis, in Table 2 shows of options their willingness to reduce the risk of climate change. Their possibilities are represented through: utilising informal credits, save and sell harvest gradually, private saving from non-farming income. Following are the types of mitigation performed by respondents to reduce the risk of the natural disaster.

Table 1 Identification respondent's willingness to pay crop insurance premium

Category	*Willingness*	*Number of respondents*	*Percentage (%)*
I	No	348	93.29
II	Yes	25	6.71
	Total	373	100

Source: Primary data processing

Table 2 Types of adaptation to coping flood and drought in Surakarta residency

No.	*Adaptation option*	*Number of respondents*	*Percentage (%)*
1	Store harvest it in a warehouse and then sell it when needed	57	15.28
2	A reserve of personal funds from the allowance	153	41.01
3	Through informal credit scheme	101	27.07
4	Sell owned cattle	58	15.54
	Total	373	100

Source: Primary data processing

4.2 Economic valuation of losses caused by flood and drought

Based on data from the Village Potential Statistics (Podes) in 2008, it can be seen that the area of land for rice fields is almost the same for housing and yard designation. According to Podes 2008, the total farming area of Surakarta Residency is 526,700 hectares consisting of 169,857 hectares of rice fields or 32.02% of the entire area. Meanwhile, space for housing and yards is 34% and 32% of the total area, respectively.

Potential losses suffered by farmers can be estimated or calculated through the level of disaster risk on agricultural land due to flooding or drought. The level of risk can be measured based on the level of probability and the magnitude of the impact.

Table 3 shows the vulnerable area of rice fields to flood and drought based on GIS estimation. According to Table 3 informs that 36.71% of Surakarta having vulnerable areas to flood is paddy fields, whereas, the areas that have drought vulnerable is 24.54% of the total rice field area. Therefore, the width of the drought vulnerable area is not as extensive as flood vulnerable areas.

The potential loss by farmers in Surakarta Residency is predicted by the amount of squares of areas that are a vulnerable to flood and drought. Calculation the potency of loss is $Qx = f(A \times Pt)$, this formula is modified into $LP = f(A \times L)$, in which LP Potency of Loss, A = the squares of the area, L = the loss per hectare. It was assumed if a farmer's suffer harvest failure per hectare. If the area that vulnerable to flood is 62,364 hectares and vulnerable areas to drought are 41,703 hectares, then the loss can be computed as Table 4.

Table 3 Agricultural land of flooding and drought risk area in Surakarta residency

Potential risk of flood or drought	*Square(ha)*	*Percentage*
Potential risk area to drought	41,703	24.54
Non-potential risk area to drought	128,153	75.45
Potential area to flood	62,364	36.71
Non-potential area to flood	107,492	63.29
Total of agricultural land	169,857	100

Source: Estimation by GIS

Table 4 Potential loss caused by flooding and drought in Surakarta residency

Potential risk of flooding/drought	*Squares (ha)*	*Loss (million IDR)*
Potential risk of drought	41,703	83,407
Potential risk of flooding	62,364	124,728
Total		208,137

Source: Processed data

Table 4 indicates that the potential loss experienced by farmers is 208,137 million IDR or about 208 billion IDR per failed harvest. Calculation in Table 4 is based on the assumption that farmers' loss per acre is 2 million IDR.

4.3 WTP of adaptation efforts

Some variables in this model consist of three categories, they are physical, socioeconomic, and farmer's perception. They have been estimated to prove what variables affect WTP adaptation. Physical variables used in this research is squares of paddy fields, then socioeconomic variables are represented by education level and income level. Variables that including into individual perception was used risk perception due to climate change.

Table 5 indicates that respondents' willingness to make adaptation were affected by levels of income, levels of education, types of disaster, and the respondents' residency. Squares of area (ownership of land) and respondent of risk perception did not affect respondents' willingness to perform adaptation expenditures.

The income level has a positive effect on the WTP, meaning that when the respondent's income increases, the WTP will also increase (Wong and Zeng, 2015). The level of education turned out to have a positive influence to increase WTP. The results of this study are following several previous studies, such as Song et al. (2012), Suryanto and Kuncoro (2012) and Rulleau et al. (2015).

The diversity in respondents' location has a significant influence on the willingness to adapt. The respondents living in Sragen Regency slightly have different WTP for adaptation from the respondents living in Karanganyar and Sukoharjo. The difference in the WTP for adaptation is due to the differences in the frequency of flood and drought, occurrence, see also Fan and Davlasheridze (2016).

Two variables that do not affect WTP are ownership of land and perception of risk. In the study area, the area factor does not have a positive impact on crop insurance because some farmers only work as farmers, so it is not a decision-maker. Variable of risk perception does not influence considerably to the WTP; it probably can be explained that crop insurance is a new product. As a new product, insurance crop still needs a further introduction and market awareness (Hendrawan and Nugroho, 2018).

Table 5 Variables that influence WTP of adaptations efforts

		Equation	
		Model 1	*Model 3*
Variable	*Definition of variables*	*Full Model*	*Best Model*
PERCEPTION	Respondent risk perception to climate change	0.001	–
		(0.507)	
L_Large	Squares of paddy fields area	–0.000	–
		(–1068)	
LINCOME	Income level per month	1.058	1.058**
		(1207)	(21.177)
PDDK	Highest education level	0.010	0.003**
		(1.691)	
Disaster2	Dummy for drought	0.001	–
		(0.271)	
Region2	Dummy for Region 2	0.004	0.006*
		(0.692)	(1202)
Region3	Dummy for Region 3	0.010	0.125**
		(1.482)	(2.505)
Region4	Dummy for Region 4	–0.006	–
		(–0.563)	
Constant		–1813	–1783
R^2		0.613	0.612
Adjusted R^2		0.603	0.607
F statistic		63.618	115.475
Classical assumption test	Heterocedasticity	Hetero	–
	Multicolinearity	–	–

[*significant at level α = 5% or 0.05, **significant at level α=10% or 0.1, (...) = t statistic value].

Source: Primary data estimation result

Levels of education have a significant and positively affect to WTP for adaptation effort. Impact of increasing level of respondent's education will increase the willingness to do adaptation. When the respondents have higher education level, they probably will have wider experience and insights, including in receiving new information on mitigation. Impact of the education level to WTP also be reported by in China (Song et al., 2012; Fan and Davlasheridze, 2016).

This research showed that types of disasters failed to be distinguished amount of WTP significantly for farmers who experience flood and drought. They assumed that flood and drought have the same effect on WTP for adaptation. Previous research by Weichselgartner and Pigeon (2015) and Pandey et al. (2018) found that variables of individual knowledge toward disaster risk more significant than different type of disaster risk.

5 Conclusions and implications

5.1 Conclusion

After discussing both of the variables that affect to WTP significantly or not, this research can be concluded that:

The areas that are considered vulnerable to flood are Surakarta, Sukoharjo, and Sragen. Municipality of Surakarta mainly covered by a residential area, therefore the potential loss in the agricultural sector is not significant, different with the area vulnerable to flood in Sragen Regency and Sukoharjo Regency. Meanwhile, the area in regencies that included into vulnerable to drought mostly are located in Wonogiri, Boyolali, and Sragen.

The potential loss experienced by farmers when there a risk of flooding and drought struck is 207,137,000,000 IDR (207 billion IDR). The areas vulnerable to flood and drought, based on SIG calculation, were 62,365 hectares (flood) and 41,704 hectares (drought).

WTP of farmers to do adaptation are the levels of income, levels of education, types of disaster, and the disaster area. The adaptation options was performed through, among others: saving grains in the barn and sell them gradually, using informal credit (neighbour or money lenders), and farming diversified such as cattle. It is recommended to consider the investigation result that most respondents' are not willing to buy premium crop insurance (approximately 95%). The amount of money they were willing to prepare to do adaptation of potential loss was very low at less than 50 million IDR.

5.2 Implication

The areas identified as vulnerable to flood and drought should perform anticipation to reduce the risk of potential loss. The expectations that can be taken are measuring structural and non-structural actions. The structural measures to cope with flood such as the revitalisation and development of dam for Bengawan Solo, while the non-structural measures can be performed through improving the dissemination of disaster awareness. The community can be involved in the mitigation measures integrated into a coordinated mitigation measure by the government, such as disaster insurance.

The potential loss of 208 billion IDR is significant. Most of the farmers with low-income experience negative effect from climate changes. If the damage cannot be anticipated, then farmers may experience a decline in their assets. Climate changes have the potential to decrease the level of farmers' welfare.

Awareness of farmers to do adaptation such as crop insurance is still meager. The farmers are still need improve their understanding for negative impact on climate change. In short term, government policy to support the subsidy for crop insurance are good decisions. Perhaps after three until five years crop insurance has been conducted, the evaluation for this program is needed. The next research is investigation on potential of moral hazard from respondents according the subsidy program on crop insurance.

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Crop insurance as farmers adaptation for climate change risk on agriculture in Surakarta residency Indonesia

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Crop insurance as farmers adaptation for climate change risk on agriculture in Surakarta residency-Indonesia

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Abstract: This paper aims to examine variables that influence willingness to adaptation, besides to estimate production loss due to climate change. Specific goals can be split into three parts: the first step was to do mapping by geographic information systems (GIS). The second step was to assess economic losses by using production loss tools. Finally, the last step was identify the factors that affect farmers' decisions to adapt the climate changes risk. The research method used was a quantitative method by surveying areas classified as vulnerable to crop failure. There were 380 householders involved in this research. The approach used was the contingent valuation method (CVM). The results indicated that 128,154 hectares of agricultural land were vulnerable to natural disasters; whereas 41,704 hectares were vulnerable to drought. The estimated loss in these areas was more than 207 billion IDR, derived from the vulnerable agricultural land area to flooding or drought, and then multiplied by the potential loss of production. One policy to overcome injuries included crop insurance. However, the results revealed that 93% of respondents were not willing to pay premium of crop insurance. The willingness to pay for premium rate was less than 50,000 IDR per harvest period. It implies that the implementation of crop insurance in Indonesia still requires government subsidies.

Keywords: climate change; adaptation; crop insurance; willingness to pay; WTP; vulnerability; risk management; flood; drought; farmer.

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1 Introduction

1.1 Background

The world has induced the phenomenon of global warming since 1950 (Treut et al., 2007). Global warming is characterised by an increase in carbon dioxide caused by accelerating economic activity in recent years. Unsustainable economic growth strategies that conduct most of the countries tend to ignore environmental problems. Based on study of Chouaïbi and Abdessalem (2011) reported that high consumption of electricity energy has affected positively to economic growth in Tunisia. The impact of high economic growth has adverse risks, such as climate change.

The risk of climate change will not only affect national food security but also farmers' welfare. Based on the research conducted by Gravitiani and Suryanto (2017), climate changes have caused 41,704 hectares field in Surakarta to be vulnerable to drought and 62,365 hectares field in Surakarta to be susceptible to flood. The potency of farmers' loss was 207 billion IDR for each planting period when harvest failure.

Ownership of land by farmers in Java are not broad significantly; most of them only have less than 500 m (BPS, 2019). Besides the physical characteristic, their level of education is still low actually and they do not have extensive knowledge consequently. Therefore, they do not have broad market access and the ability to avoid the adverse risks of climate change. Based on this condition, the risk reduction associated with farmers capability is still needed assistance and improvement.

The strategies undertaken by farmers in Indonesia include diversifying crops, such as rice and corn. The other plans are selling products periodically, making loans to the informal sector, or even selling assets that they already have, such as livestock of sale products (Wollenberg et al., 2016; Alam et al., 2017). According to Gravitiani and Suryanto (2017), the reduction in the risk of climate changes in Surakarta Residency was mostly made through shifting assets owned by farmers. Nearly 50% of recognise of farmers that they had to sell their assets to cover losses. Another interesting fact was that 94% of farmers refused to join in to participate in crop insurance. According to respondents, they did not understand crop insurance schemes, and even they did not know that the government provided subsidies for them to pay premiums.

Crop insurance is a type of disaster risk management by transferring risk to other parties. Strategy with portfolio management is still constrained by several factors such as limitation of understanding and knowledge about disaster risk management and climate change. The program to provide the crop insurance scheme is realised by partnering with insurance company. The Ministry of Agriculture conducted a pre-implementation test for crop insurance in October 2012 with an area of 1000 hectares in each area. The success of this program depends on the accurate market analysis, which consists of the report on the demand side (farmers) and the supply side (insurance company).

Based on the preliminary explanation, this research tried to analysis of how much IDR that farmers want and willing to pay premiums. This analysis is useful as basis for calculating how much subsidy is needed by the government. To increase farmers participation in insurance, an analysis of factors influencing willingness to pay (WTP) for adaptation is also needed. Based on this analysis it can be determined what kind of policies that needed by the government to increase awareness of farmers awareness and guaranty for sustainability of insurance programs.

1.2 Specific objectives

This research aimed to map vulnerable areas to flood and drought in Surakarta Residency. Based on the map, it will evaluate the impact of disaster such as flood also drought on agriculture land. After valuation has been finished, we tried to analyse the variables that determine farmers' choice to make an adaptation. The last objective was to determine the factors that affect to adaptation.

1.3 Urgency of research

Although it has been realised that climate change harms the agricultural sector, risk reduction efforts have not been optimal. Farmers are the most vulnerable because of climate change, so this research focuses on how farmers can reduce the risk.

Crop insurance is a form of adaptation that has been developed in several countries, such as Thailand, China, and Australia. Crop insurance is useful to promote community empowerment because this scheme involves participation of farmers. Thus the role of government will be reduced or even disappear in the long run. Farmers are also will be able to reduce the risk of decline in production and incomes, as well as to secure capital for the next planting season.

2 Literature review

The leading cause of climate change is increasing in the earth's average temperature on earth. It indicates by increasing in the amount of greenhouse gas (GHG) emissions in the atmosphere. Extreme events that can be encountered, for example, an area that is experiencing heating, but other regions experiencing significant cooling. Due to the irregularity of this climate phenomenon, the climate can be colder and hotter than usual. In addition, it can also create chaotic weather phenomena, including erratic rainfall, dramatic changes in wind direction, etc. (Ochieng et al., 2016).

Research on how to cope with changes made by Kang et al. (2017) and Alhassan and Hadwen (2017), both of Kang et al. (2017), Alhassan and Hadwen (2017) state that adaptation strategies develop adaptation strategies for climate change in infrastructure and other resources. Adaptation strategies through the following actions:

- create inventory and eliminate potential risks in land and air resources
- adjust and improve facilities and infrastructure focusing on changes in hydrological and air resource potential management
- enhance marketing systems and production management systems mainly cropping patterns, types and varieties of plants, and soil treatment systems.

Crop insurance products are generally categorised as micro-insurance schemes, which are called to serve small-scale farmers. Farmers with limited land are more vulnerable when they experience crop failure due to climate change. When crop failure, they are more susceptible to disease, accidents, disability, loss of property. Farmers are also vulnerable to unemployment due to limited skills outside the agricultural sector. Furthermore, poverty and vulnerability to risk can cause poor people to drown in worse conditions (Fosu-Mensah et al., 2012).

Peasant communities are considered unable to pay the premiums required in premiums of crop insurance. Fosu-Mensah et al. (2012) also stated that self-insurance is used to copy risks such as selling cattle or goats, jewellery, crop reserves, or doing other work outside the main job in developing countries. At least two research conducted by Ali and Erenstein (2017) and Abugri et al. (2017) showed a similar trend.

2.1 *Agricultural insurance (crop insurance)*

The agricultural insurance program in Indonesia is still in the initial stages of implementation. This program began in 2015 by Regulation of the Minister of Agriculture No. 40/Permentan/SR.230/7/2015 and it was operated in limited regions. Investigation about agricultural insurance, especially in Indonesia, has not been done much as in countries such as Japan and Thailand. The provision of subsidised insurance premiums in Indonesia is also still under evaluation to determine the optimal level.

As the agriculture sector in a developing country, in Indonesia, it is still traditionally carried out, and farmers' ability to avoid risk is still low. This statement is supported by Altieri and Nicholls (2017), Roco et al. (2015) and Reidsma et al. (2010).

2.2 Previous researches

Sumaryanto and Nurmanaf (2007) have stated that the government's role in the development of agricultural insurance is crucial. The development of crop insurance as influencing inflow requires commitments, policies, programs, reliable and consistent political support (Zaytsev, 2016). The principal pillars of agricultural insurance design include essential elements, primary structure, and necessary requirements. Meanwhile, Wang et al. (2015) stated that the role of the government is recommended to increase the number of agricultural insurance premiums. Part of government is needed because the people's interest in participating in insurance is still low.

The linkages between climate change and food production is very strength. Wheeler and Von Braun (2013) researched the relations of climate changes and crop productivity. Furthermore, Ruminta (2016) explained the negative trend quantity of production of farmers in Bandung regency. Their research indicated the development of adaptation and mitigation for climate changes and agricultural adaptation program have to be prepared until 2050. The results indicated that the changes in air temperature have a more significant potential of a negative impact than the differences in precipitation in affecting the surplus (deficit) of the Indonesian food supply.

Investigation of the probability between agricultural and non-agricultural households to adapt was done by Hazarika and Yasmin (2018). Likelihood or tendency of variables was used as predictive variables such as household variables, main domestic work, access to agricultural income, formal education, years of farming experience, distance to the nearest financial institution, total, total consumption expenditure, and full land ownership. The results of this research were significant financial problems for those who have access to non-agricultural income. Barkah and Raharja (2018) stated from supply side, product of crop insurance should have standardising of pricing and quality of services.

The researches related to the adaptation for natural disaster insurance have been conducted by Kousky et al. (2018) in USA; Quandt and Kimathi (2015, 2016) in Kenya and Wang et al. (2015) in China. Quanth and Kimathi (2015) focused on how the population could adapt because of climate changes and the importance of local knowledge. This research examined which was the most vulnerable whether the three livelihood options are keeping camels, business, or modern agriculture. The results showed that the three types could be maintained for many reasons. Keeping camels were taken because more resistant during the dry season. Business and modern agriculture were not too dependent on the weather, and they can improve food security and income. Local wisdom of the community must continue to be maintained because it makes the community stronger.

The variables used to estimate the WTP amount are carried out by Fahad and Jing (2018). Multiple linear regression models were used to the testing of construction validity and reliability of WTP estimates. These variables are severity, types of plants planted, income levels, education levels, length of farming, and levels of public awareness about climate changes. Previous researches used similar variables that used by Fahad and Jing (2018), they have been done by Suryanto et al. (2012) and Arshad et al. (2016).

3 Research method

3.1 Data

The spatial data is needed to figure out the areas that categorised as vulnerable to floods or droughts caused by extreme weather. The information is included: Regional map of Surakarta Residency with 1:25 000 scale based on RBI; geological map sheet of Surakarta Residency with 1:100,000 scale; data of high point areas in Surakarta Residency; information of roads; information of rivers; information of land use; flood inundation data for Surakarta Residency; river discharge data; data of rainfall in Surakarta Residency; and data of soil infiltration in Surakarta Residency.

This research utilise secondary data generated from various source such as Central Bureau of Statistics (BPS); The Bureau of Meteorology and Geophysics (BMKG); National Board of Planning (Bappenas), Public Work, Ministry of Agriculture, Local Government in Surakarta Regency, and other relevant institutions.

3.2 Sampling method

All farmer household of farmers (HH) who lived in vulnerable area due to climate change in Surakarta Residency are become population. Heads of household were chosen as the unit of analysis because they assumed to be the decision-maker in the family. The number of samples used was decided by following the tables compiled by Krejcie and Morgan (1970) in Sekaran (1992). Based on Krijcie and Morgan table, there were 380 respondents.

3.3 Analysis tools

This research employs several methods such as Economic Valuation using contingent valuation method (CVM) approach.

3.3.1 Geographic information systems

Geographic information system (GIS) method was chosen because in this research it did not try to explain temporal influences and did not require 3D images. GIS in this research was only needed to simulate areas that have a level of vulnerability based on influencing factors. Meanwhile, CVM is a stated preference approach to asking for willingness to pay for goods/services that have no market price (Abugri et al., 2017; Suryanto et al., 2017; Fahad and Jing, 2018).

3.3.2 Valuation of loss in production

Climate changes impact such as flood will affect to farmers negatively. The number of losses caused by natural disasters can be detected from the switch (decrease) in productivity. Previous study proved that flood and drought may cause total crop failure for farmers as they did in the Southern Kulonprogo, a regency in Yogyakarta Province (Saptutyningsih and Suryanto, 2011) and also in Ghana (Abugri et al., 2017).

The potential of losses that caused by climate change impact can be predicted using the following model:

$$LP = f(A \times K) \quad (1)$$

LP: agricultural harvest of potential loss due to climate change

A: land area that is potentially affected by flooding or drought

K: estimation of the expected loss per hectare.

After economic valuation of potential loss that suffered by farmers, the next step is to analyse the factors that affect to avoid the negative risk due to climate change. CVM is an approach to determine the WTP to reduce losses due to flood and drought. CVM is a method to estimate value; especially for respondents to provide the number they want to pay with certain obstacles.

According to discussing of previous research and theory, we tried to analyse to WTP's variables together with other variables. The independent variables include perceptions of disaster risk, income levels of respondents, education levels attained, types of disaster, and county of residence (dummy variables).

Model of WTP equation has been adapted from Arshad (2016). WTP could be predicted by some independents variables as follows:

$$WTP_i = a_0 \sum_{k=1}^{11} \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \beta_5 x_{i5} + e \quad (2)$$

Variables

WTP	=	The amount of IDR that the respondent received to pay the crop insurance premium that can be claimed when the crop fails due to flooding and drought
X_1 = Percept	=	Respondent's perception according to potential risk due to climate change (flood or drought).
X_2 = Education	=	Respondent's level of formal education that have been reached.
X_3 = Income	=	Respondent's total income that earned per month including by the earning member of households.
X_4 = Region	=	Dummy variables to distinguish the region vulnerable to drought and floods.
X_5 = Types	=	Dummy variables to distinguish the types of droughts and floods

4 Analysis and discussion

4.1 Descriptive analysis and GIS

Based on data Department of Public Works (2010), the total area of Bengawan Solo watershed is ±19,778 km^2; it can be divided into four subwatershed (Sub-DAS). The parts of subwatershed: the first part is Bengawan Solo watershed with a total area of ±16,100 km^2 and the second is Grindulu Lorog rivers and watershed in Pacitan with a total area respectively ±1517 km^2. The third is small basin in the north coast ±1441 km^2 approximately; The fourth is the smallest subwatershed, it namely, Kali Lamong catchment area, with a total area of ±720 km^2.

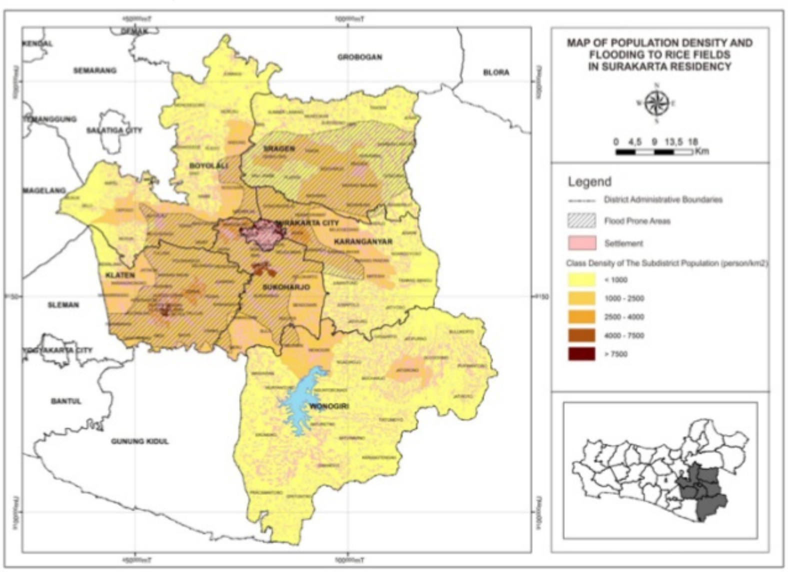
The Bengawan Solo watershed includes upstream region (Wonogiri, Karanganyar, Sukoharjo, Sragen) and the downstream area around Bojonegoro, Ngawi, and Madiun. The city of Bengawan Solo upstream area and Madiun river covers ±6072 km^2 and

3755 km^2 respectively. The upstream of Bengawan Solo and Madiun River from Merapi volcano (±2914 masl), Merbabu mountain (±3142 masl), and Lawu mountain (±3265 masl), while the downstream that covered by Bengawan Solo is ±6273 km^2. Administratively, the watershed of Bengawan Solo covers 17 regencies including Boyolali, Klaten, Sukoharjo, Wonogiri, Karanganyar, Sragen, Blora, Rembang, Ponorogo, Madiun, Magetan, Ngawi, Bojonegoro, Tuban, Lamongan, Gresik, and Pacitan, and three municipalities including Surakarta, Madiun, and Surabaya.

Bengawan Solo watershed is located in a tropical area dry season. It around May to October periodically while rainy season since November – April. The average of humidity is 80%, and the average temperature is 26.7°C monthly. The other characteristics are the monthly average of sunshine approximately 6.3 h, and the monthly average of wind speed is 1.2 m/s (Department of Public Works, 2010).

Based on GIS results in Figure 1, Boyolali and Karanganyar regency are known to have a lower level of risk than other areas in Surakarta Residency. In general, Wonogiri regency has a low-risk level, but some districts are vulnerable to drought and flood. Anticipation can be performed by people who live in the areas exposed to disasters by making adaptation or mitigation.

Figure 1 The map of vulnerable area and population density in Surakarta (see online version for colours)



Source: GIS estimation result

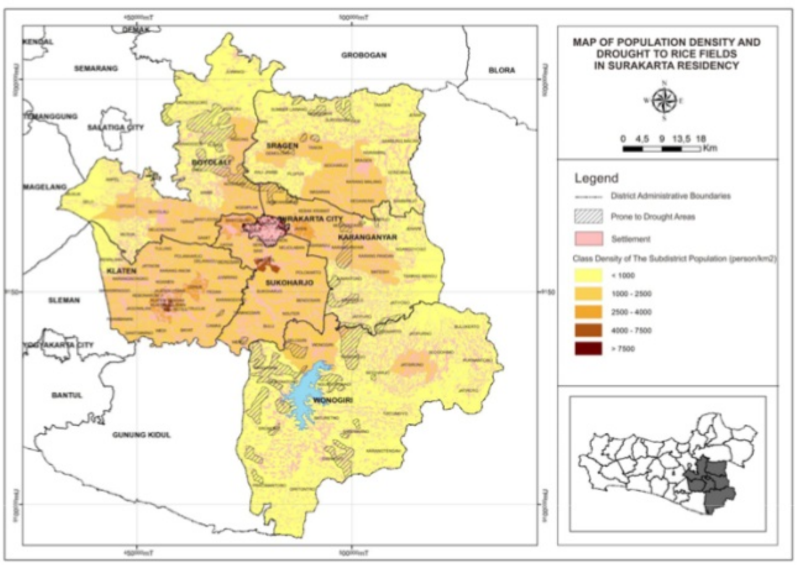
Based on Figure 1, although all regencies in the city of Surakarta have the potential to experience the risk of inundation during heavy rain, the riskiest located in Pasar Kliwon District. Most areas in Sukoharjo, Klaten, and Sragen Regency also have the potential to have flood-prone regions, mainly due to high rainfall and overflows from the Bengawan

Solo River. Sukoharjo and Sragen regencies are vulnerable to flooding because Bengawan Solo passes through these areas.

The vulnerable areas in Surakarta municipality mostly are residential and not paddy fields, area, different from Sukoharjo, Klaten, and Sragen mostly are paddy fields. Analyse of GIS result determine the area vulnerable to flood whether located in paddy fields or resettlement.

The areas with drought risk in Surakarta are presented in Figure 2. Result of GIS was showed that the regions with drought risk, although not as wide as the areas with flood risk, spread in almost all Surakarta areas. Most of the areas with drought risk are rice fields located in Wonogiri Regency, Karanganyar Regency, and Boyolali Regency. Wonogiri is a regency that has the widest area when affected by drought. Meanwhile, Klaten and Sukoharjo are two regency areas without drought risk.

Figure 2 The map vulnerable area for drought and the population in Surakarta Residency (see online version for colours)



Source: GIS estimation result

Crop insurance was offered to farmers as a scheme to decrease their risks due to climate change. When farmers experienced losses in their harvest caused by climate change, then they could claim the insurance company. The questionnaires were distributed to respondents to understand their willingness to pay a crop insurance premium. The analysis result can be seen in Table 1.

Based on Table 1, as almost the farmers in developing countries, willingness to pay premiums is still low. Majority of the respondents (93.29%) are not willing to purchase the premium of crop insurance and only 6.71% answer yes. Further analysis, in Table 2 shows of options their willingness to reduce the risk of climate change. Their possibilities are represented through: utilising informal credits, save and sell harvest gradually, private saving from non-farming income. Following are the types of mitigation performed by respondents to reduce the risk of the natural disaster.

Table 1 Identification respondent's willingness to pay crop insurance premium

Category	*Willingness*	*Number of respondents*	*Percentage (%)*
I	No	348	93.29
II	Yes	25	6.71
	Total	373	100

Source: Primary data processing

Table 2 Types of adaptation to coping flood and drought in Surakarta residency

No.	*Adaptation option*	*Number of respondents*	*Percentage (%)*
1	Store harvest it in a warehouse and then sell it when needed	57	15.28
2	A reserve of personal funds from the allowance	153	41.01
3	Through informal credit scheme	101	27.07
4	Sell owned cattle	58	15.54
	Total	373	100

Source: Primary data processing

4.2 Economic valuation of losses caused by flood and drought

Based on data from the Village Potential Statistics (Podes) in 2008, it can be seen that the area of land for rice fields is almost the same for housing and yard designation. According to Podes 2008, the total farming area of Surakarta Residency is 526,700 hectares consisting of 169,857 hectares of rice fields or 32.02% of the entire area. Meanwhile, space for housing and yards is 34% and 32% of the total area, respectively.

Potential losses suffered by farmers can be estimated or calculated through the level of disaster risk on agricultural land due to flooding or drought. The level of risk can be measured based on the level of probability and the magnitude of the impact.

Table 3 shows the vulnerable area of rice fields to flood and drought based on GIS estimation. According to Table 3 informs that 36.71% of Surakarta having vulnerable areas to flood is paddy fields, whereas, the areas that have drought vulnerable is 24.54% of the total rice field area. Therefore, the width of the drought vulnerable area is not as extensive as flood vulnerable areas.

The potential loss by farmers in Surakarta Residency is predicted by the amount of squares of areas that are a vulnerable to flood and drought. Calculation the potency of loss is $Qx = f(A \times Pt)$, this formula is modified into $LP = f(A \times L)$, in which LP Potency of Loss, A = the squares of the area, L = the loss per hectare. It was assumed if a farmer's suffer harvest failure per hectare. If the area that vulnerable to flood is 62,364 hectares and vulnerable areas to drought are 41,703 hectares, then the loss can be computed as Table 4.

Table 3 Agricultural land of flooding and drought risk area in Surakarta residency

Potential risk of flood or drought	*Square(ha)*	*Percentage*
Potential risk area to drought	41,703	24.54
Non-potential risk area to drought	128,153	75.45
Potential area to flood	62,364	36.71
Non-potential area to flood	107,492	63.29
Total of agricultural land	169,857	100

Source: Estimation by GIS

Table 4 Potential loss caused by flooding and drought in Surakarta residency

Potential risk of flooding/drought	*Squares (ha)*	*Loss (million IDR)*
Potential risk of drought	41,703	83,407
Potential risk of flooding	62,364	124,728
Total		208,137

Source: Processed data

Table 4 indicates that the potential loss experienced by farmers is 208,137 million IDR or about 208 billion IDR per failed harvest. Calculation in Table 4 is based on the assumption that farmers' loss per acre is 2 million IDR.

4.3 *WTP of adaptation efforts*

Some variables in this model consist of three categories, they are physical, socioeconomic, and farmer's perception. They have been estimated to prove what variables affect WTP adaptation. Physical variables used in this research is squares of paddy fields, then socioeconomic variables are represented by education level and income level. Variables that including into individual perception was used risk perception due to climate change.

Table 5 indicates that respondents' willingness to make adaptation were affected by levels of income, levels of education, types of disaster, and the respondents' residency. Squares of area (ownership of land) and respondent of risk perception did not affect respondents' willingness to perform adaptation expenditures.

The income level has a positive effect on the WTP, meaning that when the respondent's income increases, the WTP will also increase (Wong and Zeng, 2015). The level of education turned out to have a positive influence to increase WTP. The results of this study are following several previous studies, such as Song et al. (2012), Suryanto and Kuncoro (2012) and Rulleau et al. (2015).

The diversity in respondents' location has a significant influence on the willingness to adapt. The respondents living in Sragen Regency slightly have different WTP for adaptation from the respondents living in Karanganyar and Sukoharjo. The difference in the WTP for adaptation is due to the differences in the frequency of flood and drought, occurrence, see also Fan and Davlasheridze (2016).

Two variables that do not affect WTP are ownership of land and perception of risk. In the study area, the area factor does not have a positive impact on crop insurance because some farmers only work as farmers, so it is not a decision-maker. Variable of risk perception does not influence considerably to the WTP; it probably can be explained that crop insurance is a new product. As a new product, insurance crop still needs a further introduction and market awareness (Hendrawan and Nugroho, 2018).

Table 5 Variables that influence WTP of adaptations efforts

		Equation	
		Model 1	*Model 3*
Variable	*Definition of variables*	*Full Model*	*Best Model*
PERCEPTION	Respondent risk perception to climate change	0.001	–
		(0.507)	
L_Large	Squares of paddy fields area	–0.000	–
		(–1068)	
LINCOME	Income level per month	1.058	1.058**
		(1207)	(21.177)
PDDK	Highest education level	0.010	0.003**
		(1.691)	
Disaster2	Dummy for drought	0.001	–
		(0.271)	
Region2	Dummy for Region 2	0.004	0.006*
		(0.692)	(1202)
Region3	Dummy for Region 3	0.010	0.125**
		(1.482)	(2.505)
Region4	Dummy for Region 4	–0.006	–
		(–0.563)	
Constant		–1813	–1783
R^2		0.613	0.612
Adjusted R^2		0.603	0.607
F statistic		63.618	115.475
Classical assumption test	Heterocedasticity	Hetero	–
	Multicolinearity	–	–

[*significant at level $\alpha = 5\%$ or 0.05, **significant at level $\alpha=10\%$ or 0.1, (...) = *t* statistic value].

Source: Primary data estimation result

Levels of education have a significant and positively affect to WTP for adaptation effort. Impact of increasing level of respondent's education will increase the willingness to do adaptation. When the respondents have higher education level, they probably will have wider experience and insights, including in receiving new information on mitigation. Impact of the education level to WTP also be reported by in China (Song et al., 2012; Fan and Davlasheridze, 2016).

This research showed that types of disasters failed to be distinguished amount of WTP significantly for farmers who experience flood and drought. They assumed that flood and drought have the same effect on WTP for adaptation. Previous research by Weichselgartner and Pigeon (2015) and Pandey et al. (2018) found that variables of individual knowledge toward disaster risk more significant than different type of disaster risk.

5 Conclusions and implications

5.1 Conclusion

After discussing both of the variables that affect to WTP significantly or not, this research can be concluded that:

The areas that are considered vulnerable to flood are Surakarta, Sukoharjo, and Sragen. Municipality of Surakarta mainly covered by a residential area, therefore the potential loss in the agricultural sector is not significant, different with the area vulnerable to flood in Sragen Regency and Sukoharjo Regency. Meanwhile, the area in regencies that included into vulnerable to drought mostly are located in Wonogiri, Boyolali, and Sragen.

The potential loss experienced by farmers when there a risk of flooding and drought struck is 207,137,000,000 IDR (207 billion IDR). The areas vulnerable to flood and drought, based on SIG calculation, were 62,365 hectares (flood) and 41,704 hectares (drought).

WTP of farmers to do adaptation are the levels of income, levels of education, types of disaster, and the disaster area. The adaptation options was performed through, among others: saving grains in the barn and sell them gradually, using informal credit (neighbour or money lenders), and farming diversified such as cattle. It is recommended to consider the investigation result that most respondents' are not willing to buy premium crop insurance (approximately 95%). The amount of money they were willing to prepare to do adaptation of potential loss was very low at less than 50 million IDR.

5.2 Implication

The areas identified as vulnerable to flood and drought should perform anticipation to reduce the risk of potential loss. The expectations that can be taken are measuring structural and non-structural actions. The structural measures to cope with flood such as the revitalisation and development of dam for Bengawan Solo, while the non-structural measures can be performed through improving the dissemination of disaster awareness. The community can be involved in the mitigation measures integrated into a coordinated mitigation measure by the government, such as disaster insurance.

The potential loss of 208 billion IDR is significant. Most of the farmers with low-income experience negative effect from climate changes. If the damage cannot be anticipated, then farmers may experience a decline in their assets. Climate changes have the potential to decrease the level of farmers' welfare.

Awareness of farmers to do adaptation such as crop insurance is still meager. The farmers are still need improve their understanding for negative impact on climate change. In short term, government policy to support the subsidy for crop insurance are good decisions. Perhaps after three until five years crop insurance has been conducted, the evaluation for this program is needed. The next research is investigation on potential of moral hazard from respondents according the subsidy program on crop insurance.

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a.	Kelengkapan unsur isi artikel (10%)	4			4
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c.	Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	12			11
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	Total = (100%)	**40**			**38**
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a. Kelengkapan dan kesesuaian unsur isi artikel :

Artikel disusun dengan guideline sesuai yang ditetapkan oleh jurnal dimulai dengan introduction, literature review, method, result and discussion and conclusion. Judul sesuai dengan isi dan substansi

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Artikel cukup bagus dan masih jarang ditulis sehingga menjadi keterbaruan tentang asurasi di sector pertanian. Jumlah referensi yang disitasi sebanyak 34 artikel menjadi tambahan wacana sehingga artikel ini semakin kaya. Implikasi yang ditawarkan juga cukup bagus dan sesuai dengan pokok bahasan

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Bidang ilmu ekonomi lingkungan dan ekonomi pertanian sangat cocok dengan ekonomi pembangunan

Surakarta, ...10 JUN 2020......

Reviewer ½ **

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Pangkat,Gol Ruang	: Pembina Tk.I /IV/b
Unit Kerja	: Fakukltas Ekonomi dan Bisnis
Bidang Ilmu	: Ekonomi Pembangunan

*Dinilai oleh dua Reviewer secara terpisah

**Coret yang tidak perlu

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