Questionnaire Survey on Farming Adaptation for Climate Variability in Serang Municipality, Indonesia

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Abstract: Dependence on agro-climate condition, rice field farming system in Serang Municipality is one of sector that vulnerable to climate variability. Analysis on local climatic data series, which are temperature, precipitation and number of rain days, shows the tendency of temperature increase and the shift in rainfall pattern. Based on questionnaire survey result, the majority of paddy farmers already aware of the changes in climate and experienced the impact in their farming system. Statistical analysis indicates some attributes of farmers that significantly related to adaptation measures are land ownership, type of rice field, and distance with water resources, meanwhile the internal factors (characteristics, knowledge and perception) only have small influence on adaptation measures. Both of structural and non-structural adaptation approaches can be used as adaptation strategies to overcome the impact of climate variability.

Key Words : *climate variability, adaptation measures, questionnaire survey, paddy farmers*

1. INTRODUCTION

Awareness of climate change issues has increased along with the breadth of studies on the impact of the climate change and the global warming in various sectors. In addition to environmental field, other sectors that are directly related to human activities, such as economic, social, and governance, also facing barriers and obstacles with the climate change issues. One of the systems likely to be affected by the climatic condition is agriculture.

The climate change affects agricultural production due to the presence of extreme weather, temperature changes, rainfall fluctuation and seasonal patterns shift. The changes and anomalies in climate can also be troublesome to predict the schedule of planting and harvesting, as well as the water availability for irrigation. Cropping pattern systems in Serang municipality still highly depends on agro-climate condition, especially for paddy farming systems which became the main food crops and agricultural commodities featured for the majority of farmers in the district.

Adiningsih studied the climate variability effect on rice productivity in West Java and East Java using remote sensing data[1)], and it was found that the 1997's El Nino has decreased rice productivity both in West Java and East Java province. Statistic Central Bureau of Serang Municipality recorded a sharp decline in rice production in 2014 compared to 2013, which is from 101,159 ton to 78,441 ton. This most likely caused by the floods that struck 139 ha of rice fields in Kasemen sub-district in 2014, as data obtained from Banten Provincial Crop Protection Agency.

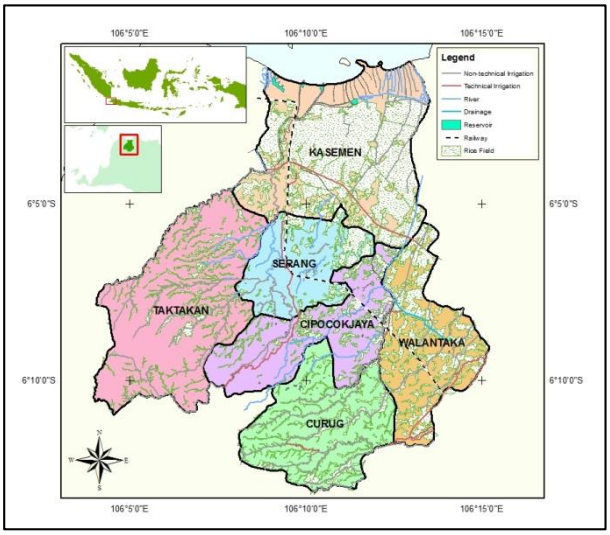

Figure 1: Study Area

Adaptive responses to the climate variability in farming practices are an important factor to coup the negative impacts from changes in climatic condition. Therefore, how farmers perceive and respond to the climate change is a key to plan and determine the appropriate adaptation strategies in agricultural practices.

2. RESEARCH OBJECTIVE

The main goal of this research is to formulate

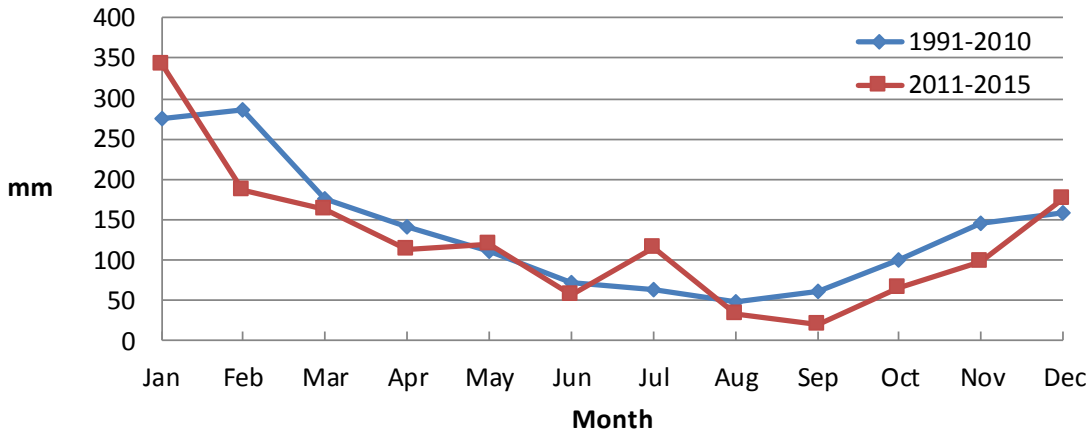

Figure 2 Average monthly rainfall Graphs' for baseline period and present period

appropriate adaptation methods to climate variability for paddy farming system in Serang municipality. The objectives of this study are as follows;

1) To determine the current climatic condition in Serang Municipality.
2) To identify farmers' perception on the climate variability impact in study area.
3) To identify adaptation measure taken by farmers on paddy farming system to adjust with the climate variation impact.
4) To formulate adaptation strategies of the climate variability impact for paddy farming system in Serang municipality.

3. RESEARCH METHODOLOGY

3.1 Research Study Area

The study area is Serang Municipality, Banten Province. There are six sub districts in the study area, namely Curug sub district, Walantaka sub district, Cipocok Jaya sub district, Serang sub district, Taktakan sub district and Kasemen sub district. Map of the study area can be seen in Figure 1.

3.2 Data Collection

Primary data and secondary data were obtained from a questionnaire survey, field observations and interviews. The questionnaire survey was conducted to rice farmers who are a member of farmers groups in each sub-district, while the interview is done to relevant stakeholders, such as chief of agencies, local agriculture office staff, agriculture supervisor, and the head of the farmer group. The secondary data was obtained from relevant government institutions, especially in the form of documents, reports, and statistical data.

3.3 Data Analysis Method

This study is designed by using an explanatory design with a two-phase mixed method[2]. The first phase is done by collecting and analyzing quantitative data, followed by qualitative data. The qualitative data is used to provide additional explanations of the findings from quantitative data analysis.

a) Climate Data Analysis

Climatic data consists of temperature data, precipitation and the number of rain days over a period of 25 years. The data were analyzed statistically.

b) Questionnaire Survey Analysis

Data from the questionnaire were analyzed using quantitative approach and followed by descriptive analysis to explain the result. The quantitative approach uses a series of statistical analysis, which is cross tabulation, chi-square (χ^2) tests and correlation model, to identify farmer's vulnerability and factors be expected to influence the farmers' decision to take adaptation measures.

4. RESULT AND DISCUSSION

4.1. Climatic Condition in Serang Municipality

To identify any changes in the climate, it is necessary to compare the climate statistical parameters (precipitation and temperature) for two different climatic periods. One is the baseline period 1991-2010 and the other is the present period 2011-2015. Figure 2 shows the average monthly rainfall for baseline period and present period. The graph shows the changes in rainfall patterns in wet months and dry months.

The average monthly precipitation in the present period is lower than the baseline period except for

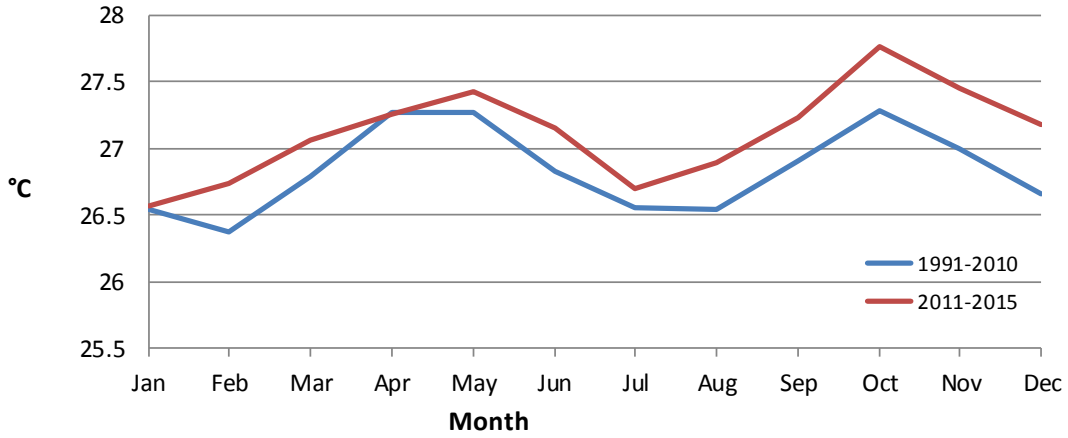

Figure 2 Average monthly rainfall graph for baseline period and present period

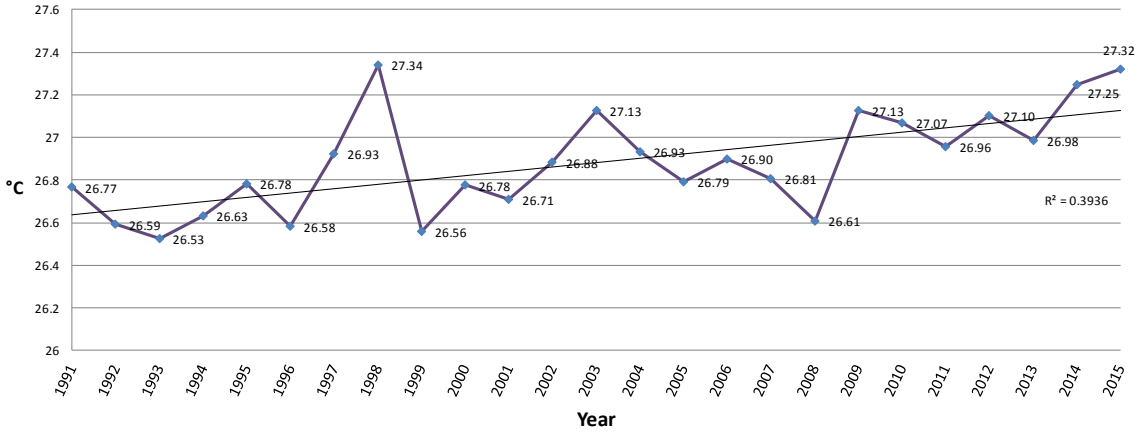

Figure 4 The Annual average temperature from 1991 – 2015

January, May, July, and December. The peak of rainy season is shift from February in the baseline period to January in the present period. There is also a significant increase in the variance of rainfall in January and July.

In Serang municipality, there are two cropping seasons in a year both for irrigated and rainfed land. The first planting season starts from the middle of October to March, and the second planting season starts from April to September. Due to the limited of water availability, in the second planting season only the land which technically irrigated plant paddy. Meanwhile, in the rainfed land, farmers usually plant dry crops (palawija) or unplanted the land. The changes in rainfall pattern and intensity will hamper farmers to determine the starting time of planting and harvesting seasons.

In addition to rainfall changes, from Figure 3 it can be seen that there is an increase in the average temperature at nearly in each month, except for January and April. The maximum rise is occurred in December approximately 0.5°C.

Figure 4 shows the annual average temperature data. It indicates a tendency of increase during 25 years' period, namely by 0.8°C. The average temperature significantly increased from 2009 to 2015. In these years the average temperature is almost over 27°C.

Although the observational data clearly shows the rise in surface temperatures in Serang municipality, it is hard to say whether the changes on climate can be attributed to the global warming. The Intergovernmental Panel on Climate Change (IPCC) reported that the temperature increase in 2000-2100 period is predicted about 2.1 - 3.9°C[3]. In addition, to determine the occurrence of climate change, the World Meteorological Organization (WMO) requires the calculation of averages for consecutive periods of 30 years, thus considered long enough to eliminate year-to-year variations.

Meanwhile, Figure 5 shows the annual total of rain day data from 1991-2015 and it indicates the anomaly with no tendency to increase nor decrease. The fewest of total rain days recorded in 1997, which was reported as El Nino year, with the total number of

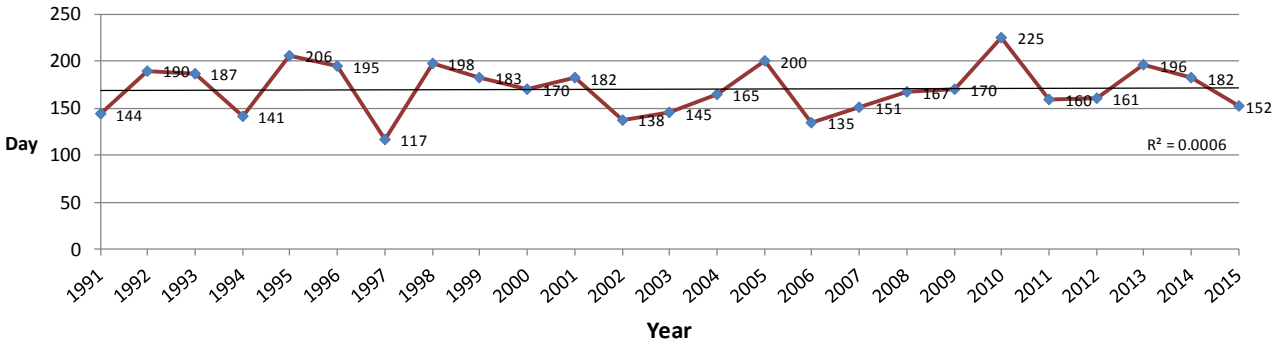

Figure 5 Annual total rain days from 1991–2015

Table 1. Descriptive Statistics of Respondents

Variables		Frequency	%
Education Level	- Elementary	124	64.6
	- Junior HS	40	20.8
	- Senior HS	26	13.5
	- Bachelor degree	2	1.0
Farming Experience	- <10 years	81	42.2
	- 10-20 years	78	40.6
	- 21-30 years	16	8.3
	- >30 years	17	8.9
Agricultural Skill	- Never get training	72	37.5
	- Ever get training	120	62.5
Land Ownership	- Combination	36	18.8
	- Lease/Profit Sharing	99	51.6
	- Private	57	29.7
Paddy Field Area	- <1ha	106	55.2
	- 1-3 ha	82	42.7
	- >3 ha	4	2.1
Type of Rice Field	- Tidal rice field	0	0.0
	- Rainfed	86	44.8
	- Irrigated field	106	55.2
Type of Irrigation	- Non-technical irrigation	24	21.8
	- Semi technical irrigation	21	19.1
	- Technical irrigation	65	33.9
Distance from Water Resource	- <100 m	76	39.6
	- 100-500m	73	38.0
	- >500m	43	22.4

rainy days in a year was 117 days.

4.2. General Characteristics of Respondents

A questionnaire survey was conducted to provide the basis quantitative information of paddy farmers' knowledge of climate change, perception and risk perception of climate variability, also the adaptation measure that has been taken by farmers. A total 192 paddy farmers have responded from six sub-district. The characteristic of farmers was also identified through the questionnaire on the level of education, farming experience, agricultural skill, land ownership, cultivation area, type of rice field, and the field distance to water resources.

Table 2. Farmers' Awareness on Climate Change

Variables		Frequency	%
Know about climate change	- No	62	32.3
	- A Few	61	31.8
	- Yes	69	35.9
Received information	- No	38	19.8
	- A Few	46	24.0
	- Yes	108	56.3
Notice the changes in climate	- No	3	1.6
	- A Few	22	11.5
	- Yes	167	87.0
Notice the extreme events	- No	31	16.1
	- A Few	34	17.7
	- Yes	127	66.1

Table 1 shows overall the characteristic of respondents. More than a half of the respondents took formal education up to elementary school (64.5%), and the majority of them has farming experience less than 20 years. Meanwhile, 62% of farmers have participated in agricultural training that provided by the government. These three variables are important to understanding about farmers perceive on climate change. As Notoadmojo said that age, education level, experience, and information are the factors that affect persons' knowledge and how they make decisions on something[4)].

For the characteristic of respondents' paddy farming system, a half of the rice field is irrigated land with technical irrigation, and the majority of the farmers have less than 3 ha land. As for the ownership, only a few of the rice field are owned privately.

4.3. Hydraulic Analysis

Table 2 shows the result of awareness of farmers on climate change. The majority of respondents had been aware of the change in climate. Although more than a half of respondents already received the information about climate change, only one-third of

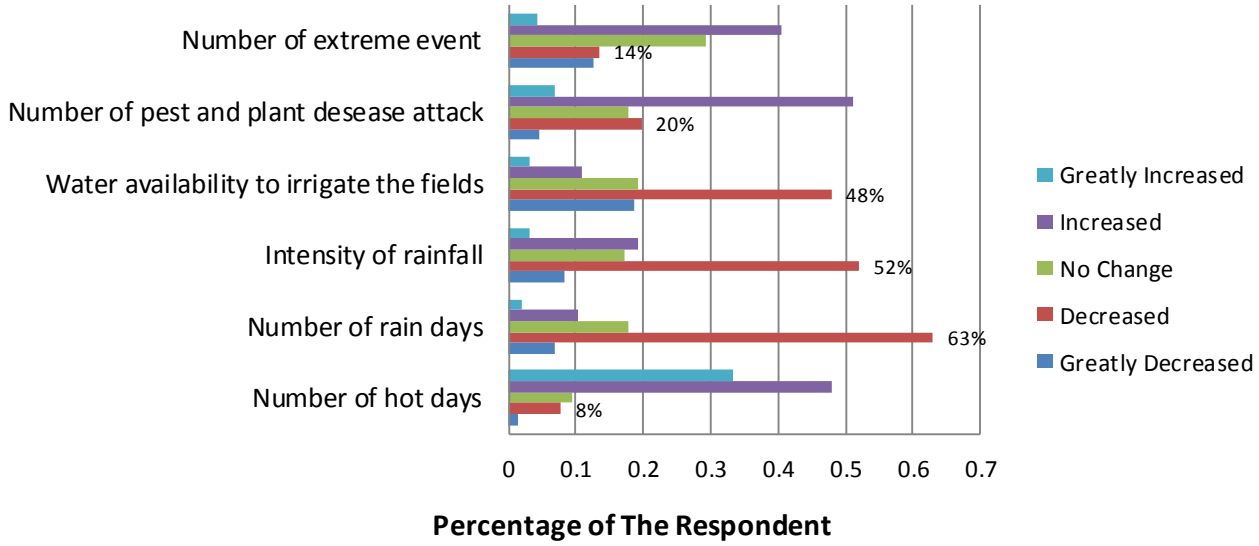

Figure 6. Farmers' Perception on Climate Variability

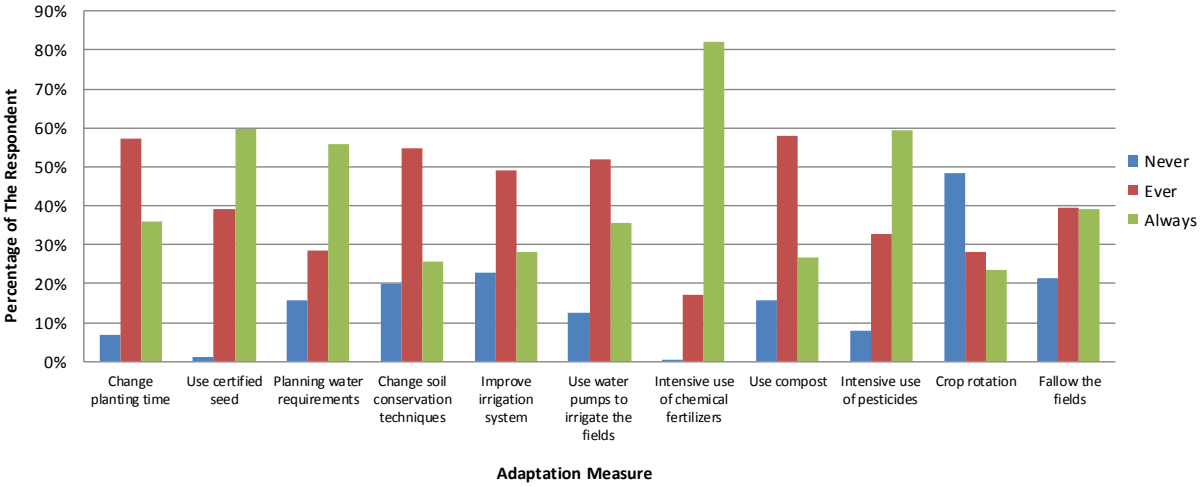

Figure 7. Adaptation Measures taken by Respondents

them knows the term of climate change. The changes in climate in the last five-year period is perceived by 87% of respondents, as well as 66% of them notice the extreme events, such as flood and drought, occurred in their sub-district.

Generally, most of the respondents observed the changes in climate as shown in Figure 6. 63% of farmers felt the decrease in number of rain days as well as the decrease in rainfall intensity and water availability for irrigation. These results are in line with Bappenas predictions that from 2015 Java-Bali area will suffer from a gradual decrease in water supply due to the increase in the temperature and rainfall changes[5]. However, from climatic data, there is no tendency of decreased in number of rain days. The decline began in last two years. It is indicated that farmers' perception is influenced by the current situation or the previous experience.

On the other hand, the increased in number of hot days, extreme events and the number of pest and plant disease were perceived by respondents, respectively 48%, 41%, and 51%.

The changes in climatic condition were identified by the majority of respondents as the adverse impact on their farm, such as reducing crops yield (55%), causing losses (62%), and reducing crops' quality (58%). They also agree that the condition makes them difficult to determine the planting time (57%) and difficult to irrigate the fields (48%).

4.4. Factors Influenced Farmers in Adapting Climate Variability

Figure 7 shows some adaptation measures taken by farmers to encounter the impact of climate variability.

Table 3. Factors Affecting Famers' Action on Adaptation

Agriculture Measures	Farming Experienced	Agricultural Skill	Land Ownership	Paddy Field Area	Type of Rice Field	Distance from Water Resources
Change planting time	-	-	-	+	-	-
Use certified seed	+	-	-	-	-	-
Planning water requirements	-	-	-	-	-	-
Change soil conservation techniques	-	-	+	+	-	-
Improve irrigation system	-	-	+	-	+	+
Use water pumps to irrigate the fields	-	-	-	+	+	+
Intensive use of chemical fertilizers	+	+	+	-	+	+
Use compost	-	-	-	-	+	-
Intensive use of pesticides	-	-	+	-	-	-
Crop rotation	-	+	+	-	+	-
Fallow the fields	-	-	-	-	+	+

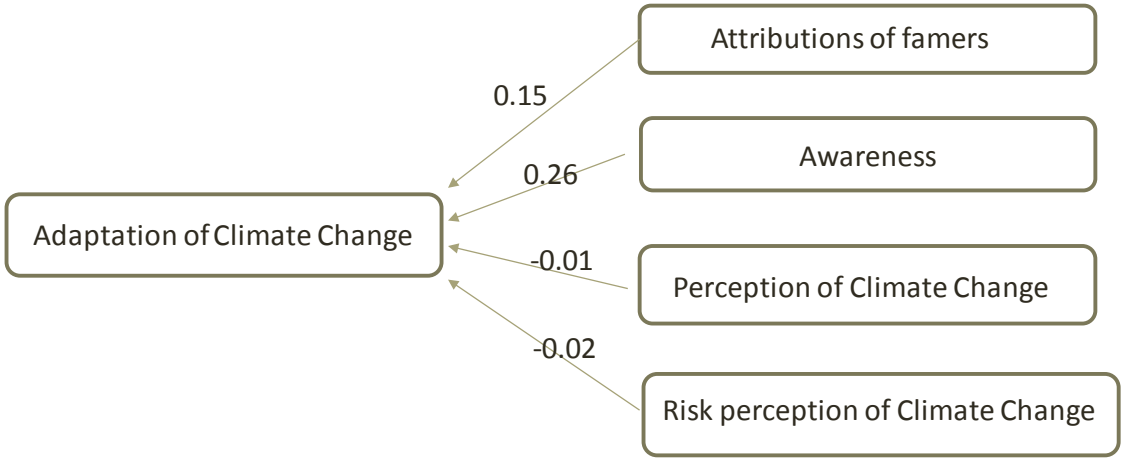

Figure 8. Correlation model between adaptation measures and influenced factors

It is noticeable that a large number of farmers use chemical fertilizer (82%) and pesticides (59%) intensively. To overcome water shortage, the respondent use water pumps to irrigate their fields, improve irrigation systems, and make water requirement plan. Meanwhile, a small part of farmers always use compost, do the crop rotation, and change soil conservation techniques.

The cross tabulation and chi-square test were performed on the attributes of farmers and the adaptation measures (Table 3), to identify factors that influenced farmers' decision on taking some agricultural measures on their farm. The type of rice field affects most of the agricultural measures that have been taken by the farmers. Farmers who have non-irrigated land is likely to use water pumps to irrigated their farm due to the water shortage and take decision to fallow the fields or do the crop rotation in the dry season. The similar result is showed in the distance from water resources variable, where the variable influences the decision on improving irrigation systems, using water pumps to irrigate the land, using chemical fertilizer and fallowing the fields.

The type of ownership of land also affects some of adaptation measures, such as changing the soil conservation techniques, improving irrigation system, using chemical fertilizer and pesticides, also doing the crops rotation. Farmers who have their own rice fields have the potential to put more effort on adapting with climate variation. Meanwhile, there are no attributes of the farmer that significantly related to the respond on planning water requirements. Possibly because it has become a common thing that farmers do before planting the crops. Most of farmers who were interviewed revealed that the water demand plan is done before the planting season arrives. Especially for plant vegetative phase which is the most demanding water phase.

The correlation analysis is used to identify the factors that influence the farmers on performing

adaptation measures in their fields and is shown in Figure 8. It shows that there is no strong correlation between adaptation measures with four variables, namely farmers' attributions, knowledge of climate change, perception of climate change, and risk perception of climate change. Although some farmers have making adjustment in their farm, but the decision on taking the action is not so much related to the individual internal factors. Research findings from Smith, et al. reported that the relationship between adaptive responses of farmers to the climate variation with climatic stimulation is still lack of certainty[6]. Moreover, the role of external factors in influencing agricultural adaptation measures cannot be ignored. The exogenous forces, such as economic, policy, environmental, and technology, may amplify the adaptation measures in farming practices.

The different characters of agricultural area in each sub-district may affect the correlation model. For example, in Taktakan sub-district more than 50% of the rice field is rainfed, while in Kasemen sub-district the agricultural area is almost irrigated fields. The government policy focuses the agricultural activity on two sub-districts, namely Kasemen and Cipocok Jaya. It may lead to inequality on aid and agricultural information deployment for the other sub-districts.

4.5. Adaptation Strategies on Climate Variability for Paddy Farming System

The importance of the adaptation strategies on the agricultural sector, especially in paddy farming system, is to prepare and anticipate the impacts of climate variability and strengthening farmers' resilience from negative consequences of climate disruption. Therefore, planning and implementation of the adaptation strategies must involve all of the stakeholders, government, private sectors and farmers themselves. The adaptation strategies can be performed through two approaches, which are structural and non-structural adaptations[7]. The structural adaptation is the activities to increased paddy production system with the improvement of the physical condition, such as upgrading irrigation systems, reservoir constructions, and provision of facilities for agricultural information system. On the other hand, the non-structural adaptation can be conducted with the institutional strengthening, farmers' empowerment, the development of the agricultural cultivation technology, regulations, and equitable distribution of the agricultural information.

The adaptation strategies Serang Municipality are shown as follows;

1. Inventory condition of irrigation networks and planning program for improvements in irrigation networks as well as new irrigation area development plan to include climate change factors in the planning process.
2. Construct reservoir and water storages, especially on the rainfed area.
3. Mitigating climate change in regional level, especially in sectors that sustain the local economy.
4. Develop agricultural training, such as climate field school, integrated plant management field school, and integrated pest control field school to empower farmers in selecting and implementing cultivation technology adapted to the climatic conditions.
5. Equalize opportunities for farmers to obtain information and agricultural training.
6. Socialization of the climate information in a sustainable manner by agriculture department or the BMKG to the farmers, so that the farmers can make proper planning and in accordance with the climatic conditions of the farming.

5. CONCLUSIONS

The main results of this study are shown below.

1) It is found from the climatic data analysis that there is a tendency of increase in the average temperature over 25-year period in Serang municipality. The shift in rainfall pattern, as well as the intensity, was also found, but it cannot be said it was induced by the climate change.
2) From the questionnaire survey on paddy farmers, the majority of respondent already aware of changes in the climate, and experienced the impact of this change in their farming systems.
3) Some attributes of farmers that significantly related to the adaptation measures are land ownership, type of rice field, and land distance with water resources.
4) Although the adaptation measures already carried out by the respondent, the factors that influences farmers’ decision to take the adaptation measures has little correlation with the farmer's internal factors (characteristics, knowledge, perceptions).
5) There is a need for further assessment to identify factors influencing to the adaptive response by

taking account of the external forces, such as economy, policy, environmental, and technology.

6) The local government should conduct mitigation on the impact of climate change for the regional scale to prepare and anticipation of oncoming impact, and also planning the appropriate adaptation strategies in accordance with the needs and conditions in Serang Municipality.

References

1) Adiningsih, Erna S.: Climate Variability Effect on Rice Productivity Based on Remote Sensing Data, J. Agromet 14(1-2): 71-86. 1999.
2) Creswell, John W., and Vicki L. Plano Clark.: Designing and Conducting Mixed Methods Research. Sage Publications, London,2008.
3) IPCC et al. Climate Change 2007: Impact, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press. 2007
4) Notoadmojo, S.: Pendidikan dan Perilaku Kesehatan. Rineka Cipta. Jakarta. 2003.
5) Bappenas. Indonesia Climate Change Sectoral Roadmap (ICCSR). Synthesis Report. 2009.
6) Smith, B., McNabb,D., and Smithers.: Agricultural Adaptation to Climatic Variation. Climatic Change 33: 7-29. 1996
7) Ministry of Agriculture.: Pedoman Umum Adaptasi Perubahan Iklim Sektor Pertanian. 2011

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