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Climate change impacts on the agricultural system in PulauSapi Village, Malinau, North Borneo, Indonesia

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Abstract:*This present study aims at determining the effects of climate change on the agricultural system in Malinau District, North Borneo, Indonesia, especially in the PulauSapi Village. The descriptive explorative was employed as the method of this research. Involving 25 farmers as the respondents, the data were collected through conducting structured interviews and questionnaires about climate change and agriculture. The results showed that most of the yields from rice fields were for household consumption, while the daily living costs were supported from non-agricultural income. The impacts of climate change as extreme climate such as a long drought to be farmers experienced occurred in 2015. The impacts of climate change identified by farmers are the decline in agricultural production and water availability, and the increasing number of pest attacks. To minimize these impacts, the government recommended three periods of cropping calendar for rice and gave counseling services for farmers. The counseling was provided by the agricultural extension staffs or trained workers to assist farmers in improving agricultural yields and adapting with climate change.*

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I. Introduction

Until recently, climate change is considered to become one of the most important challenges for today's world. As a result of global warming, the significant changes in climate have impacts on many different sectors of life, such as the rise of temperature and the seasonal shift. In addition, climate change had also affected the level of rainfall intensity and environmental conditions. This phenomenon is inevitably experienced by the largest island in Indonesia, Borneo Island. In this island, climate change causes the decrease of rainfall intensity, increasing the rate of forest fires and the land drought (Anggraini, 2011).

Facing the challenges of climate change agriculture becomes a vulnerable sector. It is difficult for farmers to determine the beginning season for rice planting since they have problems in predicting the occurrence of dry season. Consequently, this leads to the decrease in rice production, and even crop failure due to floods and increasing pests. This ultimately affects farmers' income, and can even lead to food crises (Setiawan, 2015).

Over the last 40 years (1974-2016), the province of North Borneo has experienced an increase in air temperature and a decrease in rainfall. The maximum air temperature occurs in November at 34.40 ˚C, whereas the minimum air temperature occurs in February at 23.40 ˚C.

The province of North Borneo has a potential of agricultural land with the total area of 115,721.57 Ha. In fact, although the economy depends on agriculture, only 14,265.05 hectares are occupied by the rice fields. As the largest district in North Borneo, occupying 56% of the province, Malinau is highly potential for the development of food commodities (rice). Serving as a home for the indigenous tribe called *Dayak*, 38.74% of the population of Malinau, dominated by *Dayak* tribe, works in the agricultural sector (Anonymous, 2015). However, since the land is mostly dominated by forests (almost 4 million Ha), forest fields become the most common farming system in the district. The creation of new farm fields and the preparation of land are conducted with *huma* and *humatugal* system through the forest clearing. This activity is carried out by a group of farmers (*senguyun*) (Nuralang, 2005) by working together. Using the local seeds, the crop cycle takes approximately six months from the preparation of land until harvesting. Unfortunately, those local seeds are not resistant to unpredictable weather conditions affected by climate change, causing considerable crop losses for farmers.

This study is important because the information about the impacts of climate change on agriculture in North Borneo is still difficult to discover. Therefore, this research aims at determining the effects of climate change on the agricultural system in PulauSapi Village, Malinau District, North Borneo, Indonesia.

II. Material and Methods

This research was conducted in PulauSapi Village, Malinau District, North Borneo, Indonesia. The site of the research lays at 114º 35' 22"- 116º 50' 55" E; 1º 21' 36 "- 4º 10' 55" N. The total area of PulauSapi Village is 535.15 km^2. The name of PulauSapi Village comes from the discovery of the carcass of a stranded cow drifting from the upper river on the island. The majority of the population is the *Dayak Lundayeh* tribe (Anonymous, 2000).

PulauSapi Village was selected as the site of the research purposively (Arikunto, 2010). It was because the village used the local seeds for the agriculture system, expecting that its agriculture system was weak in adapting to climate change. The respondents of this study were 25 farmers, representing 376 farmers in PulauSapi Village. The respondents were chosen by purposive sampling, through considering the selected respondents that could provide the required information (Silalahi, 2015).

The descriptive explorative is employed as the method of this research, using questionnaire and interview to collect the data (Sugiyono, 2011). The structure of questionnaire sought to explore further the knowledge of farmers dealing with climate change, agricultural systems, and human and economic resources. The data were analyzed descriptively by presenting the description of the observation objects informed by the respondents. Interviews with the respondents were conducted in June 2016.

III. Result and Discussion

Respondents Characteristics

The respondents' characteristics are presented in Table 1. Table 1 shows the age of respondents ranged from 31 to more than 60 years old (averagely 49.94 years). Having a closer look at the age standpoint, the highest percentage of the population was at the age of 41-50 and 51-60 (32%, respectively). The respondents were classified as productive because all of them were 15-64 years old.

It can also be seen in Table 1 that all the respondents have attended formal education. The table shows that nearly a half of the population (48%) has attended the senior high school level. In addition, there was 24% of the population who studied in the junior high school, and 4% in the elementary school level. Meanwhile, the rest of the respondents attended the academy or higher education (24%).

From Table 1, it can be seen that the years of farming experience ranged from 1 to 50. Most of farmers experience farming in 1-10 years period (36%) and only 4% of farmers experience farming in the long period (31-40 years). The experience of farming has been obtained from generation to generation, inherited from the parents to their children through the farming activities in the fields since childhood, while on average, they began to be independent after marriage (17 years old).

Table no 1: Respondents' Characteristics

Characteristics		Percentage (%)
Age (Years)	31-40	16
	41-50	32
	51-60	32
	>60	20
Formal Education	Elementary school	4
	Junior High School	24
	Senior High School	48
	University	24
Farming Experience (Years)	0-10	36
	11-20	28
	21-30	24
	31-40	4
	41-50	8

Gender	Male	80
	Female	20
Household	1-3	20
(People)	4-6	72
	7-9	4
	10-12	4
Land Area	0-1	24
(Ha)	1.1-2	48
	2.1-3	16
	3.1-4	4
	>4	8

According to the gender, as shown in Table 1, the field works between men and women are decided. The men must plow the fields while the women will sow the seeds. There were more male respondents (20) than female (only 5). It can be seen that the number of farmers ranges from 2 to 10 people, with an average of 5 people. The number of the household dependents is mostly 4-6 people (72%). From the data above, it can be known that each farmer own 0.5 to more than 4 hectares in average, while 48% of the respondents own 1-2 (average 2.12 Ha). The farmers also mostly work outside the agricultural sector.

Figures 1 and 2 present farmers' income

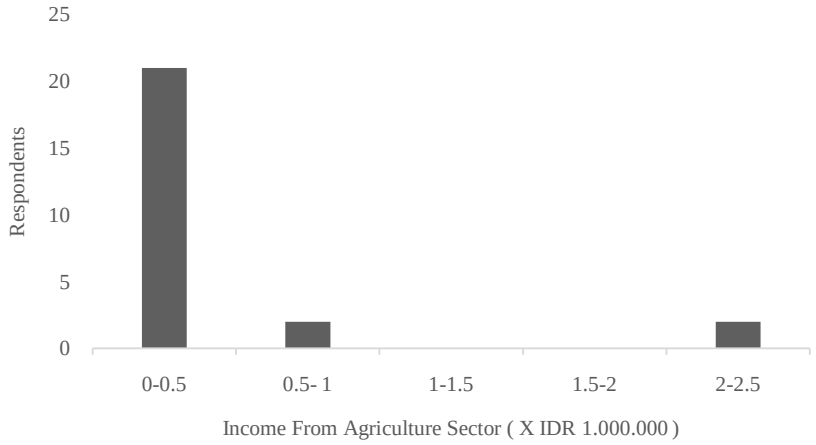

Figure 1. Farmers' income from agriculture sector per year

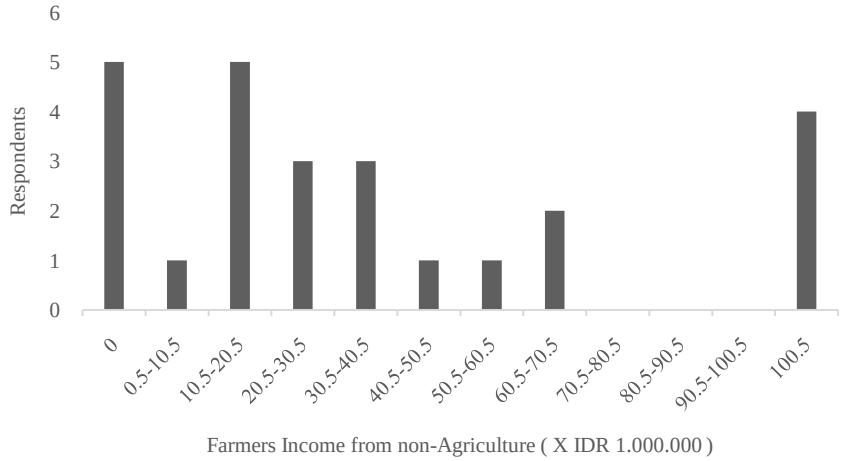

Figure 2. Farmers' income from non-agricultural sector per year

Figure 1 informs that most of farmers' income from the agriculture sector is less than IDR 0.5 million per year (84%). The figure shows that the yearly average of farmers' income from agriculture sector is only IDR 284,120 per year. It is because the rice harvested by the farmers is used more for their daily consumption and only enough for daily life. Besides farming, farmers also work in the non-agricultural sector such as civil servants, pensioners, village administrators, traders, and self-employed. The average annual income from the non-agricultural sector reaches up to IDR 113,668 or IDR 9,472 per month (Figure 2). Therefore, it can be concluded that farmers mostly fulfill their needs from the income outside of the agricultural products.

Farmers' perception and knowledge of climate change

Most of farmers generally knew about the climate change phenomenon by feeling the increase of temperature, drought occurrences, and erratic seasons. The increasing temperature conditions and unpredictable seasonal changes make it difficult for farmers to determine the planting time, as well as the increasing number of pest attacks. The ideal time of planting by using the local seeds is usually in August. However, because of the impacts of climate change, farmers advance the planting time to July.

Farmers experienced the climate change by feeling the changes in the rainy season period, air temperature, wind conditions, water availability, and agricultural yields. They also felt the seasonal shift, extreme climates, and the raise of pest attack rates. From the data above, 84% of farmers stated that the dry season was longer than in the previousyears, while the intensity of rainfall decreased. They also felt that the air temperature became hotter if compared to the previous years, but they did not feel any change in wind conditions.

One of the impacts of climate change is the occurrence of extreme weather. For a long time, in the period of 1970 – 2015, farmers in the PulauSapi Village have often experienced the extreme weather such as the drought. The long drought occurred in 2015 has led to several negative impacts on agriculture sector, including the water shortages, broken rice, and deteriorated seeds due to high temperatures. Floods that occurred within the period of 1980-2012 drowned the rice fields, roads and houses. It also rotted the rice yields and decreased the quantity of crops harvested in the year of 1983, 1999, and 2012. Through observing the extreme weather phenomenon, what farmers have felt towards the climate change since the last 5 years are illustrated in **Figure 3**.

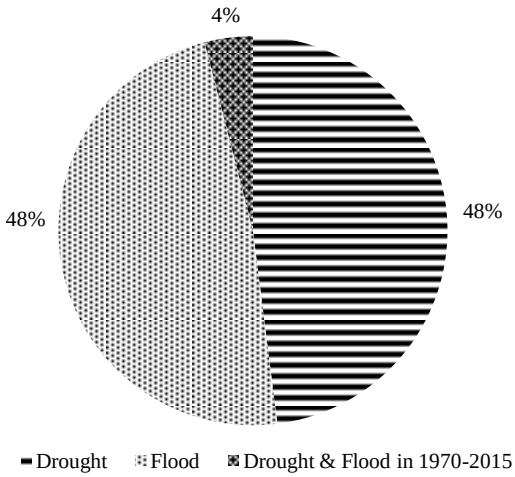

Figure 3. Farmers' perception of extreme weather occurrences

For irrigating the rice fields, the study site has only 52% irrigation so that more respondents rely on the rainwater to fulfill the water requirement for agricultural activities. It was also observed that the level of pests' attack increased due to uncertain climatic conditions. The pests' species such as sparrows, *leptocorisa*, *aphis*, caterpillars, *S. Inotata*, and *Gryllotalpa* were often increased during the drought period.

Changes in agricultural systems

Farmers usually plant the upland rice once in a year, planting in August and harvesting in January, using the local seeds (*Adan* rice cultivar). This activity was carried out together in a group of 5-6 peasants. The cooperation method for land preparation and tillage by male farmers is known as *Senguyun*. Using the fields owned by the farmer group members, it is conducted by shifting from one field to another. After the land preparation and tillage is completed, female farmers will start to plant by using wood, iron, and long bamboo to

pick up the seeds from the hands and put them in the plant hole. Long bamboo is employed to prevent a back pain that often occurs when the farmers are bending over to plant the seeds.

The agricultural system at the study site is shifting farming for the rice fields. A remote forest area is converted into the upland farm, while rice fields are converted from the surrounding forest areas. Farmers use the local seeds of rice, which needs six months from tillage to harvest. Regrettably, climate change promotes to rupture and dry rice seeds due to the drought, which results in the decline in yields. To cope with the problem, currently farmers plant the superior seeds provided by the government with the cropping period of only approximately three months. This is aimed at improving the quality and quantity of rice, called as the *Rasda program*. The *Rasda program* is a regional rice program using superior rice seeds, agricultural machineries, chemical fertilizers, and the optimization of rice fields provided by the government. The superior rice seeds that are resistant to drought, high temperature, and diseases will help in increasing the yields (Azrai, 2013). The *Rasda program* is also expected to substitute the *Raskin program*, which has a low quality. Therefore, in contrast to the previous years, recently there are more farmers working at the rice fields than the upland farms.

Farmers feel that climate change significantly reduces the water availability, realizing the fact that recently the supply of water is not sufficient to support the agricultural activities. The irrigation technology needs to be maximized especially during the rainy seasons to increase the capacity of plant props in coping with climate change, thus it can help stabilizing the agricultural activities in the face of climate change (Saptoka et al 2015).

Farmers also feel that the pest attack levels (including pests) are increasing due to the phenomenon of climate change. The pests found in the field recently are sparrows, *leptocorisa*, *aphis*, caterpillars, *S. Inotata*, and *Gryllotalpa*, *rats*, and *P. canaliculata*. In October, there are more *leptocorisa* pests, while in April to July there are more *sparrow* pests are found to exist. According to Kardinan (2011), pest control can use bio-pesticides, because Indonesia has a rich biodiversity vegetation that is useful for controlling pests. Farmers use *tuba* acid root as the natural pest repellent. *Tuba* acid is a local fruit derived from North Borneo, which can be obtained in the surroundings of the study site. However, in reality, most farmers still employ chemical pesticides provided by the government to control the pests.

In addition, to repel the pests, farmers are also using the clothes deodorant mixed with pesticides by spraying it around the fields. It is because the clothes deodorant has an odor that is not favored by *Leptocorisa* and golden snails. Sometimes, to ward off the *Gryllotalpa*, farmers also apply the pesticides by mixing it with soils during the plowing using a tractor or a rice field hijacker.

Despite of the emerge problems caused by climate change, farmers were still continuing to conduct agricultural activities in accordance with the government regulations and the local wisdom. Less attention to the weather and climate change phenomenon had resulted in the decrease of the agricultural production as shown in Figure 4. This also led to the decrease in farmers' income and welfare.

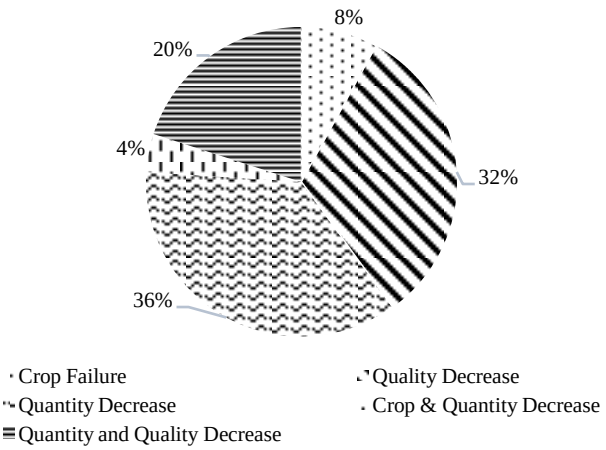

Figure 4. Climate change impacts on agricultural at study site

Farmers adapt with climate change by changing the cropping calendar. They plant earlier, from August to July to allow adequate rainfall fulfills crop water requirements. Besides, the government also advises the farmers to plant twice a year. Usually, the local seeds are planted in August and harvested in January. However, since implementing the superior seeds, the local seed planting is advanced to July. Therefore, the rainy season in January can be occupied to plant the superior seeds, and the harvesting of crops is conducted in March. Then, in April, farmers can start the planning of superior seeds again and harvest the crops in June. Afterwards, in July, they can decide to plant the local seeds cultivar started with the activities of cleaning field. The local seeds are

able to survive in the dry season and with sufficient water from the irrigation, even though their quality and quantity are reduced. Meanwhile, the superior seeds desperately need water from the rainy season. For the purpose of minimizing the impacts of climate change, the strategy implemented by the government at the study site is by employing some skilled staffs during the last five years. As the agricultural extension for farmers counseling, these staffs are assigned to develop farmers' skills in farming and improve the agriculture sector in the PulauSapi Village.

IV. Conclusion

Climate change caused the decrease of water availability and rice yields. Therefore, farmers change the agricultural system to increase crop yields and adapt with the unpredictable climatic conditions. To increase the yields, farmers utilize the superior seeds from the *Rasda program* introduced by the local government. Meanwhile, to deal with the increasing number of pest attacks, farmers use *tuba* acid roots (local fruit) as organic pesticides and also chemical pesticides provided by the government

References

[1]. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (AdultTreatment Panel III) Third report of the national cholesterol education
[2]. Anonim. 2000. Sejarah DesaPulauSapi. Malinau. Kalimantan Utara.
[3]. Anonim. 2015. Rencana Pembangunan JangkaMenengah Daerah Provinsi Kalimantan Utara Tahun 2016-2021. Kalimantan Utara.
[4]. Anonim. 2016. Badan Meteorologi dan KlimatologiGeofisika Kota Tarakan Provinsi Kalimantan Utara. Kalimantan Utara.
[5]. Anonim. 2016. KabupatenMalinauDalamAngka. Badan Pusat Statistik KabupatenMalinau. BPS KabupatenMainau. Kalimantan Utara. Indonesia
[6]. Anggraini, N. and Trisakti, B. 2011. Kajian DampakPerubahanIklimTerhadapKebakaranHutan Dan Deforestasi Di Provinsi Borneo Barat. *JurnalPenginderaanJauh dan Pengelohan Data Citra Digital*. Vol 8 page 11-20
[7]. Arikunto, S. 2010. ProsedurPenelitianSuatuPendekatanPraktik. RinekaCipta. Jakarta.
[8]. Azrai, M. 2013. JagungHibridaGenjah: ProspekPengembanganMenghadapiPerubahanIklim. BalaiPenelitianTanamanSerella. *JurnalIptekTanamanPangan* Volume 8 No 2 Page 90-96
[9]. Kardinan, A. 2011. PenggunaanPestisidaNabatiSebagaiKearifanLokalDalamPengendalian Hama TanamanMenujuSistemPertanianOrganik. *Pengembangan Inovasi Pertanian*. Volume 4 and page 262-278
[10]. Nuralang, A. 2005. *Huma Tugal*:SistemEkonomi Dayak MeratusTradisi Dan Refleksi Nilai-Nilai BudayaLokal. DalamDinamikaKearifanLokal Masyarakat Kalimantan (DinamikaKearifanLokal Masyarakat Kalimantan). Perpustakaan Nasional. Ikatan Ahli Arkeologi Indonesia. Banjarbaru. P 62-77
[11]. Sapkota, T, B; Jat, M, L; Aryal, J, P; Jat, R, K; Chetri, A, K. 2015. Climate Change Adaption, Greenhouse Gas Mitigation and Economic Profitability of Conversation Agriculture: some Examples from Cereal System of Indo-Gangetic Plains. *Journal of Integrative Agriculture.* Volume 14. page 1524-1533
[12]. Setiawan, H. 2015. Potensi KHDTK MaliliSebagaiRosotKarbondioksidaDalamRangkaMitigasiTerhadapPerubahanIklim. BalaiPenelitianKehutanan Makassar. Info Teknis EBONI Vol.12 No. 1, Juli 2015: 1-12. Makassar.
[13]. Silalahi, U. 2015. MetodePenelitianSosialKuantitatif. Bandung: RefikaAditama.
[14]. Sugiyono. 2011. StatistikaUntukPenelitian. Alfabeta. Bandung.

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