



Mitigation and Adaptation Analysis of the Climate Change Impact Using Sustainable Livelihood Model

Deffi Ayu Puspito Sari¹, Faroby Falatehan², Diki Surya Irawan¹, Gede Sedana³, Robbi Rahim⁴

¹Environmental Engineering, Universitas Bakrie, Jakarta, Indonesia

²Resource and Environmental Economic, Bogor Agricultural University, Bogor, Indonesia

³Agrotechnology, Dwijendra University, Bali, Indonesia

⁴School of Computer and Communication Engineering, Universiti Malaysia Perlis, Kubang Gajah, Malaysia

*Corresponding author E-mail: deffi.sari@bakrie.ac.id

Abstract

This study aims to identify and analyze the farmers' perception of the climate variability and the impacts of the climate variability, identify and analyze the vulnerability and the income of the farmers due to the climate variability, identify and analyze the farmer strategy in anticipating and adapting the climate variability and recommending the adaptation mechanism based on engineering, institutional, technological, social, economic, and cultural organizations to the farmer in responding to the climate variability. Most of the farmers know and understand the climate change information from the television. Farmers mostly feel this climate change through the increase in temperature and the number of dry days. The impact of the climate change affects the livelihood of the farmers, not a few farmers suffered the losses due to the decreased in productivity. To reduce the decrease in income, the farmers increase the use of input, thus affecting the income of the farmers. The results of a comparison of the farmers between 2009 and 2015, there is an increase in productivity and revenue, but this increase is lower than the increased costs incurred by the farmers. This resulted in lower revenues of the farmers in 2015 than in 2009. There are 3 kinds of the strategies which is undertaken by the farmers: economic, ecological and social adaptation. For the economic adaptation, the expectations of the farmers to the capital assets are higher than the actual condition. Ideally, the highest ideal expected by the farmers is physical capital, while the lowest is social capital. Meanwhile, for the ecological adaptation, the community seeks to improve the irrigation channel, replace commodities and utilize the appropriate technology. As for the social adaptation, farmers are expecting the help from the government. The policy implications from this research are: 1) the farmer in Jatiluwih are mostly aware of climate change, some strategies have been implemented by the farmers to maintain their income that affected by the climate change such as to work in the city or become a tour guide in their area. Based on the analysis of the sustainable livelihood, the farmers' expectation of physical capital such as electricity, water, irrigation, and roads are relatively high compared to the other capital. Because of the cost of supply is high, the provision of the physical capital is not easy, the government intervention is needed. Therefore, the farmers are expecting the government to be able to improve the condition of these facilities, especially for the irrigation. Irrigation plays an important role in farming. 2) The social capital of the farmers is high, the farmers have a good relationship with the government, indigenous people, and farmer groups. Therefore, in addition to providing the physical assistance, the government can also conduct the guidance and socialization on reducing the impact of the climate change through farmer or cultural group.

Keywords: Mitigation and Adaptation, Climate Change, Sustainability Livelihood Analysis, Subak, Jatiluwih

1. Introduction

The climate change has an impact on many aspects of life [1]–[3]. Disaster induced by the climate change are varied from natural disaster such as drought, flood, storm, landslides, [4]–[8], to a man-made disaster (food shortages, malnutrition, fire, technological disaster), [9], [10]. The climate variability is a fluctuation of the climate elements that occur suddenly but not last long. The variation of the climate is influenced by El Niño which can lead to the reduced rainfall [11], [12]. The agriculture sector is the most vulnerable to the climate variability. The climate variability can threaten the crop production systems, affecting the livelihood and the food security for billions of people who depend on the agriculture. Although Tabanan is well known for its sustainable water supply system for farming (the Subak system), the impact of the

agriculture failure due to the climate variability can be seen in Tabanan regency which is one of the rice producers in Bali as well as a tourist destination. Tabanan regency as one of the favorite tourist areas, every year visited by millions of tourists, in 2015 the number reached to 3,179,617 tourists. This district has excellent potentials for tourism, one of its outstanding potentials is the agriculture, with the rice field terraces in Jatiluwih village. This village has been recognized by UNESCO as a world cultural heritage. The total area of the rice fields reaches 22.562 square kilometers or 26.88 percent of the entire area of Tabanan regency. Therefore, one of the objectives of this study is to look at the livelihood adaptations model of the farmers in dealing with the climate variability and to give recommendation for the government of Tabanan re-



agency regarding mitigation and adaptation of the impact of climate change in the region. The sustainable livelihood (SL) approach [13], is used for the welfare improvement study while the field study has been conducted by Waqid [14]. The aims of this study are to identify and analyze the farmers' perceptions of the climate variability; to identify and analyze the level of vulnerability and the income of the farmers due to the climate variability; to identify and examine the farmer strategies in anticipating and adapting to the climate variability; to recommend the adaptation mechanism based on engineering, institutional, technological, social, economic, and cultural organizations [15]–[17] to the farmers in responding to the climate variability.

2. Research Methodology Literature Review

The object of the research in this study is the farmers who live in Tabanan district, Bali Indonesia which is a rice producing area. The respondents are the farmers who have the business in the region. The selection of the respondents conducted by Purposive Sampling. The data collected in the form of primary data and secondary data. The primary data were obtained through the interviews using the questionnaire. Some of the primary data collected in the form of production data, which includes the data on the agriculture expenditures and revenues, the perception of the farmers on climate, institutional and another variability. While for the secondary data contains the data of temperature, weather, and about the district. Table 1 shows the relationship between the objectives and the analytical tool of each objectives.

Table.1: the Relationship between the Objectives and the Analysis Tool

No	Objectives	Data Type	Collection Method	Analytical Method
1	To identify and analyze farmers understanding of climate variability and its impact	Primary and secondary	In depth interview	Qualitative descriptive analysis
2	To identify the impact of climate variability to farmers income	Primary data	In depth interview and questioner	Change in productivity and loss of earning
3	To identify farmers adaptation strategy in dealing with climate variability	Primary data	In depth interview and FGD	Sustainable livelihood asset
4	To give recommendation of the adaptation mechanism based on engineering, institutional, technological, social, economic, and cultural organizations to the farmer in responding to the climate variability	Primary data	In depth interview and FGD	Qualitative descriptive analysis

Sustainable Livelihood provides a conceptual framework, which forms an essential basis for the formulation of the action programs in the implementation of the poverty alleviation and deprivation project that are chronically recognized in many developing countries. In addition, the framework has also become a foothold for the evaluation of the particular conditions in communities that are the subjects to the intervention, vulnerability in a society that is likely to be affected (shocks, trends, seasonality) a government policy or even the environmental damage that can drag the livelihood of a community in a total bankrupt situation [18]. Empirically, almost an analysis is based entirely on the facts and the impact information recorded on the instruments developed for this study [19]–[21], then to be associated with 5 things as expressed by a pentagonal – shaped consisting of 5 elements of the capital (figure 1), which includes the access to the human capital, access to the natural capital, financial access, physical access and the access to the social capital [22], [23].

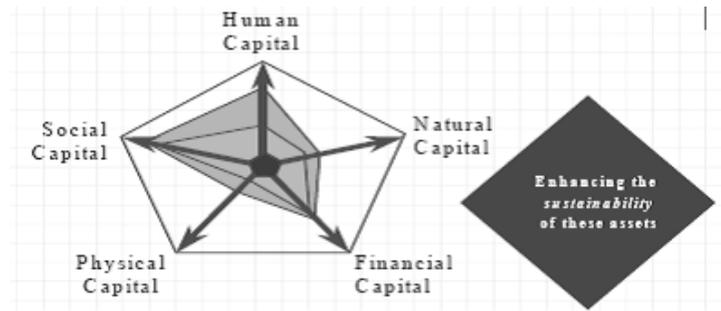


Figure.1: The Pentagonal Assets [24].

Livelihood can be declared sustainable if it can be united and used by the individuals or groups to dampen and restore the condition of the various shocks and stresses, to maintain or even develop the capital assets that they own or control, and the last is that, in their *livelihoods* activities, *livelihoods* do not pose a threat to the sustainability of the surrounding natural resources. The *sustainable livelihoods* approach places the community at the center of the development. This focus on the community as the same important in both at the higher level (when discussing the achievement goals such as poverty alleviation, economic reform or the sustainable development) as well as at the micro or community level (where in some cases this approach has been widely used) [25]. Whereas poverty is a problem faced by developing country [26], the *livelihood* can be interpreted as a livelihood strategy, which is a variety of the efforts made someone to take advantage of the various resources which have to earn to earn the income to maintain its survival. The *sustainable livelihood* approach seeks to identify the most significant obstacles faced by the human, and the most promising and open opportunity for, the community, regardless of where it came from (e.g. where, in what region or level, from local to international). This approach builds on the community's understanding or definition of these barriers and opportunities and, whenever possible, this approach can help the communities to discuss/realize these barriers and opportunities [25]. The *sustainable livelihood capital*, the ability to pursue the livelihood can be found to differ depending on social policy (culture policies and community policies) and the strengths of each resource owned by a family or individual, the actual state of the community (natural and the environmental conditions). The *sustainable livelihood* approaches have several resources, these resources are a source for finding the level of vulnerability as well as a tool for the lasting livelihood achievement. It is expected that with the *sustainable livelihood* analysis large revenue, increased prosperity, reduced vulnerability, better food safety, the use of more *sustainable* natural resource base will be achieved.

3. Results and Discussion

This study was conducted in Jatiluwih, Penebel Tabanan District Bali, with the number of the respondents who are the farmers of 26 people. In Jatiluwih, as in Bali in general, there is an irrigation system called Subak. In Bali, Subak is not an irrigation system that revives the rice fields, but the Subak that has been crowned as the world cultural heritage is also a tourist attraction for the foreign or local tourists.

The agriculture land in Jatiluwih received the water supply from some rivers flowing in Tabanan, including Yeh Pusut, Yeh Baas, and Yeh Ho. The irrigation water is divided to irrigate the seven Subak groups in Jatiluwih, such as Subak Kedamian, Umaduwi, Kesambi, Besi Kalung, and Gunung Sari. The area of the rice field in Subak Jatiluwih reach 303 hectares with 217 members.

The characteristic of the rice farmers in this village is not much like in other communities in Indonesia. Table 1 illustrates that only one farmer which his age is less than 30 years old. Most of them are the farmers over than 50 years old, which is 57.7% of the education level mostly graduated from the Primary School (SD) which is 30.77% of all respondents. Therefore, some respondents

expressed the concerns of the agriculture, because of the need of the young generation in agricultural sector. Table 1 illustrates that the number of female farmers respondents is 6 persons or by 23.08%. The women farmers in Jatiluwih are mostly aged 30 to 49 years, which is 11.54%. A total of 25 farmers or approximately 92.59% state that farming is their primary business, while the rest of 7.41% said that agriculture is a side business. Some of the farmers' side business is husbandry and trading.

Table.2: The Age and Education Level of the Farmers in Jatiluwih, Penebel, Tabanan based on the Gender

	Gender					
	Male		Female		Total	
Age	n	%	n	%	n	%
Age: <30	0	0.00%	1	3.85%	1	3.85%
SLTP	0	0.00%	1	3.85%	1	3.85%
Age: 30-49	7	26.92%	3	11.54%	10	38.46%
SD	3	11.54%	2	7.69%	5	19.23%
SLTP	3	11.54%	0	0.00%	3	11.54%
SLTA	1	3.85%	1	3.85%	2	7.69%
Age: 50-69	7	26.92%	2	7.69%	9	34.62%
SD	2	7.69%	1	3.85%	3	11.54%
SLTP	3	11.54%	1	0.00%	3	11.54%
SLTA	2	7.69%	1	3.85%	3	11.54%
Age: >70	6	23.08%	0	0.00%	6	23.08%
SLTP	1	3.85%	0	0.00%	1	3.85%
SLTA	5	19.23%	0	0.00%	5	19.23%
Total	20	76.92%	6	23.08%	26	100.00%

Note: SD-Elementary School
SLTP-Junior High School
SLTA-Senior High School

The experience of these farmers is mostly more than 15 years; there are 17 people or about 65.39% of them whereas the farmers who have more than 25 years' experience is 6 people or 23.08%. While the farmers who have less than 15 years' experience is 9 people. There are only 2 women farmers who have experience more than 25 years (Table 2).

This long-standing farmer's experience is expected to understand what is happening with the climate change or variability and its impacts on the agriculture, particularly in Jatiluwih.

Table.2: Farmers Experience in Paddy Farming Based on Age and Gender

Age/ Farming Experience (in Year)	Gender					
	Male		Female		Total	
	n	%	N	%	n	%
Age: <30		0.00%	1	3.85%	1	3.85%
15-24		0.00%	1	3.85%	1	3.85%
Age: 30-49	7	26.92%	3	11.54%	10	38.46%
5-14	6	23.08%	2	7.69%	8	30.77%
15-24	1	3.85%	1	3.85%	2	7.69%
Age: 50-70	1	46.15%	2	7.69%	4	53.85%
5-14	1	3.85%	0	0.00%	1	3.85%
15-24	5	19.23%	0	0.00%	5	19.23%
25-34	4	15.38%	1	3.85%	5	19.23%
>35	2	7.69%	1	3.85%	3	11.54%
Age: >70	1	3.85%	0	0.00%	1	3.85%
25-34	1	3.85%	0	0.00%	1	3.85%
Total	20	76.92%	6	23.08%	26	100.00%

The farmers who have the primary occupations as farmers, on average have an agriculture land area of 81 acres or 0.81 ha, while the farmers who choose as the farmers as a side job has a higher average land area which is 150 acres or 1.5 ha. Most of the farmers use their capital (25 farmers or 96%). The farmers who have a

source of loan capital (1 farmer or 4% of the respondents) usually get funds from the landowner, then share the profit equally.

The farmers in Jatiluwih plant various types of varieties, there is local rice and variety rice. The local varieties are usually planted in the rainy season with the harvest time up to 6 months. The local varieties in Jatiluwih are red rice and white rice. While in the dry season (Gadon/ Gadu), an example in July – August, the farmers grow high yielding varieties such as IR 64, Inpari 13, Ciherang or Cigeulis and secondary crops.

Table 3 illustrates that the farmers plant the local rice cultivated starting from December to February, but mostly planted in early December. The harvest of the farmers who grow the local rice is relatively the same, in June. There is 1 farmer or about 4% who planted in February. Most of the farmer, 17 people or approximately 62.96% started to plant the local rice in December.

Table.3: The Local Rice Planting Time

Month	Planting Local Rice	
	Total	Percent
Local Rice	27	100.00%
1 – 6	9	33.33%
12- 6	17	62.96%
2 – 6	1	3.70%
Total	27	100.00%

While the time of superior rice planting for the farmers is not in August and September with the harvest time is in November and December. This can be seen in table 4. Most farmers who plant the superior rice from August to November is about 17 people or about 62.96 percent.

Table.4: The Variety Rice Planting Time

Month	Planting Variety Rice	
	Total	Percent
8 - 11	17	62.96%
8 - 12	6	22.22%
9 - 11	1	3.70%
9 - 12	3	11.11%
Total	27	100.00%

All of the respondents, who are the members of Subak are the members of the farmers group, in the Subak System, the farmer who utilize this Subak are the members of the farmer groups as well. So, all members of Subak are the members of the farmer's group. The counseling given to the farmers is usually attended by the members of the farmer's groups, but sometimes the farmers do not always come at the counseling time. And sometimes, the farmers do not know the existence of the counseling. In the study area, the advice conducted by the government in Jatiluwih which was followed by more than 50 percent of the farmers or about 66.67 percent, mostly the attendance of counseling are the owner of the land. Some counselling topics are the manufacture of organic fertilizer, cropping pattern, post-harvest land treatment, on site irrigation, pest control, cultivation and the post-harvest (table 5).

Table.5: The Members of Farmers Group Following the Counseling

Members of Farmers Group	Ever Followed the Counseling from the Government					
	Yes		No		Total	
	n	%	n	%	n	%
Yes	8	29.63%	4	14.81%	12	44.44%
No	10	37.04%	5	18.52%	15	55.56%
Total	18	66.67%	9	33.33%	27	100.00%

Furthermore, table 6 shows the number of farmers who have followed the counseling and implemented the advice. Approximately 37 percent of the farmers who support the advice and achieve the results in their farms. While that who does not perform is 29.63 percent of all farmers.

Table.6: The Members of the Farmers Groups that Follow the Counseling and Implement the Advice

Attends the counseling	Implement the counseling advice					
	Yes		No		Total	
	n	%	n	%	n	%
Yes	10	37.04%	8	29.63%	18	66.67%
No	1	3.70%	8	29.63%	9	33.33%
Total	11	40.74%	16	59.26%	27	100.00%

Furthermore, farmers who ever get the credit from the government is 44 percent, and the farmers who do not get the credit from the government is 56%. The farmer's perception of the climate change in Jatiluwih mostly had heard about the term of climate change, (about 78% of respondent). The rest of the respondent never heard the term climate change. The farmers who have heard this term mostly know the climate change from the television and it is about 95%, while the other 5% heard from the radio. For 86% of the farmers who have heard about the climate change have understood this climate change. The understanding of climate change is proven by a variety of the perceptions about the climate change which are long dry season, reduced rainfall, increasing the hot temperature, reduced the long dry droughts, the move suddenly from the droughts into the rain, and erratic dry rain. The rest 14%, even have heard about climate change, do not understand about climate change. Table 7 illustrates the farmers' perception of the climate change which can be seen through the changing temperature, rainfall, number of the rain days, number of the dry days and flood intensity. Most farmers claim that this climate change can be felt through an increase in temperature, which is about 45.83%. Approximately 25 percent said that the temperature increased and the heat is remaining. Furthermore, the farmers feel that this climate change resulted in the decreased rainfall, about 78.26 percent of the farmers who state this. Only 4.35 percent noted that the amount of the rain did not change. Meanwhile, about 72 percent of the farmers stated that the climate change could be felt regarding decreasing the rainy days or months, while 58.33 percent noted that the climate change could be handled through the increasing of the dry day numbers. When viewed from the intensity of flooding in the river, this climate change decreased the power of the river to flood or watering Jatiluwih. Based on the perception of the farmers, most of the farmers declare the climate change through the decreasing rainfall, resulting in decreasing the rain intensity and the number of the rainy days or months.

Table.7: The Climate Change Impacts Felt by the Farmers

Condition	In-creasing	No Change	De-creasing	Did Not Know
Temperature	45.83 %	25.00%	25.00%	4.17%
Rainfall	17.39 %	4.35%	78.26%	0.00%
Number of the rainy days or months	20.00 %	0.00%	72.00%	8.00%
Number of the dry days or months	58.33 %	4.17%	25.00%	12.50%
Flooding river intensity	4.35%	4.35%	73.91%	17.39%

These changes felt by some of the farmers during the last 5 years by 46 percent of the existing farmers and only 4 percent who claimed that the climate change occurred between 5 to 10 years ago. About 50 percent of the others, they do not remember the starting time of the occurrence of the climate change.

84 percent of the farmers in Jatiluwih stated that the climate change affected the livelihood of them. They think the impact of the climate change with the occurrence of dry fields so that it cannot be cultivated, decreased source water, crop failure due to the unpredictable rainfall, the unpredictable seasons and the increased pest populations. These are the things that failed the harvest in Jatiluwih. Most farmers suffered the losses due to the climate change. Approximately 77 percent of the farmers stated this, while

the only 23 percent did not experience losses. The perceived failures are due to the reduced crops, dead rice, a reduced cultivated land area so that the existing land cannot be developed all, attacked by rodent pests, and anomaly occurs despite the lack of water, but some plants are affected by flooding. For the most part, 84 percent of the farmers claim that this climate change decreases the productivity of the farming, with a decrease of 5 to 10 percent of the crop production in regular harvest time. The farmers in Jatiluwih not only plant the rice crop but also secondary crops, like many other area of upland crop [27]. Some of these crops are planted in both the rice fields and their gardens, such as tomatoes, chili, corn, and flowers. Some of them also plant coffee on their land. According to the farmers, for about 32 percent stated that the climate change is reducing the productivity of other plants. Meanwhile, for about 68 percent of the farmers said that the climate change does not affect the other plants. However, 73 percent of the farmers does not alter their livelihoods due to climate change. While the other 27 percent of the farmers responded to their lives to mitigate the impact of climate change. The farming analysis was used to analyze the comparison of farming system in Tabanan between 2009 and 2014. Table 8 illustrates that the rice productivity in 2015 is higher than that of the rice productivity in 2009, which is about 4.7 percent higher by 2015. The price that occurred between two years, the rate in 2015 increased by about 50 percent from 2009. So, the farmers' income increased for about 122.67%, from IDR 13.70 million to IDR 30.51 million. Meanwhile, there was an increase in the cost of 126.79%, from IDR 5.77 million to IDR 13.08 million. This change in costs and revenues resulted in differences in Revenue Cost Ratio (RCR) and Benefit Cost Ratio (BCR), the ratio between the tax to expense and income against the charges. The value of RCR decreased from 2009 to 2015, from 3.37 to 2.33, as well as for BCR dropping from 1.37 to 1.33 (table 8). Based on the results of the comparative analysis of this farming analysis, it can be concluded that the acceptance of the farmers from 2009 to 2015 has increased in line with the increase in grain prices. This increase, although the increasing revenue of 119.67 percent, but if seen the value of its BCR, it is decreasing. This is because the cost increases higher than the productivity, price and the income [28].

Table.8: Comparison Analysis of the Rice Farming in Year 2009 and 2015

No	Component	2009	2015	Gap
1	Productivity (kg/ha)	6.490	6.780	4,47%
2	Price per kg	3.000	4.500	50,00%
3	Cost	5,770,002.00	13,085,910.00	126,79%
4	Revenue	13,703,682.00	30,514,185.00	122,67%
5	Benefit	7,933,680.00	17,428,275.00	119,67%
6	RCR	3,37	2,33	
7	BCR	1,37	1,33	

Livelihood is a development term which describes the ability, the ownership and the activities of an individual or society against the capital/assets. A sustainable livelihood is a comprehensive approach to overcoming the most critical constraints faced by the community. According to Saragih, this method focuses on the understanding how the individuals and the households derive and use the specific social and economic assets to seek the further opportunities, reduce risk, reduce the vulnerability and maintain or enhance their livelihoods. In doing this analysis, some assets can be called as a form of the rural social life which is *natural capital*, *human capital*, *physical capital* and *social capital* which later can be simplified as a form of the livelihood or pentagon assets.

The output of this analysis is the level of the sustainable livelihood in Jatiluwih village, Penebel, Tabanan with the sustainable livelihood rate obtained from the accumulated level of the livelihood assets (*natural capital*, *human capital*, *financial capital*, *physical capital* and *social capital*). In this analysis, it is compared to the factual circumstances and the ideal conditions or expectations. Given to this difference, it is expected that the existing assets can be directed to achieve the holdings as expected.

Natural Capital Assets

The natural resources capital assets in Jatiluwih are forests and rivers. The community in Jatiluwih is a community whose activities focus on the wetland farming so that the alternative livelihood resources derived from these natural resources are less exploited. Currently, the condition of the river in Jatiluwih is only used for the rice fields only, while the other benefits such as for fishery, still not utilized. Meanwhile, for the forest resources, people tend to preserve the forest even though people know that the forest can generate the alternative sources of the income. The woods are allowed to grow properly without being exploited. This impacts on relatively well-produced grand water, as the community does not use the river water for the fulfillment of the daily living water. Of the total natural resources, the availability of the rivers has a relatively low value due to the reduced water flow, especially in dry season.

Human Capital Assets

Human resources play an essential role in dealing with the climate change, especially related to the local wisdom, counseling, training, and utilization of the information. All these components are highly regarded for the farmers. Some things that the farmers need to improve to increase of these farming are the availability of the skill training for the farmers. This is felt by the farmers, and still low compared to what is expected by the farmers.

The next is the lack of the information about the climate change, farmers are less able to predict the weather condition that will occur [29]. Similarly, to utilize the training and the innovation for the farmers who are also still lacking.

The local wisdom felt by the farmers is relatively good because people activities in Jatiluwih usually based on the local wisdom.

Financial Capital Assets

People in Jatiluwih village are already familiar with many various financial institutions, such as banks, cooperatives, and other micro agencies. The farmers in this village almost all have used the financial institutions, especially banking. The use of the bank is to save or receive the money transfers. In the event of the problems due to the climate change, not a few farmers who take their saving money for the use of daily activities or their business purposes. This is because of the difficulties of the loan seeking from the financial institutions. The farmers feel that the financial capital is significant to their business and their daily activities, except to utilize the informal finances such as the shark loan and bank. This is because the farmers know that these two institutions have a relatively high rate of return, which will make it difficult for themselves if they do not or have not returned the debt.

Physical Capital Assets

Furthermore, for the physical resources, which is seen from the availability of the electricity, water, irrigation, and road. Jatiluwih village is a pleasant village which has enough facilities for all of the public facilities. The village has the electricity availability up to 24 hours, abundant water due to the preserved forest and irrigation system (Subak). This region has a reasonably good road network. The journey from the provincial capital, Denpasar to this area, especially to the village office, reaches approximately 1.5 hours with good road access. Physical resources that have low value is access the irrigation and roads. This is because of the discharge of the sprayed water has begun to decline and access to the agricultural land has not been paved.

Social Capital Assets

The last capital is the social capital, some assets in this group are the farmer groups, indigenous group, and the government. Based on the perception of the farmers, it can be seen that the farmers

feel a need for the availability of the farmer groups and the government in their business availability, but the level of the membership of the indigenous group, although it is crucial but still under the interest of the farmer groups and the government. It can be seen that these two institutions are active in agriculture business activities. The farmers thought that they often utilize the membership of the indigenous people, but in practice, the farmers more often use the farmer group. Integration between cultural and social resources also strengthening the resilience in facing disaster [30]. In other assets, such as the government, the farmers feel that the government is less responsive in fixing the irrigation problems. Overall, the average condition of the farmers in existing the capital asset is higher than the actual situation (figure 2). The most top ideal situation expected by the farmers is physical capital, while the lowest is social capital. It can be seen that the farmers' expectations of the physical capital such as electricity, water irrigation, and roads are relatively higher compared to the other capitals. The provision of the physical capital is not accessible, because it requires a lot of funds. Meanwhile, the social capital is a relatively low value to the ideal conditions, because the social capital in the form of the farmer group, indigenous group and the government-owned by the farmers in Jatiluwih is relatively high. They have a good relationship with the government, indigenous people, and the farmer's group.

Adaptation Strategies

Some strategies which can be done by the farmers in facing the climate change is through the economic, ecological and social adjustment [31]. The adaptation made by the rice farmers aims to reduce the impact of the losses caused by the climate change.

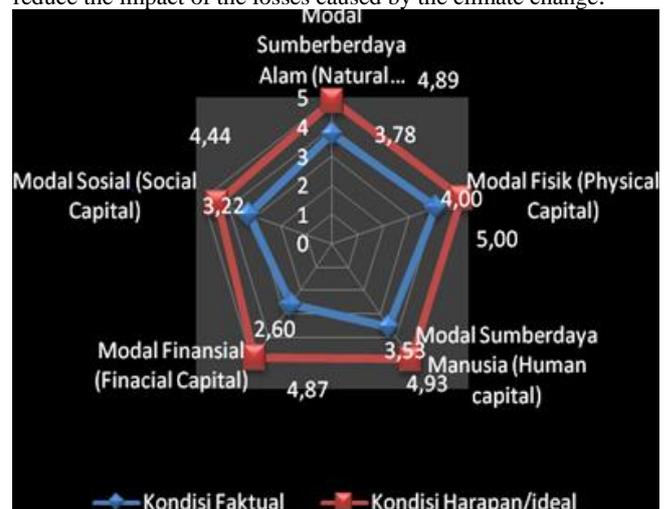


Figure.2: Pentagon Sustainable Livelihood Asset

Economic Adaptation

The economic adaptation consisted of being a non-agricultural worker in the village, becoming a laborer, becoming a city worker, maximizing nonfarm income, using savings, renting his farmland, renting the other land, selling livestock, selling jewelry, selling property, reducing the food consumption per day, owed to formal institutions (banks, cooperatives), and owed to a loan shark.

Based on the interviews with the farmers, the majority of the farmers adapt to meet the economic turmoil resulting from the climate change through the sale of the livestock is 22.22%. In Jatiluwih, most farmers have an integrated farming activity, not only in the agriculture but also in the livestock, trade and others. The second economic adaptation of farmers is as farm laborer, both in neighboring and in the neighboring village which amounted to 7.41%. The utilization of the other non-agricultural activities that can be done in the village, about 7.4 percent, for example, is to become a tour guide. One of the NGO who actively empower the farmers is Yayasan Tri Hita Karana (THK). Tri Hita Karana foundation (THK) Bali through "the spiritual tour" program seeks

to empower the farmers' member of Subak Jatiluwih. This foundation educates the farmers and Subak administrators (Pekaseh) to become the tour guides. The farmers are prepared to be a guide for the tourists visiting Jatiluwih and the surrounding areas. Through the spiritual tour program, the farmers not only sell their products to tourist but also sell the services as the local guides around their farms. Another adaptation is made through the use of the savings deposited in the bank, which amounted to 3.7%. Also, some farmers were looking for the other jobs in the city during the wait for their harvest, which is about 3.7%. The location of Jatiluwih village is not so far from the provincial capital, Denpasar.

Ecological Adaptation

The ecological adaptation carried out by the farmers from several alternative adaptations such as fertilizer intensification, the addition of pesticides, utilizing technology to overcome the problems, changing the pattern of planting, changing the harvest time, changing the crop varieties, changing the agricultural commodities, improving the irrigation channel, creating the ponds, creating drilling well and greening. Most farmers choose the irrigation improvement as one of the adaptations, as the irrigation is essential to their business. The number of the farmers who want the irrigation improvement is 14.81%. Another ecological adjustment done by the farmers is to make the pond which is 7.41%. This need to be done because one function of the lake is to accommodate the rainwater. If there is drought, the farmers will find it easier to get water. Another thing that can be done by the other farmers is to replace the commodities and crop varieties and use the technology to overcome the problems that occur. 77% of the farmers suffered the losses in their business. This happened when the farmers in Jatiluwih have experienced the drought. This water shortage impacts to the lack of the water which commonly used by everyday residents to drink, bathe or raise the livestock. The people who usually get the water from the piped water source must now collect the water from the river and the lake. The farmers in this region are trying to keep doing the business in the field of agriculture, by switching to plant the chocolate and banana.

Social Adaptation

Furthermore, for social adaptation, from several adjustments conveyed, the use of consignments from the relatives: remittances, goods, and food, the use of neighboring networks (money, products, and feeds), the utilization of the government aid, choose the use of the government assistance as the most viable social adaptation. The government is an official institution that should provide the policy for the welfare of its citizens. Some strategies that are done through the government are with the counseling, lending and repair the irrigation channels.

4. Conclusion

Most farmers understand the climate change and mostly receive information from the Television. Most farmers perceive this climate change through the increasing temperature and increasing the number of the dry days. The impact of the climate change is affecting the livelihood of the farmers, farmers who suffered the losses due to the decreased productivity. To reduce the decrease in income, the farmers increase the use of the inputs, thus affecting the farmers' income: there was an increase in productivity and revenue, but this increase is lower than the increased costs incurred by the farmers. This resulted in lower real revenues of the farmers in 2015 compare to income in 2009. There are three strategies undertaken by the farmers; economic, ecological and social adaptation. The expectations of the farmers to the existing capital assets is higher than the actual circumstances. The ideal situation that the most expected by the farmers is the physical capital, while the lowest is social capital. Meanwhile, for the ecological adaptation, the communities are trying to improve the irrigation chan-

nels, create the ponds and replace the commodities and utilize the appropriate technology. As for the social adjustment, the people expect the help from the government.

Acknowledgment

This research is funded by the grant from Universitas Bakrie, contract no 132/SPK/LPP-UB/V/2017

References

- [1] Y. Apriyana and T. E. Kailaku, "Variabilitas iklim dan dinamika waktu tanam padi di wilayah pola hujan musunal dan equatorial," *Pros Sem Nas Masy Biodiv Indon*, vol. 1, no. 2, pp. 366–372, 2015.
- [2] A. Mursidi and D. A. P. Sari, "Management of Disaster Drought in Indonesia," *J. Terap. Manaj. DAN BISNIS*, vol. 3, no. 2, p. 165, Oct. 2017.
- [3] D. Hartama, H. Mawengkang, M. Zarlis, and R. Rahim, "A Research Framework of Disaster Traffic Management to Smart City," in *2017 Second International Conference on Informatics and Computing (ICIC)*, 2017, pp. 1–5.
- [4] W. Adger *et al.*, "Adaptation to climate change in the developing world," *Prog. Dev. Stud.*, vol. 3, no. 3, pp. 179–195, 2003.
- [5] D. Ayu, P. Sari, A. Sugiana, R. Y. Ramadonah, S. Innaqa, and R. Rahim, "Kampung Pulo Environmental Planning Observed From Biophysical Aspects As Adaptation of Flood in Jakarta," *Int. J. Eng. Technol.*, vol. 7, no. 2.3, pp. 82–87, 2018.
- [6] D. A. P. Sari, S. Innaqa, and Safrilah, "Hazard, Vulnerability and Capacity Mapping for Landslides Risk Analysis using Geographic Information System (GIS)," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 209, no. 1, p. 012106, Jun. 2017.
- [7] V. O. Wati, D. A. P. Sari, and S. Sutisna, "Disaster Relief as Indonesia Soft Power Diplomacy Case of Cyclone Pam in Vanuatu," *Int. J. Multi Discip. Sci.*, vol. 1, no. 1, pp. 58–69, Feb. 2018.
- [8] N. Mamnunia, D. A. P. Sari, and H. Heridadi, "The Influence of Leadership and Competence in Puskesmas Preparedness for Supporting Flood Disaster Management (Case Study of Samarinda City in East Kalimantan Province, Indonesia)," *ADRI Int. J. Environ. Disaster Manag.*, vol. 1, no. 1, pp. 18–26, Jun. 2017.
- [9] D. A. P. Sari, F. Rumambi, and Ratih Nurmasari, "Social Economic Resilience in Facing Land and Forest Fire Disaster," vol. 4, no. 1, pp. 10–16, 2018.
- [10] D. A. Puspito Sari, I. Listiyowati, T. Nefianto, and Lasmono, "The Discrepancy between The Programs and Disaster Management Policy in Klapanunggal District, Bogor, West Java," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 135, no. 1, p. 012011, Mar. 2018.
- [11] IPCC, *Climate change 2001: Impacts, Adaptation, and Vulnerability*. 2001.
- [12] D. A. P. Sari, "Changes in the Upland Crop Farm Economy in INDONESIA," *TOHOKU J. Rural Econ.*, vol. 28, no. 2, pp. 30–37, Aug. 2010.
- [13] L. Krantz, "The Sustainable Livelihood Approach to Poverty Reduction An Introduction," 2001.
- [14] M. Waqid, H. D. Utami, dan Bambang Ali Nugroho, and M. Fakultas Peternakan Universitas Brawijaya, "KAJIAN SUSTAINABLE LIVELIHOOD FRAMEWORK PADA RUMAH TANGGA PETERNAK BROILER MANDIRI DI KECAMATAN GANDING KABUPATEN SUMENEP MADURA."
- [15] S. Al Idrus, A. S. Ahmar, and A. Abdussakir, "The Effect of Organizational Learning on Market Orientation Moderated By Job Satisfaction," *Cogent Bus. Manag.*, vol. 5, no. 1, p. 1475048, 2018.
- [16] S. Al Idrus, A. S. Ahmar, and Abdussakir, "Contribution of Organizational Learning and Market Orientation on Business Unit Performance Mediated by Job Satisfaction at Dairy Cattle Milk Cooperatives in East Java, Indonesia," *J. Rev. Glob. Econ.*, vol. 7, no. 1, 2018.
- [17] J. Suyono, A. Sukoco, M. I. Setiawan, S. Suhermin, and R. Rahim, "Impact of GDP Information Technology in Developing of Regional Central Business (Case 50 Airports IT City Development in Indonesia)," in *Journal of Physics: Conference Series*, 2017, vol. 930, no. 1.
- [18] T. Deressa, R. M. Hassan, and C. Ringler, "Measuring Ethiopian farmers' vulnerability to climate change across regional states," *Food Policy*, vol. 806, no. October, p. 32, 2008.
- [19] A. S. Ahmar *et al.*, "Modeling Data Containing Outliers using ARIMA Additive Outlier (ARIMA-AO)," *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.

- [20] U. Khair, H. Fahmi, S. Al Hakim, and R. Rahim, "Forecasting Error Calculation with Mean Absolute Deviation and Mean Absolute Percentage Error," *J. Phys. Conf. Ser.*, vol. 930, no. 1, p. 012002, Dec. 2017.
- [21] A. Indahingwati, M. Barid, N. Wajdi, D. E. Susilo, N. Kurniasih, and R. Rahim, "Comparison Analysis of TOPSIS and Fuzzy Logic Methods On Fertilizer Selection," *Int. J. Eng. Technol.*, vol. 7, no. 2.3, pp. 109–114, 2018.
- [22] M. I. Setiawan *et al.*, "E-Business, The impact of the Regional Government Development (APBD) on Information and Communication Development in Indonesia," *J. Phys. Conf. Ser.*, vol. 1007, no. 1, p. 012045, Apr. 2018.
- [23] D. Napitupulu, M. Syafrullah, R. Rahim, D. Abdullah, and M. Setiawan, "Analysis of user readiness toward ICT usage at small medium enterprise in south tangerang," *J. Phys. Conf. Ser.*, vol. 1007, no. 1, p. 012042, Apr. 2018.
- [24] N. Singh and J. Gilman, "Employment and Natural Resources Management: A Livelihoods Approach to Poverty Reduction."
- [25] P. Sebastian Saragih Jonatan Lassa Afan Ramli, "Kerangka Penghidupan Berkelanjutan Sustainable Livelihood Framework," 2007.
- [26] D. A. P. Sari and S. Kawashima, "Poverty Mapping And Poverty Analysis In Indonesia," *J. Agro Ekon.*, vol. 28, no. 1, p. 95, Aug. 2016.
- [27] A. Farobyfaltehan, F. D. Raswatie, and D. A. P. Sari, "Planting and Consumption Patterns of Upland Rice Farmer in Indonesia," vol. 1, no. 1, 2017.
- [28] I. M. S. Priandika, "Pola Kemitraan Komoditi Padi Sawah Antara P4s Sri Wijaya Dengan Subak Batusangian, Desa Gubug, Kecamatan Tabanan, Kabupaten Tabanan," Universitas Udayana, 2015.
- [29] D. A. P. Sari, M. Malahayati, T. Nefianto, and I. Kertawidana, "Disaster Early Warning and Information Services Meteorology, Climatology and Geophysics Agency's Employees Performance Observed from their Motivation and Competency," *Int. J. Multi Discip. Sci.*, vol. 1, no. 2, pp. 129–136, Apr. 2018.
- [30] D. A. Puspitosari and R. Afriono, "The Integration of Cultural Resources Management in Disaster Management at Special Region Province of Yogyakarta," *Sinergi J. Ilm. Ilmu Manaj.*, vol. 7, no. 1, Jul. 2017.
- [31] T. Budiarti, Suwanto, and I. Muflikhati, "Pengembangan Agrowisata Berbasis Masyarakat pada Usahatani Terpadu guna Meningkatkan Kesejahteraan Petani dan Keberlanjutan Sistem Pertanian (Community-Based Agritourism Development on Integrated Farming to Improve the Farmers ' Welfare and the Sustastai," *J. Ilmu Pertan. Indones.*, vol. 18, no. 3, pp. 200–207, 2013.