THE CLIMATE CHANGE AND THE LOST OF PRIMARY ECONOMIC SOURCES OF RAINFED PADDY FARMERS: A CASE STUDY FROM NAGARI SIMAWANG, WEST SUMATERA, INDONESIA

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ABSTRACT

This paper presents the result of the preliminary study on the impact of climate change on rural livelihood in one small village (Nagari2 Simawang), subdistrict of Rambatan West Sumatera, Indonesia This study was supported by the PEER-UsAID program from 2012-2015 *to learn about the dynamic of climate change and natural resources management in the surrounding Singkarak Lake in West Sumotera from June* 2012 *to Mei* 2015. *From the preliminary study that was conduct from August* to *November* 2012, *it is found that for almost* 10 *years, the rainjed paddy-field area in this village could not be cultivated for their paddy or other food crops due* to *the unavailability of water. While, before that, this paddy-field was the main source of staple food for all inhabitants in this village and even able* to *supply for their neighbors. Various adaptive strategies done by farmers in group actions within this village have been identified, not only by male but also by female farmers, for instance in raising cattle in their rainfed-paddy field area. However, not allfarmers successful with their adaptive actions. While many of families have been forced to migrate to several capital cities for their own lives. Further research actions is being applied to develop better adaptive strategies using participatory approach by involved relevant stakeholders including government and private agencies within the area.*

Keywords: *water resources, rainfed-paddy farmers, adaptive strategies, rural livelihoods*

INTRODUCTION

The facts of the increased of the earth temperature is not an issue or just a public opinion anymore. Various results from scientific researches using global climate data have been published internationally in various forms of publication; journal, books, working papers, and etc. On the IPee (2007a) report, it was stated that the changes of land uses and deforestation in the tropical region has lift up around 1.7 billion ton of carbon to the atmospheres. Moreover, it was globally reported that if there is not much changes of the exploitation activities of natural the year of 2100, that of course will worsely affects the balance of energy in the atmosphere and the hydrological cycle in the earth surface.

Findings from relevant researches, either at global, regional or local level, have been reported in numerous publications in order to develop people awareness about the reality of climate changes. Salih (2009) has published his editorial book consists of researches findings about the relationship between the climate changes and sustainable development in many parts of the world, that were corning out from various experts from various discipline. In this book, Salih has given his notes that the impact of climate changes has not only influences the food availability or even food security but also creates conflicts in many aspects, social, political, cultural, market and environmental conflicts.

In Indonesia, the publication of research findings related to the concrete model of adaptation and mitigation of adaptive agricultural system at regional level are relatively low, either in national or international publications. The research team from Andalas University got the research grant from PEERUSAID (from June 2012 to Mei 2015) to conduct a research about the dynamic of climate change and natural resources management in the region where for almost three decades has been investigated by numerous researchers from various backgrounds, that is in the surrounding areas of Singkarak Lake. Significant issues or problems of natural resources in this region have been widely published, especially about the conflict of water resources management in Singkarak Lake and the forest degradation in the catchment of Singkarak and the catchment of agam-kuantan in general. The catchment degradation that reduced sharply the land cover of the region have influenced the hydrological cycle within the region. One of the main concern of this research is about the agricultural and livelihood changes in the surrounding Singkarak, because the region in the surrounding Singkarak Lake is located in the rain-shadow area *(daerah bayang-bayang hujan)*which usually dried and have uncertainty of rainfall.

The preliminary visits to the region in the first-two months of the project, has identified one specific issue in the eastern part of Singkarak, that is in Nagari Simawang, subdistrict of Rambatan, Tanah Datar. Key informants from this Nagaris have mentioned that their rainfed, paddy field have been suffering from the lack of water and uncertainty of rainfall for more than 10 years. More than 50 ha paddy- field who usually got enough water from their natural reservoir *(embung or talago)*, could not be cultivated anymore for more than 10 years. Their natural reservoir *(talago or embung)* as the main source of water, did not able to keep water for long, even for one season of paddy. As the consequences, unlike before, most of household farmers now have to buy their rice for daily consumption or depended on the rice subsidy program *(beras miskin* or *raskin)* from the government.

Based on the above mentioned background and research problems, this preliminary study, that was conducted from September to November 2012, have three main objectives, are:

- to analyze the empirical facts of climate change in the study site,
- to describe the impact of climate change to the agricultural activities and the livelihoods of the local communities in the study site, and
- to identify the alternative strategy of adaptation and mitigation.

REVIEW OF RELEVANT LITERATURES

In accordance to the objectives of the study, previous research publications from the case site and other relevant references are then reviewed here in order to develop specific framework and methodology. Helmi (2003) have explored the issues of water management conflict in Singkarak, specifically Lembang basin in the upstream and Ombilin basin in the downstream of Singkarak lake. One important point from Helmi is the issues of integration among various stakeholders within the Singkarak lake basin, not only farmers or water users, but also adminitrative sectors from two district government, and private and government-owned companies. The author, furthermore, recommended the importance of integrating all stakeholders into one institutional framework that may able to accomodate the construction of integrated water resources management (IWRM) pattern from the upstream upto the downstream of Singkarak Lake.

Febriamansyah (2004) have also presented the result of his study on water resources management in the Ombilin-Singkarak sub-basin in the international round-table discussion - in Padang. This study have identified various water resources management problems within the sub-basin, including, flood, land slide, water pollution, water conflict, catchment/forest degradation and also issues that coming out from other users like inland fishery, mining and electric plants. As like Helmi, Febriamansyah has also recommended a holistic approach to integrated various stakeholders of water resources management that may able to help one new body of water resources management called Balai Pengelolaan Sumberdaya Air (BPSDA) Kuantan-Indragiri assigned under the Water Resources Management Agency of West Sumatera Province.

In the context of the impact of climate changes to agricultural system, several international publications have identified various indications. Brown and Funk (2008) has identified that the real direct impact of climate changes for the last decade is the changes of agricultural pattern and food system. This is also been mentioned by Schmidhuber and Tubiello (2007), which specifically stated that all quantitative assessment shows four aspects of agricultural changes due to the climate changes, are: food availability, food stability, food uses and access. In their quantitative prediction model, they predicted that between 5 to 170 million people will be lack of food (hunger) in 2080.

In the context of the development of methodology that study the relationship between the climate change and agriculture, Parry (1990) has given the first step of empirical quantitative method to predict the impact of climate changes to agricultural conditions in several countries in Asia, Africa and America. The impacts did not only on plant growth, but also the impact to the condition of the agricultural land, plant diseases and pest, and also food productivity. Here, Parry has simply used the mathematical functions to develop prediction model that link the determination of climate change to the agronomy and other technicalaspects of agriculture. Research and modelling that was developed by Parry is actually a reflection from the

study of IPCCthat was published earlier, where IPCC mentioned the general prediction of the worse impact of climate changes if there is not much changes of human behavioral pattern in natural resources exploitation.

FAO's Interdepartmental Working Group (IDWG) on Climate Change (2008), which was lead by Wulf Killmann has published one guidance material or framework that could beused by researcher to analyze the impact of climate change to agriculture and identify the alternative for adaptation and mitigation. This document presents wide and complete description about various possibility of impacts due to the global warming and climate change to food system and food security. Moreover, this book explores various potential strategy of adaptation and mitigation that could be done to maintain the food security conditions.

Dinar et.al. (2009) triedto answer this challenge by developing simulation model that could be used by decision makers in African countries that generally depended on agriculture sectors. With their agriculture economic background, Dinar has involved the research team from various discipline to analyze the interrelationship between climate variability and crop analysis. Therefore,this study has elaborated various aspects; hydrology, climatology, and agricultural system, using cross-sectional and historical data. In addition, based on their quantitative simulation model from the above mentioned data, they have successfully developed synthetic model for each country to be used to design their sustainable agricultural development strategies that more adaptive to the climate changes.

Intenational organization like OECD (Organization for Economic Cooperation and Development) have also supported the discovery of analytical model for adaptive agriculture in regard to the climate changes. Wreford et.al. *(201D)* have received the research grant from OECD to explore the impact of climate changes specially to agriculture. The approached used by Wreford et.al., to develop adaptation and mitigation pattern is more economic and public policy approach.

RESEARCH METHODOLOGY

In general, this preliminary study used the combination of qualitative and quantitative approach. The method is the modification of the frameword developed by previous study that was available in three main references; that are: FAO (2008), Dinar et.al. (2009), and Wreford et.al. (2010),

First, to analyze the climate (rainfall) variability in order to assess the indication of climate change in the case site, this study use the schmidth-fergusson method to identify the changes or the shift of wet, dry and humid months of the 30 years data from the closest rainfall station in the subdistrict of Rambatan.-

Second, to identify the changes of agricultural and livelihood activities in the case site, this study applied the households survey to the community who have the paddy-fields in the rainfed area *(sawah tadah hujan)* that was locally called *hamparan sa wah ketaping*. Since there area around 75 HH have paddy-field in this *hamparan*, this study have chosen 30% of them as the respondent. While, in order to enrich the information about the changes

of agricultural system in the case site, this study has conducted a focused group discussion (FGD) with relevant key informants, such as agriculture extention officers, nagari and jorong leaders and other key persons in the Nagari Simawang. The FGD was also done with the purpose of identifying the alternative strategies of adaptation and mitigation.

PRELIMINARY FINDINDS

OVERVIEW OF THE CASE SITE

Nagari Simawang is located in the eastern part of Singkarak Lake in West Sumatera that is administratively under the District of Tanah Datar (see Figure 1.). The area of Nagari is nearly 5,400 ha that consists of 8 jorong or sub-villages; *Koto Gadang, Derek, Baduih, Padang Data, Ombilin, Batulimbak, Pincuran Tujuah and Piliang Bendang.*

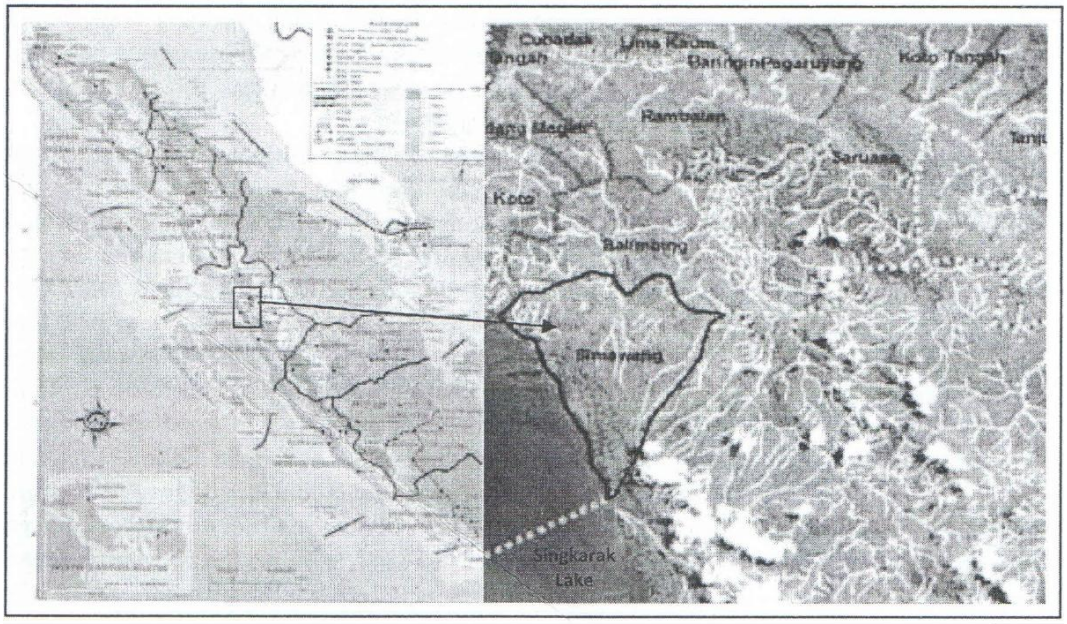

Figure 1. The Study Site, Nagari Simawang in West Sumatera

As written in the Nagari profile book in 2012, the population of Nagari Simawang is 1.952 households or approximately around 9.000 inhabitants. The majority of households are working as farmers, and around a quarter of that are considered as poor households who are registered to get regular rice subsidy (wellknown as *beras miskin* or *raskin).*

According to Sandy (1987) the western part of Sumatera island usually get maximum rainfall in November and December, and minimum rainfall in July or August. In addition, according to Koesmaryono et.al. (1999) the impact of EI-Nino that usually bring longer period of dry season, are not too strong in the equatorial region, including the region of West Sumatera Province.

Since Sumatera island is divided by the long mountainous area called *bukii barisan* from North to South, the climate condition in eastern part of

bukit barisan get lesser rainfall than the western part, and the area is known as the rain-shadow area. It is included the area around Singkarak lake and also the region of Simawang in the eastern part *of Bukit Barisan.*

THE CliMATE ANALYSIS

During this preliminary study, we analyzed the rainfall variability in the case site using the rainfall observation data from the closest station in subdistrict of Rambatan. Before the current data is analyzed, this study also identified the results of rainfall analysis from the previous studies. Siamet and Berliana (2008) used a wellknown Schmid-Fergusson method to identify the shift of the rainfall pattern in Solok (close to Rambatan). The rainfall rate every month for each period is.identified as dry, humid or wet month. Then, in order to state the status for each month for long period of records, they just calculated the mode of the occurrence of wet, dry of humid month at each period. As a result, Figure 2 shows us that the dry season has shifted from May in the period of 1951-1975 to June in the period of 1976-2000. While, when they added the record upto 2003, the dry season became uncertain where the wet months from April to October and from January to February.

Period	A	M	J	J	A	S	O	N	D	J	F	M
1951-1975		X	X	X	O							
1976-2000			X	O	X	X						
1976-2003								X	O			X

X dry month: < 60 mm
O humid month : 60 - 100 mm
wet month: > 100mm

Figure 2. The Shift of Rainfall Pattern From The Previous Study

This study then tried to identify the local climate change using the observed rainfall data from Rambatan rainfall station. Figure 3 shows the yearly pattern of wet, dry and humid months based on Schmid-Fergusson method. It could be seen here that the rainfall pattern since the last 10 years are very uncertain compare to the previous period (or before 1990s) where the dry season for about three or four months will usually started in June. Then, from November to May (about 7 to 8 month) were considered as wet months where the rainfall rate were usually high or above 100 mm. From our discussion with key informants, the earliest pattern of rainfall were identified by them, that mentioned the availability of water in their natural reservoir *(embung* or *talago)* to support their rainfed-paddy field for two short season during the wet months. Since more than the last 10 years, farmers facing the uncertainty of wet months in the case site. Their talago (called *talago janik)* could not able to keep water for long to support even one season of paddy in their rainfed areas.

Year	MONTH											
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
1982						O	X	X	X	O		
1983						O	X				O	
1984						O		X	O	O		
1985				O		X	X	X		O		
1986						X	O	X			O	
1987						O	X		O		O	
1988							O			X		
1989				X	X	X	X	X				
1990						O	O	X	O			
1991		O				O	X	X	X	X		
1992						X		X		X		
1993		X	X			O		X				X
1994						O	X	X	X	O		
1995			X			X	X				O	
1996					O		X		O	O		O
1997		X	O			O		X	X	O		O
1998						O					X	O
1999			O	X			O				O	
2000		O	O	O	X	X	O			X		
2001		O	X			X	O	X		O	X	
2002		O				X						
2003					X	O	O					
2004					X	O		X				
2005		O			O	O					O	X
2006		O		O			X		O			
2007		O	O			O			X		X	
2008	O				X	X				X	X	X
2009					X		O					X
2010						X				X		
2011						X	X	O				O

Figure 3. The Shift of Rainfall Pattern in The Case Site

THE AGRICULTURE AND LIVELIHOOD CHANGES

As mentioned earlier, the changes of seasonal pattern of rainfall has created the uncertainty water availability for the rainfed-paddy area in the case site. Although there are more than 100 ha of rainfed-paddy area in Nagari Simawang, this study focused on the area called *hamparan so wah ketaping* of around 50 ha which approximately owned by around 75 farm households who live in *Jorong Darek* and *Jorong Koto Gadang* (Figure 4). Beside from the direct rainfall, the their paddy- field could get the water flow from *talago janik* with the distance of 500 meters from the *hamparan* and one spring within the hamparan.

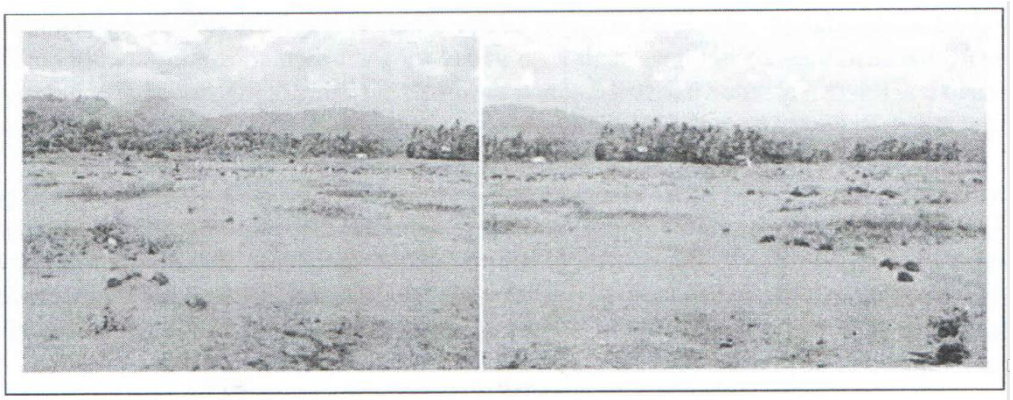

Figure 4. Current Rainfed Paddy-Field *(sawah tadah hujan in hamparan sawah ketaping)*

From the sample survey of those farm households (HH), the average area of paddy-field per HH are around 0.4 ha (see Table 1.). Before the dry period, almost all of respondents ableto cultivate their sawah for twice a year, mainly during the wet season from October/November to April/May. One of the key informant during the FGD evenmentioned that when he moved to Jorong Koto Gadang by marriage in 1998, he still able to cultivate paddy for two season using the spring water within the hamparan, but one year after that when the spring water became unstable, he could hot able to plow it anymore.

Before dried period	
average rainfed paddy field	cultivate 0.4 ha rainfed paddy, for almost twice a year
average production	1.400 kg Gabah per season
sold paddy	20% HH sold their paddy for about 25% of yield
dry-land farm *(Iadang)*	40% HH cultivate their dry land for cassava, corn and sometimes chili

It was also identified by the sample survey that from the average production of their rainfed paddy-field of around 1,400 kg per season, 20% of HH used to sell their paddy for about 25% of their yield. Beside having income and staple food from their rainfed paddy- field, 40% of HH have also the dryland *(Iadang or parak)* which was cultivated for cassava, corn and sometimes chili

Since the last ten years, when the rainfall were uncertain and the water volume air talago janik were much lower than usual, farmers started to left their paddy-field uncultivated one by one. One key informant even mentioned that the decrease and uncertainty of rainfall had influenced the confidence offarmers to cultivate their paddy-field They have failed for many times. When they tried to plow their field after few days of raining, and then started with nursering their seed *ibenih],* the rainfall did not come for a bit long and their field became hard and hard to be planted.

Table 2 shows the summary of sample survey about the current condition of their farming activities. Only around 5 HH still able to cultivate

their rainfed-field for at least one a year. They mainly use the spring water within the paddy-field area, that usually still able to water for around 2 ha of paddy-field. It is identified that, at this time most of them (42%) working as farm labour who work on other paddy- fields in Nagari Simawang or neighbor's Nagari. Because they do not have their own paddy for their own consumption, 80% of HH used to buy their staple food from market and even 40% of them are registered as poor family to get the rice subsidy from the government.

Those who have skill as building worker (25%), work as ready regular labour for housing or furniture. The other respondent mentioned their current occupation as small trader *(warung, kedai* or coffee house) and other services. Migration became one escape strategy for young people. Almost 75% of HH mentioned that some of their member have migrated to the city like Pekan Baru, Padang or even Jakarta. Information from the FGD even mentioned that the migration from Nagari Simawang mainly started from 1980s and becoming higher in 1990s.

Table 2. The Current Condition of Farm HH on The Dried Period

On the dried period (current condition)	
% HH cultivate their rainfed paddy field	Only 5% (around 5 HH) still able to cultivate their rainfed field, for at least one a year
% HH own cattle average cattle per HH	field, for at least one a year 25% HH (started from 1990s) 3 cattle (sapi/kerbau) and 3 goats (kambing)
rice acquisition	20% HH cultivate another paddy fields 80% HH buy from market 40% HH got rice subsidy *(raskin*
Other sources of income	42% HH working as farm labour 25% HH working as building labour 13% HH working as trader (coffee shop or warung) 21% HH work in other services
migration	Almost 75% of HH mentioned that some of their members migrate to the nearest city, and 10% of them have migrated since 1980s

It seens that 25% of Household raising cattle in the open grazing in their rainfed area. Averagely, each HH have three cattle either cow or carabau. However, this individual cattle management have to conflict with agriculture activities in the rainfed area, because it gives less opportunity for farmer to plant the cash crop in this area. If we look at the secondary data, the impact of

climate change could also be related to the changes of land use cover in Nagari Simawang and its surrounding area. Figure 5 shows the changes of land use from three different years. In detail, the tabulation of each land use in Nagari Simawang is presented in Table 3.

This table shows that the paddy-field area decreased sharply from 245 ha in 2000 to 185 ha in 2008. Beside it has been changed to settlement, this paddy-field area has mainly became *semak-belukar* or grass area.

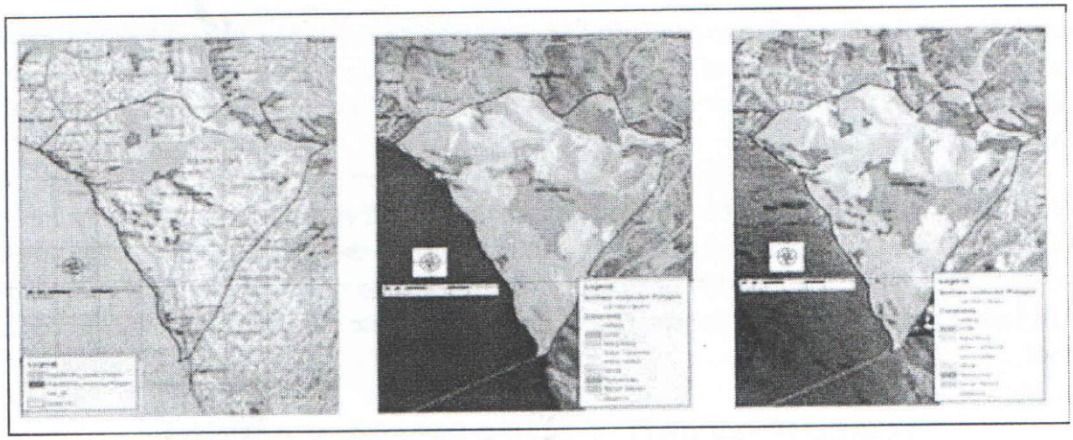

Figure 5, Land Use Map of Simawang in 1976, 2000 and 2008

Table 3. Landuse Changes in Nagari Simawang

No	Jenis lahan	1976		2000		2008	
		Ha	%	Ha	%	Ha	%
1	Paddy-field	131,60	5,33%	245,83	9,96%	185,51	7,52%
2	Settlement	156,50	6,34%	159,99	6,48%	209,67	8,50%
3	Road	13,40	0,54%	14,56	0,59%	15,66	0,63%
4	Dry land (Iadang)	503,43	20,40	628,23	25,46%	1078,2	43,69%
5	Water body (talago)	66,21	2,68%	52,98	2,15%	50,48	2,05%
6	Pine forest	207,09	8,39%	125,58	5,09%	70,19	2,84%
7	Semak belukar	530,17	21,48	437,62	17,73%	26,52	1,07%
8	Alang-Alang (grass area)	303,92	12,32	98,98	4,01%	102,23	4,14%
9	Kebun campuran (mix farm)	497,20	20,15	645,75	26,17	671,06	27,19
10	Kebun kelapa (coconut farm)	58,29	2,36%	58,29	2,36%	58,29	2,36%
		2.467,81	**100%**	**2.467,81**	**100%**	**2.467,81**	**100%**

ADAPTATION AND MITIGATION OF CLIMATE CHANGES

The terms of "adaptation" and "mitigation" are two important terms that are fundamental in the climate change debate. According to IPee (2007b) adaptation "are actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climate conditions." This definition is not much different with the understanding of Mitchell and Tanner (2006), where according to them, adaptation is the behaviour of people or group of people or natural systems in a

adjusting their condition to the changes of climate and their environment. In related to that, the mitigation is defined as a systematic and direct action to the causes of climate change.

From that understanding, the adaptation is understood as actions that may tackle the effects of the climate change, and the mitigation is understood as an action that may tackle the causes of climate change. In general, the more mitigation efforts done by human activities, the less will be the impacts to which we will have to adjust, and the less the risks for which we will have to try and prepare.

In Nagari Simawang, in line with the adaptation efforts done by the local people, the local government (district and provincial government) have tried to develop adaptation and mitigation actions to help the livelihoods in this Nagari. One adaptation action has been done by the Dinas Peternakan (Animal Husbandry Agency) through the cattle (cow) development program started in 2010. The agency has given an assistance to a group of farmers in Jorong, Koto Gadang to raise the cow in a group management system. They have given funds (revolving fund) to the group to provide all input factors to raise the cattle as the alternative sources of income. Around 10 offarmers involves in this group to raise 10 cows in their group cage. In order to provide water for this cattle, the agency has build the water pond from a small spring close to the cage.

In term of mitigation effort, in 2011, the Public Work agency has rehabilitated the *talago Janik* in the purpose to increase the capacity of this natural reservoir. However, according to the key informant, due to a technical method done by the agency that digged the talago too deep, the porosity of the surface were ruinned and resulting higher porosity than before. After one year of construction, *talago Janik* could not keep the rainfall water for long.

CONCLUSION AND FURTHER RESEARCH AGENDA

The preliminary study of the 3 years period of PEER-USAIDresearch grant in the study site, at least, got several conclusions, are:

1. The facts of global warming have influence the local climate change in the surrounding Singkarak Lake as the rain-shadow area.
2. The changes of the seasonal pattern of rainfall could be the indication of local climate change in the case site.
3. The rainfall variability in the case site shows the uncertainty of rainfall season that affect the uncertainty of water availability for the rainfed paddy in Simawang
4. Various adaptive strategies have been implemented by the affected farm households, such as, raising cattle, working as farm labour, small trading and migrate to the nearest cities/town.
5. Local government have tried to help the people by introducing the cage system of raising cattle and rehabilitated their natural reservoir *(talago Janik)*. The first assistance could able to reached 10% of HH only, while the rest are raising the cattle individually in the open field of their rainfed area. This individual cattle management have to

conflict with agriculture activities in the rainfed area, because it gives less opportunity for farmer to plant the cash crop in this area.

From that conclusion, this study has defined the agenda for further research activities, such as:

- conducting an in-depth study and action research on the institutional and management aspects to support:
  - integrated farming system in the rainfed areas.
  - nursery business and conservation action to their degraded land
- conducting an agroecotechnology study to discover a suitable rice variety for the dry land *(padi gogo)*

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REFERENCES

Brown, Molly E. and Christopher C. Funk. 2008. Food Security under Climate Change.In Science 1 February 2008, *Vol*. 319 *no*. 5863 *pp. 580-581*

Dinar, Ariel., Rashid Hasan, Robert Mendelsohn, and James Benhin. 2009. Climate change and agriculture in Africa: Impact Assessment and Adaptation Strategies. Earthscan Publication Limited: London, UK.

FAO's Interdepartmental Working Group (IDWG) on Climate Change, 2008. "Climate Change and Food Security: A framework document". FAO: Rome

Febriamansyah, 2004, Institutional Development for Ornbilin-Singkarak sub-Basin. Presented in International Roundtable Discussion, ICRAF, Padang March 2004.

Helmi. 2003."Role Sharing dalam Pengelolaan Sumberdaya Air". Makalah dipresentasikan dalam Sosialisasi Kelembagaan Balai PSDA di Sumatera Barat. Padang 14 Oktober 2003.

IPCC, 2007a. Summary for policy makers. Climate Change 2007: Synthesis Report. Fourth Assessment Report of the Intergovernmental Panel for Climate Change. [Available online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdfJ

IPCC, 2007b. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Mitigation of Climate Change. [Available at: http://www.ipcc.ch/ipccreports/ar4-wg3.htm.J

Koesmaryono, Y., R. Boer, H. Pawitan, 1999. Pendekatan IPTEK dalam Mengantisipasi Penyimpangan Iklim. dalam Prosiding Diskusi

Panel, Strategi Antisipatif Menghadapi Gejala Alam EI-Nino dan l.a-Nia untuk Pembangunan Pertanian, PERHIMPI. Bogor

Parrv, Martin, 1990. Climate Change and World Agriculture. Earthscan Publication Limited: London, UK.

Sandy, I.M. 1987. Iklim Regional Indonesia. Jurusan Geografi FMIPA Universitas Indonesia. Jakarta.

Salih, Mohammad (editor). 2009. Climate Change and Sustainable Development: New Challenge for Poverty Reduction. Edward Edgar Publishing: Chentelham, UK.

Schmidhuber, Josef and Francesco N. Tubiello. 2007. Global Food Security under Climate change. in *PNAS (Proceeding of National Academy of Sciences), December 11,2007 vol. 104 no.* 50 *19703-19708*

Slamet S., Lilik and Sinta Berliana 5., Indikasi..... Prosiding seminar nasional Pemanasan Global ... Fakta, Mitigasi dan Adaptasi.

Tanner, Thomas and Tom Mitchell, 2008, Entrenchment or enhancement: could climate *I* change adaptation help reduce poverty? Working Paper No.l06. The Chronic Poverty Research Centre, Institute of Development Studies (IDS): University of Sussex, Brighton

Wreford, Anita., Dominic Moran and Neil Adger. 2010. Climate Change and Agriculture: Impacts, Adaptation and Mitigation. OECD: France