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Rural Households' Vulnerability Assessment to Climate Variability
The Case of Peang Lvea Commune, Odongk District, Kampong Speu Province, Cambodia

Cheb Hoeurn

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The Case of Peang Lvea Commune, Odongk District, Kampong Speu Province, Cambodia

Cheb Hoeurn

December, 2013

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List of Abbreviations

ADB	:	Asian Development Bank
CC	:	Climate Change
CDRI	:	Cambodia's Leading Dependent Development Policy Research Institute
EEPSEA	:	Environmental and Economic Programme for Southeast Asia
IOM	:	International Organization for Migration
IPCC	:	Inter-Governmental Panel on Climate Change
MAFF	:	Ministry of Agriculture, Fisheries, and Forestry
MoE	:	Ministry of Environment
MoH	:	Ministry of Health
NCDD	:	The National Committee for Sub-national Democratic Development
NCDM	:	National Committee for Disaster Management
NGO	:	Non-Governmental Organization
NIS	:	National Institute of Statistics
RGC	:	Royal Government of Cambodia
RUPP	:	Royal University of Phnom Penh
UNDP	:	United Nations Development Programme
WB	:	The World Bank
WFP	:	World Food Programme

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Abstract

Cambodia is one nation that is most vulnerable to climate variability and change. The effects of climate change– if as severe as predicted – may erode efforts to alleviate poverty and food security of farmers. While climate change vulnerability assessments are considered as a principal vehicle for informing the need for adaptation, there have been few studies on climate change vulnerability at the community level in Cambodia, where these effects are often the hardest. This study aims to address this knowledge gap through a vulnerability assessment study at the grassroots level.

The study seeks to assess vulnerability levels by examining this at the household level, their exposure, sensitivity and adaptive capacities to respond to climate variability and change – particularly drought. Qualitative and quantitative data was used in the study, with information from both primary and secondary sources. One hundred and eighty villagers were involved in the household survey while six participants were involved in the in-depth interviews (Key Informant Interviews).

The study found that Peang Lvea Commune is vulnerable to climate change variability. Most households in Peang Lvea Commune (86.3 per cent) are vulnerable to climate variability – particularly drought –due to a low degree of exposure, medium sensitivity, and low adaptive capacity. They have a low exposure degree because they have never experienced any hazards besides of drought, and drought does not frequently occur in the commune, for example, households only maximally experienced drought for three years since 2005 to 2012. The community has a medium degree of sensitivity to climate variability. Households distribute most of the family labor to the agricultural sector, particular rice production, and source of income generation is also dependent on this climate sensitive sector. In addition, the community has a relatively low ability to adapt to environmental changes. Rural households have insufficient water for agricultural production and domestic consumption, one crop planting habit, low income, lack networking with neighbors and villagers in the commune. Hence, given that there are five capacities for households to respond to drought hazards, only human capital is the medium while physical, natural, financial, and social capital, is low. Though the commune is not often exposed to climate related hazards like drought, the study indicates that the commune is vulnerable to climate variability due to its medium sensitivity and low adaptive capacity to climate variability.

While the exposure cannot be addressed in the short term, the way to reduce the vulnerability is to decrease sensitivity, and increase adaptive capacity. Improving local livelihoods through livelihood diversification would decrease sensitivity to climate variability. To increase adaptive capacity, adaptive strategies such as development and rehabilitation of reservoirs, irrigation system and water storage facilities, increase of water efficiency in agriculture and promotion of farmers' saving groups or cooperatives is needed.

1. Introduction

1.1 Background

The consequences of climate variability and change are potentially more significant for the poor in developing countries than for those living in more prosperous nations (ADB, 2009). It is strongly highlighted that those who are dependent on economic activities that are sensitive to climate change, would be directly impacted through productivity levels and diminished livelihoods (USAID, 2007). Slow agricultural productivity growth, declining income growth, and problems of maintaining food security, for instance, already pose challenges to many countries in the region of Asia and Pacific (ADB, 2009).

Cambodia has been relatively identified as one of the most vulnerable to climate variability and change (Yusuf & Francisco, 2009), and her sectors of -agriculture and fishery, are already concluded to be the most vulnerable (ADB, 2009 and Allison et al., 2009). For this reason many researchers and studies believe that the Cambodian people, especially those who are dependent on agriculture and fishery (or rural households), are also vulnerable to climate change and variability.

According to USAID (2007), the common use of vulnerability assessment explains that vulnerability is a function of exposure, sensitivity and adaptive capacity. Adapting to climate change involves reducing exposure and sensitivity and increasing adaptive capacity (USAID, 2007). That is why climate change vulnerability assessments are regarded as a principal vehicle for informing the need for adaptation, addressing the question of "what are we adapting to?" as well as aiding the selection and evaluation of specific adaptation options (Preston & Stafford-Smith, 2009).

1.2 Research Rationale

While vulnerability assessment is inevitably needed to address the climate change impacts and adaptation (Füssel, 2007), there are fewer studies about climate change vulnerability in Cambodia. Most of these studies focus on the national and sub-national level and very few studies at community level where most households are severely affected. Thus, this study is

conducted to fill gaps of vulnerability study in the literature by emphasizing the grassroots level.

1.3 Research Objective

The study generally aims to assess rural households' vulnerability to climate variability, particularly drought hazard. The study specifically aims to:

1. Assess exposure levels of household to climate variability and drought hazard
2. Assess sensitivity level of rural households, and
3. Assess adaptive capacity of rural households in responding to climate variability

1.4 Research Question & Hypothesis

The main research question is "to what extent are rural households in Peang Lvea Commune vulnerable to climate variability?" With this research question, the study attempts to test the following hypothesis.

1. Majority of rural households are slightly exposed to climate variability
2. Majority of rural households are sensitive to climate variability
3. Majority of rural households have a low adaptive capacity to respond to climate variability
4. Majority of rural household are vulnerable to climate variability.

1.5 Scope and Limitation of the Study

The study on vulnerability assessment of rural households to climate variability are scoped and limited through the study subject, site, target group, and time period. Firstly, the study only captures hazards which occur at the study site, especially drought. The study does not differentiate whether it is natural hazard or climate change induced hazard. Secondly, Peang Lvea commune, Odongk district, Kampong Speu province is selected as the study site because it has been mapped as a vulnerable commune to climate variability and change. Finally, the drought frequency was only captured during the period of 2004 to 2012 which was employed to assess the vulnerability of rural household to climate variability.

2. Conceptual Framework of Vulnerability

The concept of vulnerability has been a powerful analytical tool for describing the state of susceptibility to harm, powerlessness, and marginality of both the physical and social system, and for guiding normative analysis of actions to enhance well-being through the reduction of risk (Adger, 2006). However, there are so many terms of vulnerability that have been used and discussed (Adger, 2006; Alwang, Siegel, & Jørgensen, 2001; Brooks, 2003; Füssel, 2007; Füssel & Klein, 2006). While the term of "vulnerability" is now a central concept in a variety of other research contexts such as ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, land change, and climate impacts and adaptation (Adger, 2006; Füssel, 2007), this term has no universally accepted definition, largely because different disciplines use the term differently to explain their areas of concern (Deressa, Hassan, & Ringler, 2009; Füssel, 2007).

However, the scientific use of 'vulnerability' originally has its roots in geography and natural hazards research (Füssel, 2007). According to Preston & Staford-Smith (2009), they believed that the integrated view of vulnerability of two concepts in natural hazards (Risk-Hazard Model & Press-and-Release Model) resulted in the IPCC' definition of vulnerability.

> "*Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity"*(McCarthy et al., 2001).

Vulnerability, is a function of the sensitivity of a system to changes in climate (the degree to which a system will respond to a given change in climate, including beneficial and harmful effects), adaptive capacity (the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate), and the degree of exposure of the system to climatic hazards (McCarthy et al., 2001).

There are common terms across theoretical approaches: vulnerability is most often conceptualized as being constituted by components that include exposure and sensitivity to

perturbations or external stresses, and the capacity to adapt (Adger, 2006). The framework had been employed in many recent studies (ADB, 2009; Gbetibouo & Ringler, 2009; Yusuf & Francisco, 2009).

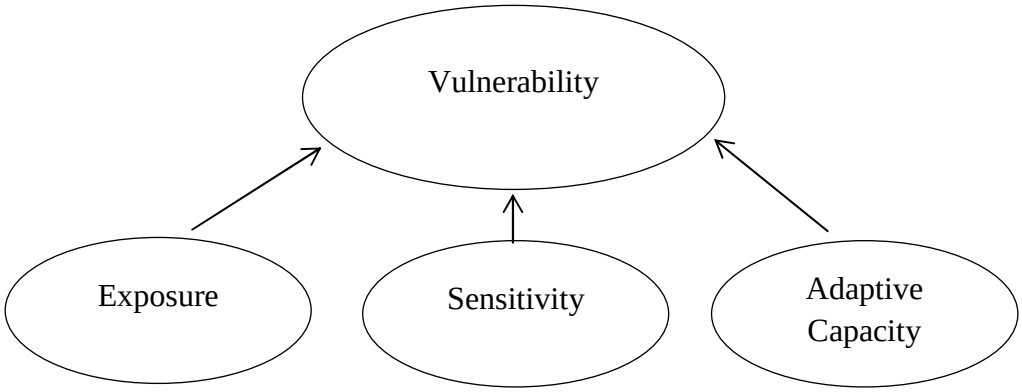

Figure 1. Conceptual framework of vulnerability

Exposure is defined as the nature and degree to which a household experiences environmental or socio-political stress. The characteristics of these stresses include their magnitude, frequency, duration and the real extent of the hazard (Burton et al cited in Adger, 2006). Exposure to environmental hazards, especially drought is well studied in many countries where agriculture is dominant (Luers, Lobell, Sklar, Addams, & Matson, 2003; Zarafshani et al., 2012). The methods employed to understand the nature of these climate disasters varied from author to author. Liverman's study on vulnerability of farmer's in Mexico to drought suggested that using diverse quantitative data sources can enable us to identify the place and people who are prone to drought (1990). The study only applies the experience of drought at the village level as one indicator for the exposure, and there are a number of studies that employ hazard frequency as a proxy for exposure (Deressa et al., 2009; Hahn, Riederer, & Foster, 2009). To get more concrete exposure from different households, experience of water shortage is also employed (Hahn et al., 2009). In short, there are two indicators that capture drought exposure: frequency of drought since 2004 to 2012 (number of years experienced drought at the village level), experiences of water shortage during 12 months of year 2012 (number of months of experienced water shortage at the household level).

Table 1. Exposure' Indicators

Variable	Explanation
Frequency of drought	Number of drought years from 2004 to 20012 in a particular village. It is assumed that households in same village have the same frequency of drought.
Water shortage	Number of months households struggle to obtain water for their domestic consumption in the 12 months of the year 2012

Sensitivity refers to how households could be negatively affected by environmental stresses (Yohe & Tol, 2002). The sensitivity to climate change and variability could be operationalized by the number of indicators which are already conducted by Aulong & Kast (2011), Below et al (2012), Gbetibouo & Ringler (2009), and Hahn et al (2009). However, only some indicators are adapted because of data availability and its relevance, especially to drought hazard. The indicators capturing sensitivity are the dependency ratio, percentage of active family labor working in the agricultural sector, percentage of the annual income generated from farming, and number of months the household experienced food shortage in the 12 months of the year 2012. Totally, there are four variables that measure sensitivity of a household to drought hazard.

Table 2. Sensitivity' Indicators

Variable	Explanation
Dependency ratio	(Age below 15+ age over 65)/ total family members
Proportion of active family labor working agriculture	Active agricultural labor/total family labor
Percentage of annual income generated from agriculture	Income generating from rice production/ total annual income
Food shortage	Number of months household struggle to obtain food for their family in the 12 months of the year 2012

Adaptive capacity is the households' ability to withstand or recover (Ebi et al., 2006). Adaptive capacity encompasses a number of components. The households which are highly adaptive to hazards can be considered to be adaptive in terms of six components (Smit & Pillifosova, 2001) such as economic stability, technology, information and skills, infrastructure, institutions and networking, and equity. These six dimensions are similar to the sustainable livelihood approach (SLA) which consists of social capital, human capital, financial capital, physical capital, and natural capital, and this approach is already carried out to assess vulnerability in Aulong & Kast (2011), Below et al (2012), Gbetibouo & Ringler (2009), and Hahn et al (2009). Here, adaptive capacity in responding to a drought hazard, are measured by five capacities namely: physical capital (infrastructure), social capital (institution and networking), human capital (information and skill), and financial capital (economic stability).

- Social capital refers to the relationship of households with other villagers. It is understood that if household have good relationship with others villagers, they will have a high adaptive capacity in terms of social capital because they will get help from those villagers and neighbors. Social capital is represented by the average number of receiving and giving agricultural assistance, and borrowing and lending money (Hahn et al., 2009).
- Natural capital is represented by agricultural land size and average crop diversity. It is assumed that if households have a higher natural capital. It is assumed the higher? Agricultural land size and different types of crops that households have, the higher their adaptive capacity.
- Financial capital is represented by income per capita, and percentage of income generated from non-agricultural sectors. It is assumed that if a household has financial capital, they have higher adaptive capacity to respond to climate related hazards.

Table 3. Indicators of adaptive capacity

Capital	Variables	Explanation
Natural	Agricultural land size	Total size of agricultural land in particular households

Capital	Variables	Explanation
	Average Crop Diversity	The number of crops grown by a household e.g., (rice, cucumber, water melon, corn, and bean). If a household grows one of these crops, they get one score.
Financial	Income per capita	Total annual income/ total family member
	Percentage of income generated from non-agricultural sectors	Total income generated from non-agricultural sectors/total annual income.
Human	Percentage of active laborers/household	Total family laborer/total family members.
	Level of education of household's head	Education grade which household' head has finished.
	Experience of farming of household head	Number of years which household' head had involvement.
Social	Average number Receiving and giving agricultural assistance	Receiving number (rice mill, rice seed, pull rice seedling, sowing rice seedling, and harvesting)+ Giving number (rice mill, rice seed, pull rice seedling, sowing rice seedling, and harvesting). If a household gives and receives one assistance, they get one score.
	Average Borrow: Lend Money ration	If a household either borrows or lends money with money, they will get one score. If they have both, they get two scores.
Physical	Percentage of Irrigated agricultural land	Total agricultural land size/ total agricultural land.
	Number of water sources	Total accessible water source for domestic consumption.

- Human capital is represented by the percentage of active laborers/household, level of education in schooling years that household's head finished, and experience of farming of the household head. It is assumed that if a household has human capital, they have a higher adaptive capacity to respond to climate related hazards.
- Physical capital is represented by the percentage of irrigated agricultural land of the household and number of accessible water sources. It is assumed that if a household has physical capital, they have a higher adaptive capacity to respond to climate related hazards.

3. Research Methodology

Both qualitative and quantitative research is employed in the study. Qualitative research employs both a desk review and key informant interviews. The desktop research is conducted through extensive and comprehensive literature reviews in order to capture the indicators for the households' vulnerability assessment. Then, six Key Informants were interviewed with in-depth interviews to consolidate the indicators. The in-depth interviews were conducted with two academia in Phnom Penh, one person from the Provincial Department of Agriculture in Kampong Spue, one person from the Provincial Department of Water Resources in Kampong Speu, one person from the Provincial Department of the Environment in Kampong Speu, and a commune chief of Peang Lvea, Odongk District, Kampong Speu Province.

Consolidated indicators, on the one hand, were gathered by using households' survey. Face to face interviews were conducted to gather primary data from 190 households and six villages' heads. Structured questionnaires were employed to facilitate face to face interviews.

3.1 Data Collection

To conduct, face-to-face interviews at the household, the number of samples is determined by probability sampling. Sampling used two steps. Firstly the number the sample from communes is determined by the equation (Yamane, 1967) which is illustrated below:

$$n = \frac{N}{1 + Ne^2}$$ Equation 1

Where *n* and *N* is number of samples and population in the commune, respectively, *e* is standard error (7%). According to this formula, 178 samples out of 1371 households is interviewed. However, 180 households were interviewed.

To ensure data reliability and validity, cluster sampling is employed in the Peang Lvea. The commune is clustered into three zones (impact, medium impact, and high impact zone). In each zone, there are two villages, and samples of zone or village are selected using the formula below.

$$nx = \frac{n}{N} hx \qquad \text{Equation 2}$$

Where *nx* is the village sample, *nthe* total samples in the commune, and N, hx is the total population in the commune, and village, respectively. The sample by households is shown in the table 1.

Table 4. The number of population and samples in targeted sites

Zone	Name of village	Household	Sample
Zone I	Trapeang Rumchek	50	30
	Khvet	80	30
Zone II	Chvek	84	30
	Trapeang Skon	94	30
Zone II	Kandal	121	30
	Trapeang Andoung	96	40

Lastly, random sampling was employed to conduct the interviews. Face to face interviews are conducted by using structure questionnaires. One the one hand, all six village heads were also interviewed primarily to gather the drought frequency information.

3.2 Selection of the Study Area

Peang Lvea is selected as the study site for a number of reasons. Firstly, Kampong Spue is one of the most vulnerable province to Climate Change in Cambodia (Chhinh & Cheb, Fourthcoming; MoE, 2006; Yusuf & Francisco, 2009), and is also one of the poorest

provinces in Cambodia. Peang Lvea commune has been mapped as vulnerable commune from three different reports (Chann & Kong, Fourthcoming; Provinical Committee for Disaster Management of Kampong Speu, 2010; WFP, 2003a) while there is lack of evidence at the household level. For these reasons, Peang Lvea commune is selected as the study site.

Located in the Northern part of Kompong Speu, Peang Levea commune is administratively located in Odongk district; there are 18 villages in Peang Lvea commune. Households in Peang Lvea commune are primarily dependent on agriculture where its population has high agricultural dependency. With a total population of 7859 households, 99.2 percent of the labor force are working on agriculture (NCDD, 2011). Given that the majority of the people are working in agriculture, there are no plots of irrigated farmland (NCDD, 2011), and 49.95% or 748 families own less than one hectare of rice land. Seriously, given rice production in the wet season, rice yield is dramatically reduced from 1.5 ton per hectare in 2008 and 2009 to only 1 ton per hectare in the year of 2010 (NCDD, 2011). Peang Lvea commune is highly effected by drought due to a poor irrigation system and highly-dependent rain-fed agriculture (NCDD, 2009; WFP, 2003a, 2003b).

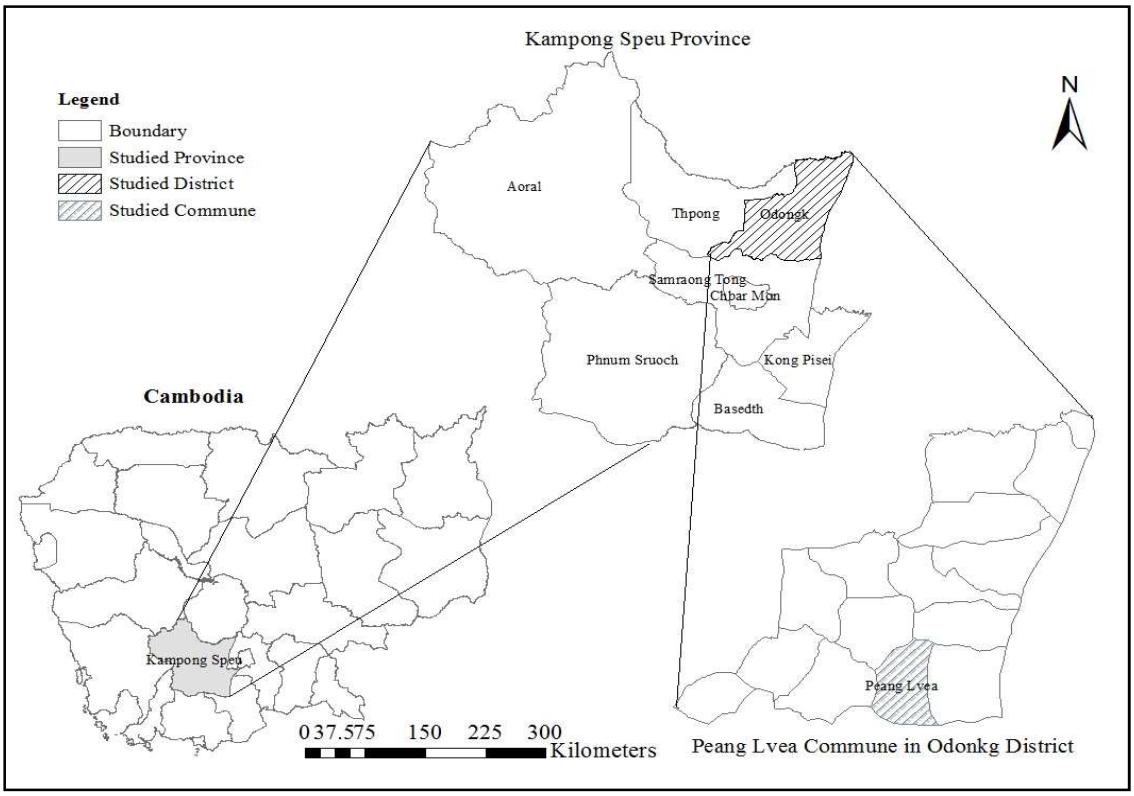

Figure 2. Site of vulnerability studies

3.3 Analytical Approach

The study only employs the indicator approach for assessing vulnerability to climate change as Luers, et al (2003) stated that indicator approaches are valuable for monitoring trends and exploring conceptual frameworks. These levels of vulnerability may be analyzed at the local, national, regional, and global scales (Deressa et al., 2009). Hinkel (2011) believed that the indicator approach is only suitable for finer scales where the system is not complicated. Hinkel (2011) believed that there are four types of arguments to select indicators for vulnerability assessment to climate change and variability- deductive, inductive, normative, and non-substantial arguments. This study only employs the normative argument of the indicator approach to assess vulnerability to climate variability. Hinkel (2011), believe that the normative argument of equal weights is frequently used in aggregation as the example in The Livelihood Vulnerability Index: A pragmatic approach is to assess risks from climate variability and change such as--A case study in Mozambique (Hahn et al., 2009). There are four steps in conducting vulnerability indexing. The first step is normalization where all indicators will are normalized to acquire an index from 0 to 1. 0 as low, and 1 as high. The indicators are explained in Appendix (1).

Step1: Normalization of Indicator

$$Ii = \frac{(Ih - \mathrm{Im}\, in)}{(\mathrm{Im}\, ax - \mathrm{Im}\, in)} \qquad \text{Equation 3}$$

Where I_i is index of indicator, and I_h is the indicator of each household, and I_{min} and I_{max} is the maximum and minimum value of the indicator of each household.

After normalization of indicators, generating index of capital was employed. For example, in the case of adaptive capacity there are five capitals and each capital index is generated by using Equ. 4.

Step 2: Generating index of capital

$$Di = \frac{\sum_{i=1}^{n} Ii}{n} \qquad \text{Equation 4}$$

Where D_i is index of dimension, and I_i is index of the dimension of each household, and n is the number of indicators.

After generating the index of dimension, step three will generate the index of vulnerability attribution (exposure, sensitivity, and adaptive capacity). For example, in the case of adaptive capacity, there are five capitals; they are calculated by using equation 5.

Step 3: Generating the index of Vulnerability Attribute (Exposure Index (EI), Sensitivity Index (SI), and Adaptive Capacity Index (ACI)).

$$VA = \frac{\sum_{i=1}^{n} Wdi * di}{\sum_{i=1}^{n} Wdi} \qquad \text{Equation 5}$$

Where D_i is index of dimension, and W_{pi} is weight of the dimension of each household, and n is the number of indicators in each dimension. Please note that all vulnerability attributes do not necessarily follow all three steps because it depends on whether each vulnerability attribute consists of dimensions or not.

After generating the vulnerability attribute, the last step is to generate vulnerability index which is shown in Equation 6.

Step 4: Generating Vulnerability Index

$$VI = \frac{(EI + SI) + (1 - ACI)}{3} \qquad \text{Equation 6}$$

Where D_i is the index of dimension, and I_h is the dimension of each household, and n is the number of indicators. The index ranged from 0 (lowest) to 1 (highest). The index is classified into four five categories-every low (0.00 to 0.20), low (0.20 to 0.40), medium (0.40 to 0.60), high, (0.60 to 0.80), and every high (0.80 to 1.00).

4. Results and Discussion

4.1 Vulnerability

Local vulnerability assessment is measured by the function of local hazard exposure, sensitivity, adaptive capacity. The results of study point to fact that households living in Peang Lvea Commune, are vulnerable to climate variability, particularly drought, due to low exposure (index of 0.12), medium sensitivity (0.40), and low adaptive capacity to climate variability (0.28 or inverse adaptive capacity at 0.72) (Figure 3).

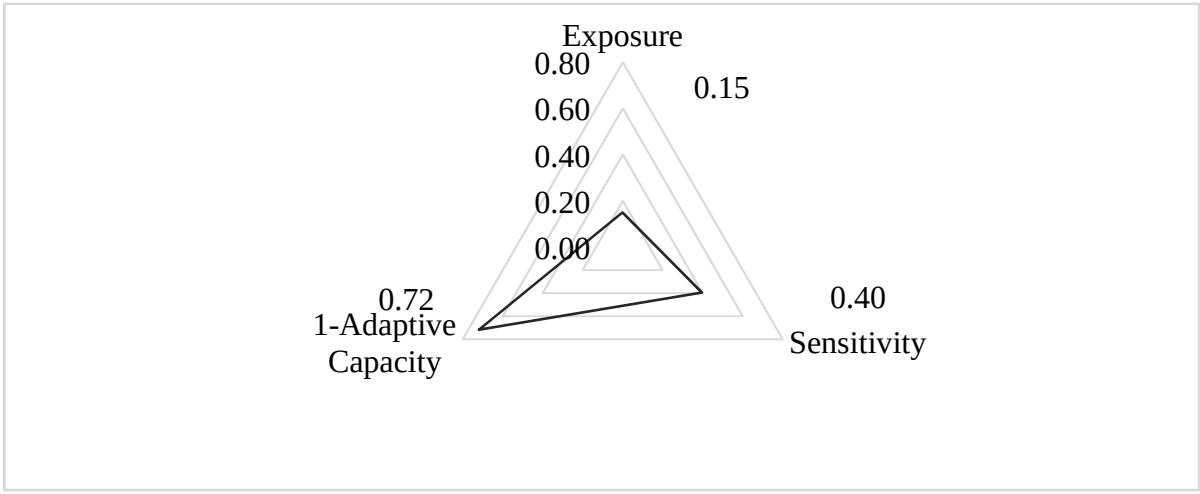

Figure 3. Vulnerability attribute and its index

Using 0.5 index as the threshold, 86.3% of households are vulnerable to climate variability. So it could be seen that a majority of households in Peang Lvea Commune are vulnerable to climate variability, particularly drought hazards. Specifically, it can be found that households in this targeted site are mainly placed in the medium and high vulnerability which is about 69.5% and 30.0%, respectively. There is only 1 household (0.5%) in the low category (Figure 4). Generally, it could be concluded that these rural households are in the medium vulnerability category to climate variability with an average index of vulnerability 0.57.

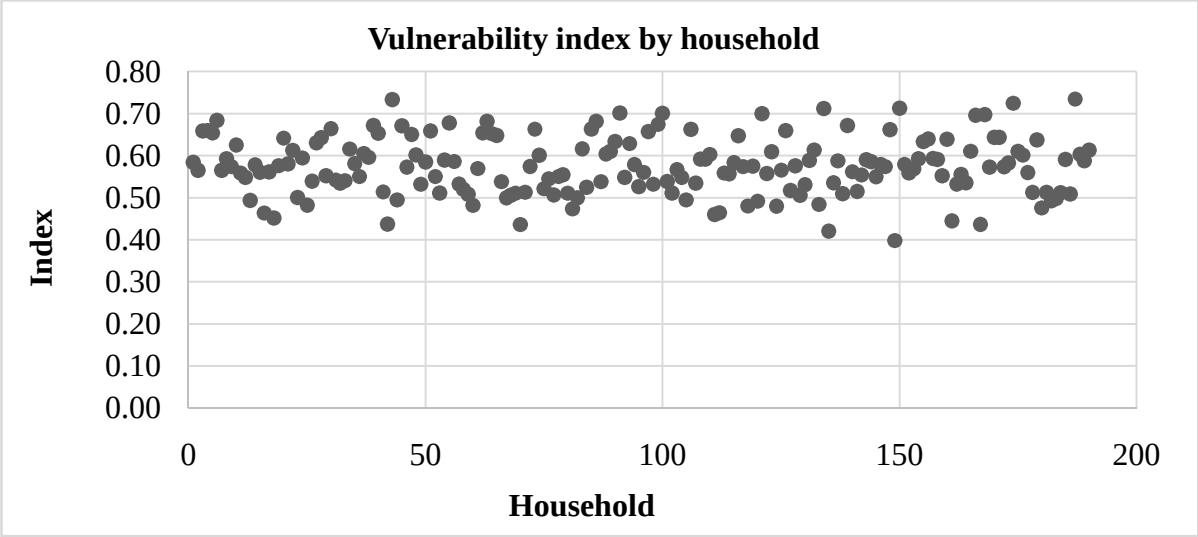

Figure 4. Index of vulnerability by household

4.2 Exposure

Exposure is represented by the drought frequency and number of months of water shortage in each household. The level of the exposure varies depending on this individual variable. It is highlighted that the variable of frequency of drought is assumed that households in the same village have the same frequency of drought. For instance, village A experienced drought of 4 years from 2004 to 2012, so all households in village A are assumed to encountered drought 4 years as well from 2004 to 2012.

The frequency of drought is slightly different from one village to another village among the six villages. Households in Trapang Rumcheak were exposed to 3 years of drought from 2004 to 2012. Households in Chveak, Kvit, Prapeang Skun village experienced 2 years of drought from 2004 to 2012. Least experienced villages are households in Prapeang Andong and Kandal, these households only experienced 1 year of drought. It is believed that rainfall is very variable because villages in the same commune experienced different numbers of drought in the last 9 years from 2004 to 2012.

The second operational variable of exposure is water shortage. Water shortage is occurs when particular household do not have enough water for domestic consumption when drought occurs in the village. With drought frequency capture exposure at the village level, water shortage can tell different exposures at the household level. Overall, all households

experienced water shortage, with some households even encountering water shortages of four months during the year 2012. On average, households in the six villages consume water insufficiently for about one month during the twelve months in the year of 2012.

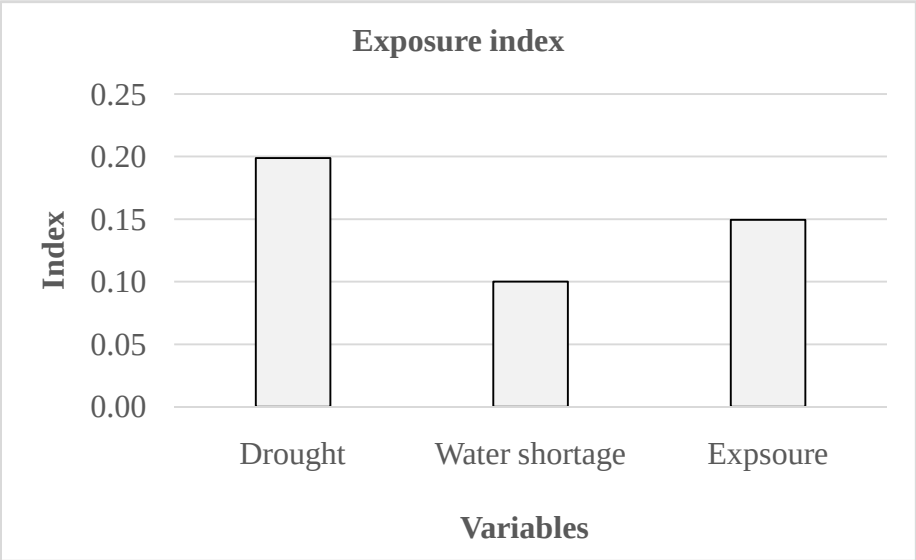

Figure 5. Level of vulnerability in each zone

Looking at the household index of each household among the 190 households, it can be seen none of these households has an index higher than 0.35. It is found that the majority of household have an index around 0.10 to 0.20. It can be found that households in these targeted sites only are in the very low and low exposure level. However, considering the index value ranging from 0 (lowest) to 1 (highest), it is believed that all households are slightly exposed to climate variability because its index is relatively high at 0.15 (Figure 5). The exposures are significantly different among the zones. Zone I is highest while zone III is the lowest. So the first hypothesis is correct that households have a low exposure to climate variability, especially drought. These results are consistent with the vulnerability assessment at the provincial and national level (ADB, 2009; Yusuf & Francisco, 2009)which state that Kampong Speu province and Cambodia as a whole has a low exposure level to climate variability and change.

4.3 Sensitivity

In this study local sensitivity to climate variability is measured by the function of dependency ratio, proportion of active agricultural laborers, percentage of income generated from rice

farming, and number of months of food shortage in 2012. Sensitive indicators are assessed upon the rated information of 190 households involved in this study.

It should be recognized that with the advantage of labor force availability in rural areas, the dependency ratio indicator is relatively low. The results of survey found that the average size of households is 5.6 persons, while total dependent members are 1.9 persons (age under 15 year olds, over 65 year old and persons with disability). This means that the dependent ratio is relative low of 0.34. In other words, households living in the study site are not sensitive in terms of the dependency ratio.

Another indicator of sensitivity is the proportion of active laborers working in the agricultural sector. The higher percentage of active agricultural labor, the higher the sensitivity is. It is clearly seen that while the average total family members is 5.6, the average member of laborer is almost 4 people per family. Three of these four family members are active laborers in the agricultural sector, especially rice farming. It can be said that households whose majority of laborers are involved in agriculture is more sensitive because the family distributes labors to the climate sensitive sector. As in this case, families in Peang Lvea commune are highly sensitive to climate variability, particularly drought, because when their rice paddy is seriously impacted by drought, their families would be unemployed immediately. The percentage of active laborers involved in agriculture is relatively high at 71.74%. Relatively speaking, the households in the study site are highly sensitive to climate variability in terms of share of agricultural laborers.

Although, households are sensitive to climate variability in terms of the share of agricultural labor, it may not be sensitive in terms of the share of income from agriculture, particularly rice farming. It can be seen that household in Peang Lvea commune are in the medium sensitivity level to climate variability in terms of income generation. Annually, households could earn around 2 million riels (about 500.00 USD) which is 40% of their total annual income.

Food shortage is another variable of sensitivity. During the 12 months of year 2012, it is found that households experiencing food shortage were from one to four months of the 12 months in the year of 2012. There are 1.15 months out of 12 months that households encountered food shortage on average.

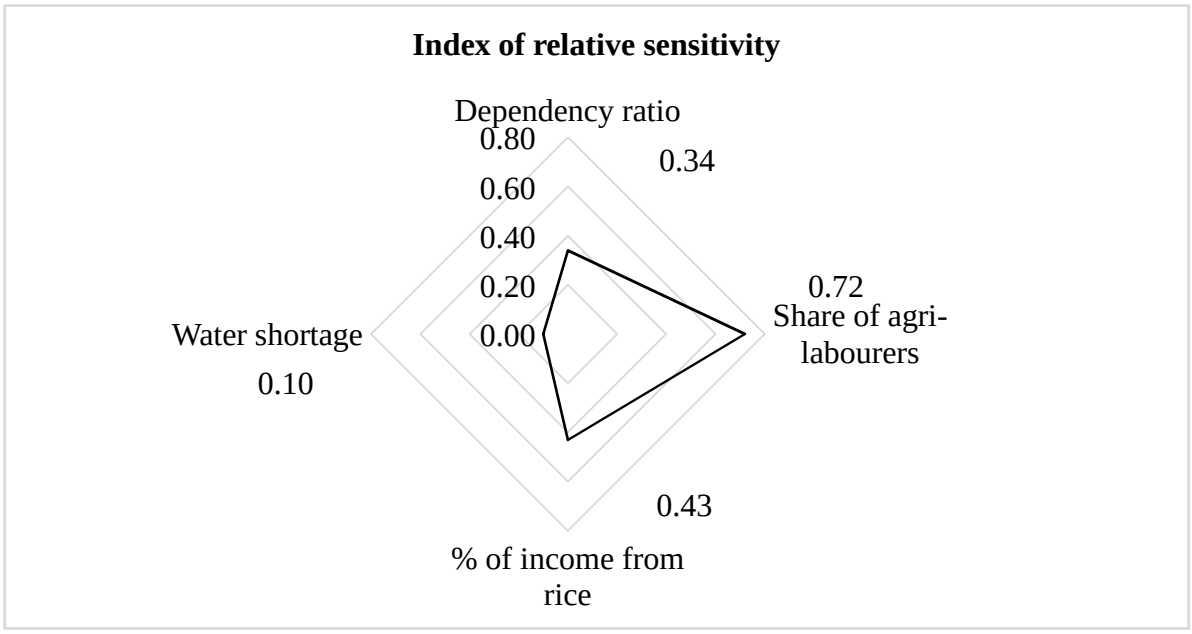

Figure 6. The contribution of sensitivity variables

In terms of the index ranging from 0 (lowest) to 1 (highest), it is found that only the share of agricultural laborer is the main variable contributing to sensitivity followed by the share of farming income, dependency ratio, and food shortage. With the exception of share of agricultural laborers, other three variables do not have index over 0.5 which means that households are not sensitive to climate variability in terms of the share of farming income, dependency ratio, and food shortage. But the share of farming income also concern in term of sensitivity because its index is 0.43 (Figure 6). This shows that the sensitivity of zone is not statistically significant.

It can be found that household in these targeted sites could be placed into four categories. 9.5% of households are placed in the very low, while the majority (44.7% of households) is placed in the low category. Households in the category medium and high are 39.5% and 6.3% respectively. Among these five categories, around 40% are sensitive to climate variability.

4.4 Adaptive Capacity

Adaptive capacity is represented by five capitals of livelihood- natural, human, physical, financial, and social capital. The level of adaptive capacity varies depending on this capital. Results of adaptive indices assessment reveals that households living in this commune have advantages in certain attributes to adaptive indices such as human capital index, but

weaknesses exists in natural capital index, financial capital index, physical capital index and social adaptive index. As can be seen in Figure 7, the average index of adaptive capacity is 0.28. This adaptive capacity resulted from 0.12 of natural capital, 0.08 of social capital, 014 of physical capital, 0.54 of financial capital, and 054 of human capital (Figure 7). Adaptive capacity is not significant among the zones of high impact, medium impact, and low impact group.

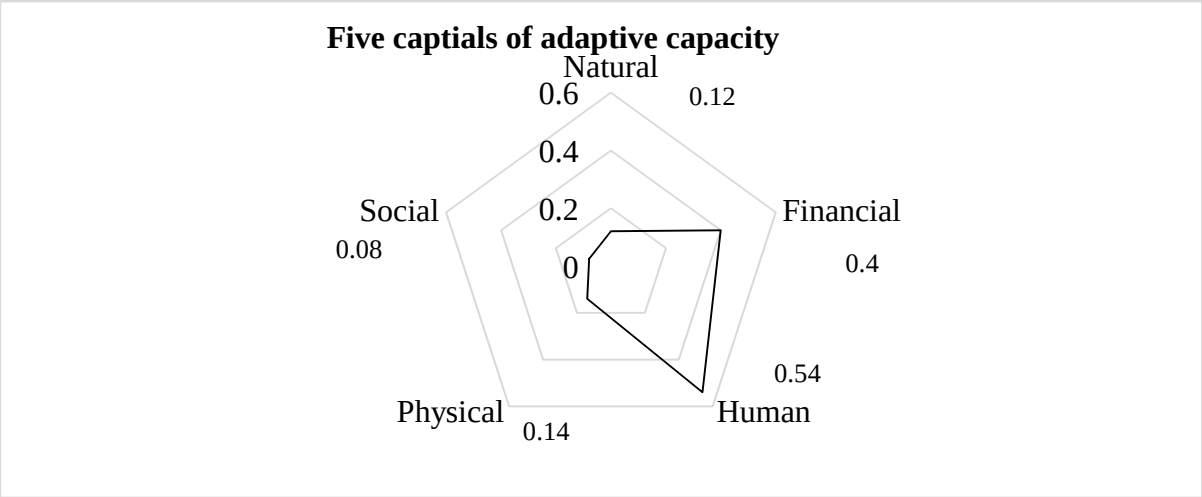

Figure 7. Adaptive capacity and its dimensions

Natural capital is the first dimension of adaptive capacity. Natural capital is determined by agricultural land, and crop diversity. Natural capital is relatively low because of small agricultural land sizes and less crop diversity. The index of natural capital is 0.12. Looking at agricultural land, its index is relatively low at 0.17. The average agricultural land is 0.85 hectares with a high standard deviation of 0.8. In addition, Average Crop Diversity (rice, cucumber, water melon, corn, and beans) is relative low in this study site. It is found that the majority only plant one crop (rice paddy) which is about 86.3 %. Households in the study site plant 1.23 crops on average. As the result, the crop diversity index of this study site is 0.08.

Human capital is another important resource for local adaptive capacity to climate variability and drought disaster. Human capital was designed to assess household human capital with a focus on percentage of labor per household, households head' s education and farming experiences of household heads. It has a high value of labor in the Peanl Lvea Commune. Among 5.6 of the total family members, there are about 4 family members that are working. In general, 70.58% of family members are working in each household of Peang Lvea

Commune. Education of households' head is relatively low. On average, household' head finished studies at grade 4.2. This means that they only finished study at primary school level. One the one hand, farming experiences of household' head is the last variable of human capital of adaptive capacity of the household. Relatively speaking, the farming experiences of household head are high. They have about 32 years of farming experience. Overall, the households in the study site have a high adaptive capacity in terms of human capital. The index of human capital is 0.54. It can be said that human capital is high because of a high index of laborers and high farming experiences. Households have a high index of laborers, with its index at 0.71. This is followed by farming experiences, with an average index of 0.58 while there is a low index of education of the household head.

Physical capital is the third dimension of adaptive capacity of each household. Physical capital is measured by the share of irrigated agricultural land, and number of water sources which households have access to for their daily domestic consumption. Share of irrigated agricultural land is remarkably low in the study site because there are no secured water reservoirs or water sources for agricultural production. Only households having rice fields in the water reservoir can access to water because the reservoir is totally destroyed. Share of this irrigated land is maximum at 64% while there are zero irrigated land for the majority of households. In addition, in terms of domestic consumption, it is no different from other agricultural purposes. Normally, households can access rainwater, pond, well, and others such as buying water from nearby households[1]. Although, households have alternative options for domestic consumption, it is found that each household can probably access two sources of water for domestic consumption which is around 1.81 sources. It is concluded that households in Peang Lvea have a low adaptive capacity in terms of physical capital, and its average index is 0.14. This low physical capital is due to low irrigated land and water accessibility. The index of percentage of irrigated agricultural land and number of water sources in the study site is 0.02 and 0.27, respectively.

The financial aspect is the fourth capital of adaptive capacity to be measured. There are two variables that measure financial capacities- per capita income and percentage of income

[1] For those who buy water, they have to transport water to the house by their own. Some sellers have vehicles to transport water to the buying household.

generated from the non-agricultural sector. Per capita income is generated by the division of total income over the total number of family members. Relatively speaking, per capita income of rural household is low at 1,539,700 riels or about 385[2] dollars per annum (32 dollars per month or 1.07 dollar per day). Another variable of financial capital is percentage of income generated from the non-agricultural sector. It is found that households in Peang Lvea Commune are slightly high because their income from the non-agricultural sector is 51.22%. Generally speaking, households in Peang Lvea commune have a low adaptive capacity in terms of financial capital because of a low per capita consumption which is about one dollar per day. The overall index of financial capital of households in Peang Lvea Commune is 0.40 which is due to the index of per capita income (0.27), and percentage of income generated from the non-agricultural sector (0.53).

Social capital plays an important role in local prevention and mitigation of the drought hazard impacts in the context of rural communities. This study investigates social capital with two indicators –number of assistance (both receiving and giving) and number of borrowing and lending money. Assistance from relatives and friends is measured by receiving and give assistance on the agricultural sector such as rice seed, pulling rice seedlings, transplanting rice seedlings and harvesting. It is found that households in Peang Lvea Commune could only maximally get 4 assistances while some households did not get even one assistance. On average, the households in Peang Lvea only got 0.22 over 8 assistances. So it can be said that their relationship is quite low. Borrowing and lending money without interest, in addition, is another variable of social capital. Families are assumed to get 0, 1, and 2 of this variable if a household cannot borrow nor lend money, only borrow or lend, and borrow and lend money, respectively. Ranging from 0 to 2, household in Peang Lvea only have 0.27 number which is low. Looking at Social Capital as a whole, it is relatively low in the study site, and its index is only 0.08. This is because of the very low number of assistance at 0.03 of the index and low in terms of borrowing money and lending (0.14 of index).

It is said that the majority of households in the targeted sites only placed in the low and very low class. 23.2%, and 75.8% of households in the very low, and low class while 1.1% of respondents (2 households) are in the medium class of adaptive capacity. It is concluded that the adaptive capacity of households living in Peang Lvea commune is relative low. This result is reliable because it is consistent with other studies which state that Cambodia has a

[2] 1 USD= 4,000 Riels

low adaptive capacity (ADB, 2009; Chann & Kong, Fourthcoming; Yusuf & Francisco, 2009).

5. Conclusions and Recommendation

Generally, Cambodia is the most vulnerable to climate change and vulnerability (ADB, 2009; Allison et al., 2009; MoE, 2001; Yusuf & Francisco, 2009). Rural households are also vulnerable and strongly impacted by climate change and variability which has resulted in climate hazards (MoE, 2005; The NGO Forum on Cambodia, 2012). Now it can also be seen at finer scales of Peang Lvea commune and Odongk where rural households are relatively vulnerable to climate variability due to low exposure, medium sensitivity, and low adaptive capacity in responding to drought hazards.

Exposure is low because of drought frequency and water shortage. It is believed that all households were slightly exposed to drought hazards because its index is 0.15. In general, households in Peang Lvea experienced drought 1.88 times from 2004 to 2012 while they encountered 1.15 months of struggling to find water.

- Having water for household consumption to reduce water shortage is highly and urgently recommended in the study site, especially clean and safe water for domestic consumption. The recommendation for rural households is to take care of their water source by improving their water management and water storage.

Sensitivity is medium. It is found that only the share of agricultural income is variable which contributes to sensitivity followed by the share of farming income, dependency ratio, and food shortage. With the exception of the share of agricultural laborers (0.72), other three variables do not have an index over 0.5 which mean that households are not sensitive to climate variability in terms of the share of farming income (0.43), dependency ratio (0.34), and food shortage e (0.10). Thus, to reduce sensitivity it is necessary to reduce the distribution of share of active agricultural labor, and share of farming income while dependency ratio and food shortage are not critical for sensitivity.

- Livelihood diversification is recommended to reduce distribution of labor in the agricultural sector and reduce income generated from the agricultural sector. The government and NGOs should take more account of this aspect in the region.

Results of adaptive indices assessment reveals that households living in this commune own advantages in adaptive indices such as human capital index, but there is a weakness in the natural capital index, financial capital index, physical capital index and social adaptive index. The average index of adaptive capacity is 0.28. This adaptive capacity results from 0.12 of natural capital, 0.08 of social capital, 014 of physical capital, 0.54 of financial capital, and 0.54 of human capital. It can be found that the majority of household in these targeted sites only placed in the low and very low class. 23.2%, and 75.8% of households in the very low, and low class while 1.1% of respondents (2 households) are in the medium class. It is concluded that the adaptive capacity of households living in Peang Lvea commune is relatively very low. It is recommended that:

- Skills of farming should be contiguously provided to households to strengthen their farming techniques to increase more human and natural capital. Government and other agencies should provide more techniques for households to plant other crops to reduce their dependency on rice production. Farming households should increase their farming skills as well to increase their one crop productivity and increase their natural capital.
- Physical capital can be increased when there is small scale-irrigation for agricultural production. So the government and sub-national government should continuously allocate a budget or assistance to build water reservoirs or irrigation in the study site. For the purpose of domestic consumption, there should be some assistance for clean and safe water sources in the commune.
- Similarly, financial capital could be increased as soon as livelihood is diversified. Group savings is also recommended to increase financial capital.
- Last but not least, to increase social capital of households is to build networks among the rural households. Households are recommended to exchange their agricultural land with other families rather than working with their own family while they do not optimize use of technology.

Since the study has limited time, there are some gaps remaining. It is also suggested that further study should include the following aspects.

- Since the study only employed normative arguments of the indicator approach- equal weight of indicator, it is also suggested to investigate different weight of indicators as well as the number of indicators. A study on the effectiveness of the adaptation of rural households as well introducing the right adaptation which would reduce mal-adaptation is recommended.

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Appendix:

Appindex1. ANOVA test on different zones (high impact, medium impact, low impact zone)

		Sum of Squares	df	Mean Square	F	Sig.
Exposure index	Between Groups	0.09	2.00	0.05	24.49	0.00
	Within Groups	0.36	187.00	0.00		
	Total	0.45	189.00			
Sensitivity index	Between Groups	0.02	2.00	0.01	0.61	0.54
	Within Groups	3.30	187.00	0.02		
	Total	3.32	189.00			
Adaptive capacity index	Between Groups	0.00	2.00	0.00	0.22	0.80
	Within Groups	1.04	187.00	0.01		
	Total	1.04	189.00			
Vulnerability index	Between Groups	0.00	2.00	0.00	0.21	0.81
	Within Groups	0.86	187.00	0.01		
	Total	0.87	189.00			

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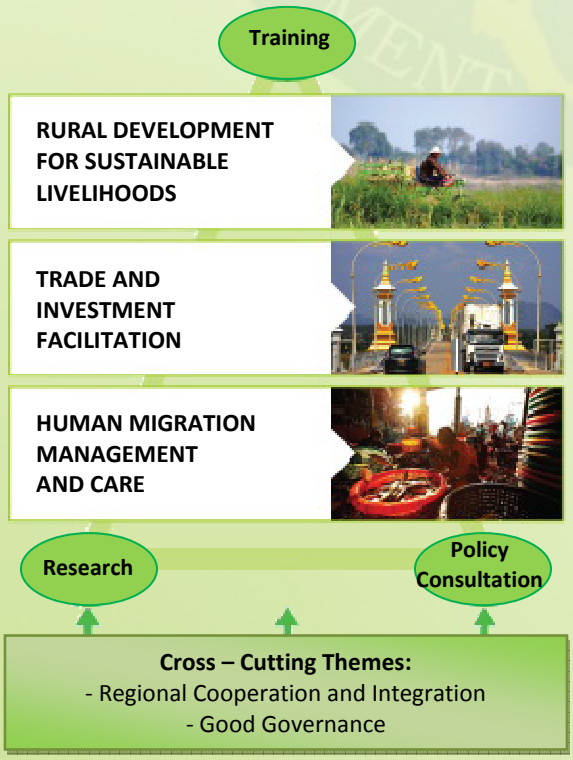

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