Research article

Climate Change Vulnerability: Household Assessment Levels in Kampong Speu Province, Cambodia

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Received 9 December 2012 Accepted 30 January 2013 (*Corresponding Author)

Abstract Cambodia's Ministry of Environment (MoE) conducted vulnerability and adaptation assessments using two different methodologies: the Global Circulation Model (MoE, 2001) and Household Surveys (MoE, 2005). They found that Cambodia is vulnerable to climate change and has a low adaptive capacity compared to other countries in Southeast Asia. Flood and drought were identified as the climatic hazards that imposed the greatest threats to rural farmers. This study, which assessed vulnerability at the household level in the drought-prone Kampong Speu (KPS) province, calculates climate change vulnerability based on the framework developed by the Inter-governmental Panel on Climate Change (IPCC). The results indicate that drought is the most severe climate hazard experienced in KPS. Farmers reported that they regularly experienced irregular rainfall distribution during cropping season that results in crop damage and/or loss. Adaptations to drought adopted by farmers include water storage, introducing drought-tolerant crop varieties, and improving knowledge about farming techniques. Other mechanisms that are also feasible are providing or enhancing secondary income capacity.

Keywords climate change, vulnerability, adaptation, assessment, rural development

INTRODUCTION

Climate change is the term most frequently used in global studies to refer to significant and lasting changes in the Earth's weather pattern that are evident in effects such as worldwide changes in in precipitation, and temperature (IPCC, 2007). However, 'climate change' is not commonly used in Cambodia, where this phenomenon is instead called 'climate variability'. The impacts of climate change can be seen spatially, temporally, socio-economically and through many other factors. An assessment of vulnerability to climate change is required before any prescriptions are given to mitigate and/or to adapt to climate change.

As defined in the IPCC report Climate Change 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 (IPCC, 2001 , p. 89). The definitions of exposure, sensitivity, and adaptive capacity can be found in climate change literature (Adger, 2006; Fankhauser et al., 1999; Eriksen and O'Brien, 2007). Explanations of how to quantify vulnerability can be found in Fussel (2007) and Hinkel (2011).

When studying vulnerability on a fine scale, for example at a household level, the study of climate change is associated with the outcomes of changes in climate in a particular geographical area such as a commune. A study may focus on a single element, such as changes in productivity, economic loss, or local knowledge of adaptation.

This paper aims to estimate and quantify vulnerability to climate change in Cambodia using

household data and to identify the household characteristics that are most impacted by climate change effects such as flood and drought.

Background

One study on vulnerability related to climate change at the household level in Cambodia was completed by the Ministry of Environment (MoE) in 2005. Climatic hazards including flood, drought, and windstorms were studied. That study (MoE, 2005) demonstrates that Cambodians have observed changes in weather patterns and experienced losses in farming production due to climatic hazards because of their low adaptive capacity. A number of possible coping and adaptation mechanisms were identified by the study, which noted there were a number of constraints to effectively adapting to climate change such as lacks in the financial, knowledge and skill aspects required to mitigate impact. Following the MoE's study, there have been a number of studies related to climate change assessment that use different frameworks, such as Try Toun (2009) and Yusuf and Francisco's (2010) EEPSEA's study. From these studies, it can be concluded that Cambodia is exposed to climate variability and that even with low degree of exposure; rural communities are highly vulnerable to changes in climate due to low adaptive capacity.

Fig. 1 shows the production lost due to flood and drought between 1984 and 2011. During the 1990s, droughts were more common than floods and occurred with very high severity, except for in 1996 when both disasters hit Cambodia at the same time during growing seasons. During the 2000s, the both floods and drought occurred every year, with the highest concentration of disasters occurring in the middle of the decade.

There was flooding in Cambodia every year between 1998 and 2011, with the most severe floods occurring in the 2000-01 growing season, based on the average level of flooding in Cambodia as recorded over the last 70 years (the 2011 flood is not included for the comparison due to lack of literature). The 2000-01 floods caused extensive damage to many social infrastructure systems, properties and agricultural plantations and during the wet season affected both people and animals in 22 provinces.

The Kampong Speu (KPS) province is the second priority project implementation in the National Adaptation Program of Action to Climate Change (NAPA) of Cambodia. The NAPA priority for adaptation is consistent with the finding of EEPSEA vulnerability mapping study, which identified that Kampong Speu is the third most vulnerable province of the 17 provinces in Cambodia. As mentioned earlier, KPS has a high incidence of poverty, and experienced drought more often and intensively than other provinces in Cambodia.

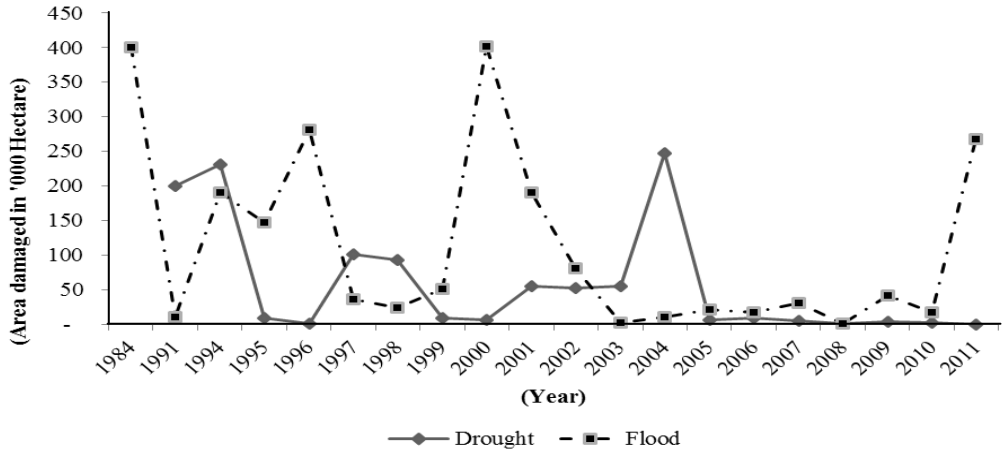

Fig. 1 Distribution of paddy rice destroyed by flood and drought in Cambodia, 1984-2011

Kampong Speu is about 40 km to the west of Phnom Penh. The province is comprised of 8 districts. The total population of the province is 716,944, of which 368,432 are female. Similar to other provinces in Cambodia, the economy of this province is agriculture-dominant and primarily

involved in rice production. The total paddy rice area of this province in 2007 was 78,000 ha, which accounted for 3.81% of the total paddy rice in Cambodia. KPS produces 245,000 tons of rice annually, approximately 4% of the county's total rice production.

Data gathering

The household survey samples were selected from 6 communes in 6 districts within two geographical areas: highland areas (2 districts/communes: Phnom Sruch/Morhasang, Oral/Tasal) and lowland areas (4 districts/communes: Chbar Mon/Chbarmon, Oudong/Peng Lavea, Bor Sedth/Kork, Somrong Tong/Rolang Chork). A total of 600 questionnaires were collected of which 200 from highland and 400 from lowland. The occurrence of natural hazards, including flash flooding, drought and windstorm, were recorded based on yes/no questions. Other variables that contributed to the index calculation were collected based on Table 1, 2 and 4.

METHODOLOGIES

Composite indicators involve two steps. First, it involves in normalizing of each indicator based on Eq. (1) and then, aggregating the indicators into one index as in Eq. (2).

The normalizing procedure is based on Eq. (1).

$$Ii = (xi - x\min)/(x\max - x\min) \quad (1)$$

Where I_i is the normalized value of indicator i, x is the original value for indicator for individual household, and x_{max} and x_{min} are the highest and lowest values of the indicator.

In order to aggregate the indicators (as in Eq. 2), weighting among the indicators is employed. The weights are obtained from focus group discussion, expert judgment and key informant interview from the study site. This is to reduce subjectivity[*]. It is very important to quantify vulnerability according to the different weights for each indicator and dimensions. The consensus method was used to gather the weight of different determinants and indicators. Eight Focus Group Discussions (FGDs) were conducted with participants from a range of backgrounds at the provincial, district and commune levels in order to come up with different weights. Weights were then averaged among all FGDs and levels.

$$Dj = \sum_{i=1}^{n} IiWi \quad (2)$$

Where D_j is the aggregate value from the product of normalized value of indicator, j is the name of index, n is the number of indicators within a particular index and I_i and W_i are the normalized value of indicator and weight of each indicator respectively.

Exposure Index (EI)

Table 1 Example of Exposure Index calculation

HH No.	Number of hazard events			Normalized Value (index)			Hazard Index
	Drought	Flood	Windstorm	Drought	Flood	Windstorm	
1	10	3	0	1.00	0.75	0.00	0.77
2	5	0	1	0.50	0.00	0.33	0.31
3	2	2	0	0.20	0.50	0.00	0.27
4	3	1	2	0.30	0.25	0.67	0.34
5	0	4	0	0.00	1.00	0.00	0.33
6	1	0	3	0.10	0.00	1.00	0.22

Exposure index in this study is composed of three hazards indicators: flash flooding, drought and windstorms. Based on social perception of hazard, we recorded number of events that household

[*] In our study site, the weights are 0.53, 0.32, and 0.15 for drought, flash flood, and windstorm respectively.