Research article

Toward Measuring the Vulnerability of Agricultural Production to Flood: Insight from Sangkae River Catchment, Battambang Province, Cambodia

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Received 15 December 2012 Accepted 10 June 2013 (*Corresponding Author)

Abstract The study proposes an indicator-based analysis on the vulnerability of agricultural production to flood issues in a river catchment area. The study site is the Sangkae River catchment area located in the Northwestern region of Cambodia and the unit of observation is the commune. Flood hazards are not restricted to the downstream lowland Tonle Sap plain; the study also considers river overflow and run-off flood events occurring upstream in Sangkae River catchment. We address the concept of vulnerability in three dimensions (exposure, sensitivity and adaptation capacity) and operationalize it in a multi-level analytical framework.We first identify indicators relevant with each of the three dimensions of vulnerability. We then combine the standardized and weighted indicators into composite exposure, sensitivity and adaptive capacity indexes, which we analyze statistically and spatially with a geographic information system. We further integrate the indicators in a hierarchical cluster analysis to establish a typology of commune vulnerability across the catchment. The results of the study showed the link between the vulnerability of agriculture to flood and the different farming systems of rural communities.

Keywords flood management, vulnerability assessment, agricultural production, watershed management, Cambodia

INTRODUCTION

Cambodia is one of the most vulnerable countries to climate change in Southeast Asia (Yusuf and Fransico, 2009). The processes of climate change are complex and diversified but are mainly at play through the intensification of the water cycle (Huntington, 2006). Climate change increases the occurrences of extreme weather phenomena, such as heavy rainfall, flood, drought, storms, etc. (Solomon et al, 2007). The modification of rainfall pattern has affected the water level of Mekong River and Tonle Sap Lake (MRC, 2010). Due to the river run-off from upper Mekong River, the water level of the Tonle Sap is projected to increase from 1 meter to 2.3 meters by the year 2030 (Eastham et al., 2008).

However, flood is not a new phenomenon in Cambodia. Many parts of the country have flooding experiences every year, particularly in the central area of the country where floods are associated with the reversal of water in the Tonle Sap River and the flooding of the large Cambodian central plain. People have developed ways to practice agriculture and fishing, which are well adapted to this unique phenomenon. As Suon rightly put, floods are usually good for rice-based agriculture but their irregularity and unpredictability bring negative impact on agricultural production and rural livelihood systems (Suon, 2007). Major flood events, such as the one that occurred in 2011, had for instance very serious consequences in the Cambodia economy. The loss of agricultural productions and degradation of physical infrastructures were worth over $400 million (CRED, 2011).

Over the last 10 years, Battambang has witnessed a dramatic agricultural colonization of peripheral forest areas. Forest cover has become the substitute for agro-industrial cash crops very rapidly, in a process fuelled by important internal immigration movements of people coming from the lowland densely populated areas (PMPSWG, 2011). The conversion of the upland evergreen forest areas into agricultural land is also very likely to affect the hydrological system and to increase surface and river water run-off (Kirsch, 2010). Future flood patterns are thus very likely to be modified by the combined effect of climate and land use change. These transformations are very likely to result in a change in agricultural production and the challenges at stake are important as agriculture is the main source of livelihood for a very large majority of Cambodian household living in the rural and who make up to 80% of the entire population (RGC, 2010a). Flooding may contribute to increased poverty in rural Cambodia and have serious consequences in terms of availability and accessibility to food (NAPA, 2006; Helmers and Jegillos, 2004).

Flood risk management has been considered as key priority for poverty alleviation and development of Cambodia (RGC, 2010b). Several institutions and committees have been established from national down to local level to respond to natural disasters (Committee for Disaster Management). In Battambang province, principles and concepts of Integrated Water Resources Management (IWRM) have been introduced for the management of water resources at the catchment level (Yem, et al., 2011) and integrated in the provincial spatial plan (PMPSWG, 2011). However, weak cross-sector coordination and the lack of tools to support decision-making have considerably impeded effective flood management (Eng, 2009). The involvement and participation of Battambang Provincial Spatial Planning Team in this research process can be viewed as a first step toward the design of a flood management, decision-making tool for provincial authorities.

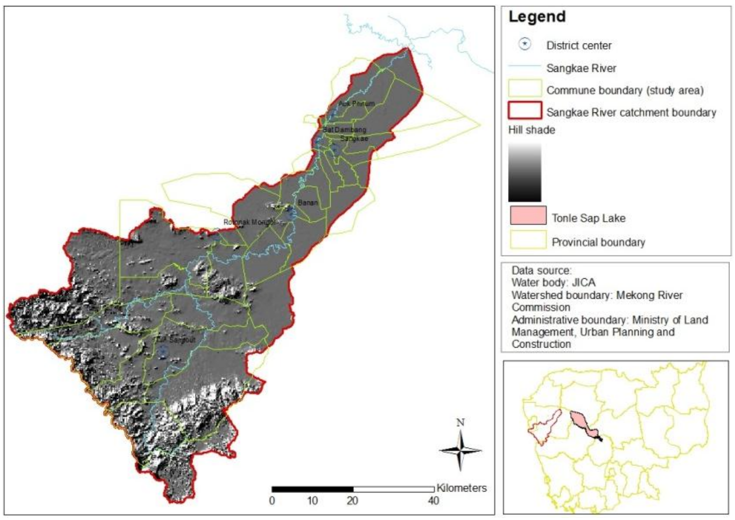

Fig. 1 Sangkae River catchment area

OBJECTIVE

The study aims to achieve two things. First, we aim to understand the vulnerability of agricultural production in Sangkae River catchment area and second, to provide recommendations to improve flood management as part of an integrated water resource management system.

METHODOLOGY

Conceptual framework

The concept of vulnerability of social and environmental systems has a history of several decades. One of the best known definitions was formulated by the International Strategy for Disaster Risk Reduction (UN/ISDR), which defines vulnerability as "the condition determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazard" (UN/ISDR, 2004). Originally envisaged in the context of natural disaster reduction, the concept of vulnerability was further developed with contributions made by climate change scientists (IPCC, 2001). Adger (2006) stresses that vulnerability is most often conceptualized as being constituted by components that include exposure to change or external stresses, sensitivity to change, and the capacity to adapt. Exposure comprises the degree, duration, and/or extent in which the system is in contact with a hazard, or subject to the change (Kasperson et al., 2005; Adger, 2006). Sensitivity is the extent to which a human or natural system can absorb impacts without suffering long-term harm or other significant state change (Adger, 2006). The system's coping capacity (Turner et al., 2003), or capacity of response (Gallopin, 2006), is also called adaptive capacity by the IPCC (2001); Adger (2006) and Smit and Wandel (2006). As noted by Smit and Wandel (2006), some authors apply "coping ability" to shorter-term capacity or the ability to just survive, and employ "adaptive capacity" for longer-term or more sustainable adjustment.

Following the IPCC framework, we address the concept of vulnerability of agriculture production to flood with three lenses: exposure, sensitivity and capacity of responses. While exposure refers to the occurrence, magnitude, and locations of the flood events; sensitivity concerns the impacts of the flood events on agricultural land and production in the River catchment. Capacity of responses deals with both the short-term coping mechanism and long-term adaptive strategy to respond to the flood impacts (Fig.2).

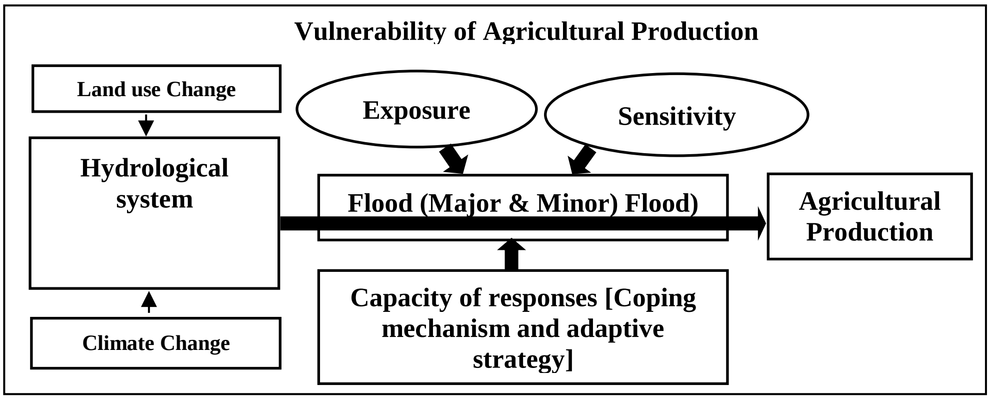

Fig. 2 Research conceptual framework

Helmers and Jegillos (2004) reported that there are two types of flood usually occurring in Cambodia: flash flood and central area flood. Flash floods result from heavy downpours upstream on the Mekong River and affect the provinces along the Mekong as well as in the southern areas of the country. The central area floods result from a combination of run-off from the Mekong and heavy rains around the Tonle Sap Lake (Helmers and Jegillos, 2004). We retain the central area flood as one separate type of flood. However, our study differentiates between river overflow flood (Sangkae river and its tributaries) and surface water run-off flood. The combinations of these floods are also considered (Fig. 3). As flood may not solely affect the down-stream part of the Sangkae River catchment (Tonle Sap flood plain), but also the up-stream part of the catchment; we decided to investigate flood in the whole Sangkae River catchment.