

Flood Management in Cambodia: Case studies of flood in 2009 and 2011

Sovannara Chea, and Alice Sharp

Abstract—Two kinds of floods occurred in Cambodia; rainfall flood and river flood. Between both of them, rainfall flood which happened more frequently, is really the main concern due to its impacts and the management options to be used in the country. Cambodian government has given the key role of management strategies to control floods impacts to the National Committee for Disaster Management (NCDM), Asia Disaster Preparedness Center (ADPC), Mekong River Commission (MRC) and Asian Development Bank (ADB). This paper focuses on the experience of Cambodia from severe floods, limitation for recovery and policy implementation. The paper also studies the policy issues, understands the flood vulnerability reduction and the policy implementation to assess the effectiveness of policies and actions. Case studies of flood in 2009 and 2011 described situation of flood, policies and activities undertaken during and after flood.

Index Terms—Flood protection; Disaster risk management; Climate change.

I. INTRODUCTION

Cambodia is a vulnerable country to natural disasters such as flood and tropical storm [1]. In world risk index, Cambodia is ranked the 9th among the most vulnerable countries because of high disaster risks, high exposure and limited technical assistant [2]. Eighty to eighty five percent of population is farmers, who live in rural area of central flood plains. One out of five households lives below poverty line due to the impact of nature disaster.

There are two main seasons in Cambodia, dry season (from October to late April) and rainy season (from May to late September). The past experience of flooding showed that the light flood is caused by typhoons and several other weather calamities [3]. Eighteen out of twenty four provinces were affected by annual river flooding along with the two major watershed, Mekong River and Tonle Sap Lake. In recent years, the flood has risen in the northwest part of Cambodia such as Pursat, Battambang and Banteay Meanchey. The average rainfall level in September was 24% higher than other months during the last ten years. This was a major cause of flooding throughout the country (Table I) [4].

To address the flood problem management, Cambodia government has promoted the knowledge about policies, activities, strategies and their implementations, which are jointly looked after by NCDM, ADPC, MRC and ADB. They have provided preparation, response, relief, recovery assistance through the previous flood experiences. The

coordination and integration of various flood risk management have raised the effectiveness of strategies to reduce flood risk through the cycle of systematic action.

This paper studies flood management policy and aims to understand the control of flood management impacts. Furthermore, the policy implementation is analyzed in the context of effectiveness of policies in real situation. Case studies focus on flood in 2009 and 2011 and the actions taken by the government for flood mitigation and preparation of strategies for disaster management.

II. CLIMATE CHANGE AND FLOOD IN CAMBODIA

Climate change is a challenge in Cambodia especially in form of changing weather conditions and disasters. Therefore, Government makes an agreement with the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and Cambodia National Adaptation Programme of Action (NAPA). The main goals of NAPA are to coordinate, implement the adaptation measures, share environmental information and create development of programs [5]. Figure 1 describes the timeline of flood that started from 1996 until 2014. It showed that the Mekong flood in 2000 was the worst experience during last 70 years in Cambodia, causing both socio-economic and physical damages. According to the NCDM official report, the floods affected about 3.4 million people with 347 fatalities, of which 80 percent of fatalities were children. Moreover, schools and other infrastructures such as hospitals, houses, and pagodas were seriously damaged, with a total estimated loss of US\$161 million. Repeatedly, floods hit Cambodia in 2001 and 2002, creating a damage approximately US\$36 million and US\$12 million respectively. In 2001, the floods killed 62 people while in 2002 the floods killed 26 (40 percent of whom were children), and many schools were destroyed [6].

In terms of flood volume, it was recorded at 475km³ from June 16 - November 8, 2000 in Kratie Province. In 2010, the recorded water volume was 193.1km³. Based on an approximation by the end of 2011 flood season, the calculated flood volume was 460km³ which is 37% higher than the long term average for Kratie of 335km³ [7].

TABLE I RAINFALL IN CAMBODIA DURING JULY, AUGUST AND SEPTEMBER

Month	Year		
	2000-2010 average (mm)	2010 (mm)	2011 (mm)
July	244.0	218.9	226.4
August	259.6	245.8	275.9
September	272.6	218.3	338.6
Average	258.7	227.7	280.3

Manuscript received March 28, 2015.

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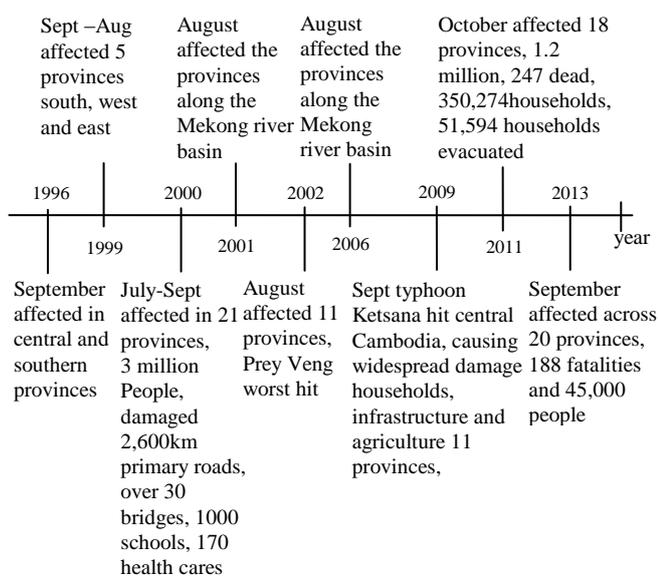


Fig. 1. Timeline of Flood

III. MAJORS FLOOD IMPACTS IN CAMBODIA

Four serious flood impacts have been studied and are classified into short, medium and long term severe impacts. Livelihood, food security and shelter are commonly regarded as first priorities in adaptation measures. They are controlled by community and officers based on flood emergency response.

A. Livelihood and food security

Livestock is a key part of rural livelihood that provide source of income and food. Damage to livelihood systems affects to people, assets and household in term of losses of food, income and basic needs in house. The assessment reveals that within the village or community, the poorest group of households, whose rice crop was totally destroyed, was the most vulnerable group. The largest impact of flood was found on food production such as agriculture, livestock, and fisheries. As for short term impact, during the flood hundred hectares of agricultural lands and grain storages were destroyed, damaged and people had to use the restore rice seed from the last harvest. Fishing is also reduced by the lower density of fish in flood waters. For medium and long terms impacts, to help compensate for this loss, and improve food security and nutrition in affected areas, the Red Cross is distributed the seeds of basic food crops, such as cassava and sweet potato to all households with access to land. People have to obtain loan or borrow crops from private sectors, NGO and government [8]. This shows that the high number of loans forced people to stay under the poverty line.

B. Shelter

At the time of flood, hundreds of houses were damaged, washed away so victims were evacuated to the nearby safety places such as pagodas, schools and other government buildings located nearby the village. People had to sleep on the ground with tents, kits and plastic sheets that Red Cross distributed for emergency needs. They were provided clothing, cooking utensils and water purification units. They lived insecure way because of lack of hygiene such as toilets, overpopulation, and clean water. As a result, they faced with health problem. For medium and long term impacts, victims

went back home to rebuild and fix their houses were destroyed [9].

C. Education

The floods have severely limited the education opportunities for a large number of children in school age including both private and public education. When disasters occurred, each school principal was responsible for reporting educational losses and damages to district office of education then informed to the provincial department. During flooding, the roads covered with water so it was impossible for students to go to school. School buildings were flooded and school materials were destroyed especial in library many books were soaked during the flood. Normally flood occurred between September to October. For short term impact, children were missing their classes because many schools delayed to open the new academic year until the end of the year. The new academic year always started in the beginning of October. Schools were closed for up to one or two month. Several schools in affected provinces that situated in high ground were used as evacuation point for people and their animals into school, particularly cattle and pigs, making school dirty. As for medium and long term impact, school tools and some buildings had to be reconstructed or rehabilitated because of flood [6].

D. Economy

Economy is the main currents to develop the country. Economy is related to many factors and if the economic growth is delayed, financial crisis will occur in country. Flood destroyed everything especially daily livelihood of population such as agricultures (productivities, lands use for agricultural activities), infrastructures (roads, bridges, canals, buildings, houses, irrigations), industry (small and medium enterprise, agro-industrial plantations), commerce (businesses, exploitations, services) and tourism. Additionally, the government organized firemen, policemen and other emergency officers to help the affected people. It usually took a couple years for affected communities to rebuilt their infrastructure, irrigation and agriculture systems to come back to stability. Government has to use the national budget to support victims that were lack of income and provide loan. In stance, flood in 2011 almost damaged all rice production and the total average yield was only 0.119 tons per hectare. It was not enough even for home consumption. So, this was the serious problem to their livelihoods. Therefore, the survey result showed the economic value of rice production 3.682 tonnes per hectare was loss by flood in 2011 [8].

IV. FLOOD RISK MANAGEMENT POLICY

Flood risk management policy is based on considerations of management measures, roles and responsibilities of government agencies and departments. Particularly floods affect the local communities in rural and remote areas, the recovery level of local communities against the negative influence of floods varies from place to place. Flood risk management measure is to enhance the resilience level of local communities through a cycle of systematic actions: preparedness, emergency response and rehabilitation and recovery in policy strategies [9]. These elements are mentioned briefly in Table II.

TABLE II. KEY ELEMENTS OF FLOOD RISK MANAGEMENT

Flood Risk Management		
Preparedness	Emergency Response	Rehabilitation and Recovery
Early warning and communications systems	Humanitarian assistance	Rehabilitation/ Reconstruction of damaged infrastructure
Contingency planning	Clean up, temporary service restoration,	Macroeconomic stabilization and budget management
Emergency responder networks	Damage Assessment	Revitalization of affected sectors
Shelter facilities	Mobilization	Incorporation

A. Preparedness

The effective preparedness response is to strengthen policies, technical and institutional capacities in national and local level. Moreover, the knowledge management technology provides training course to develop human resources and improve material resources. Associated departments in ministry of water resource and meteorology give early warning information and weather forecasting. Government support funds to prepare and review the latest information of disaster preparedness exercises, contingency plans at all levels such as evacuation training, access to vital food, non-food relief supplies in suitable way to affected people's needs. In ten years framework action plan from 2005-2010 build the resilience of nation and communities, encourage the launch emergency funds to maintain response, recovery and preparedness measures. Specific mechanisms are developed to involve the energetic participation and relevant stakeholder activities including communities, locals and nation [10].

B. Emergency response

The basic concept of emergency response is that the government is paying attention on livelihood and food security, support health needs, child nutrition needs and water sanitation needs. National Cambodia Disaster Management (NCDM) is in charge for the immediate effects and play an important role between the different routes of ministries, and the contributor community. In immediate response, government responded to flooding by providing mobile unit at the national and local administration. The unit will facilitate the creation of volunteer group that rescue the victims. Affected people were provided temporary shelter, medicine and food [11]. Red Cross and Red Crescent (RC&RC) play an important role to solve the potential issues or decrease the affect of vulnerabilities of livelihood, damage to infrastructure and increases the capacity of knowledge and skill to deal with risk disaster. RC&RC contributes the initial needs, for instance, facilities, shelter, water and sanitation, food, household kit in affected area [8].

C. Rehabilitation and Recovery

Rehabilitation and recovery framework is to apply the needs of affected communities for long term during 1-5 years. Micro project promotes government and public transportation give emphasis to projects of household asset. The recovery has been regrouped according to the duration of needs in the short term (0-6 months), medium term (1-2 years), and long term (1-5 years). The main action of government is to motivate farmer is like planting the agricultural crops on time. There are many priorities sectors such as transportation,

agriculture, education, housing, water management and irrigation, environment, industry and commerce. Recovery in agricultural sector is vital form to provide seed, fertilizer, and equipment especially with the potential threat on food security in the most affected provinces. Reconstruction and rehabilitation of roads networks in national, provincial areas that were damaged by the flood have been developed of specific standard for road construction and maintenance. Recovery education targets the school materials that were damaged, recording the number of damages classrooms to determine short, medium, and long term. Housing sector, repairing and rebuild management of house destroyed and damaged in the short term and hazard-resilient construction in the medium and long term impact. Last but not least, strategies that increase the environmental resilience recovery included: developing the use of natural resource management techniques to improve soil fertility and reduce soil erosion; cultivation of more land, and more efficient use of existing land; and increasing productivity of vegetable farming activities; rainwater harvesting or small water impounding system [12].

V. CASE STUDY

Flood occurred regularly so the government concern the response action to comprehend it carefully. Figure 2 showed the Cambodia map and most of the provinces were affected by flood. Most affected provinces are major agricultural, tourist, and economic zones in the country. Some areas were both flooded in 2009 and 2011, but flooded different affected scale, including number of evacuated families, damaged crops. But damaged infrastructure was more significant due to a combination of factors such as: unexpected gravity of the floods, both in terms of extent and intensity, longer time for waters to recede, repeated floods and flash floods, limited preparedness undertaken in advance and limited early warning.

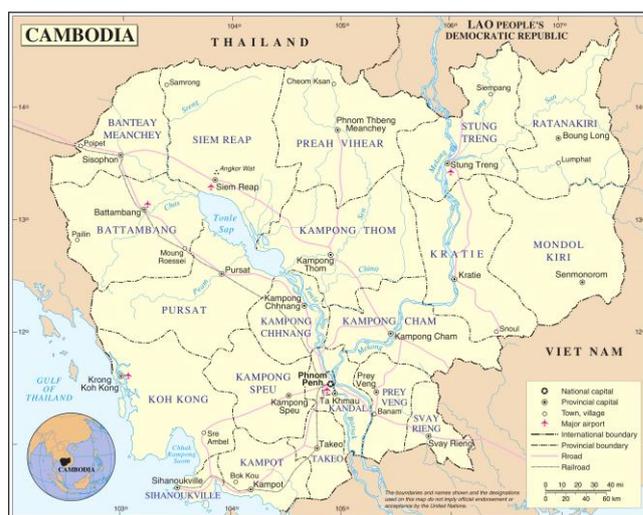


Fig. 2. Cambodia Map

In Table III summarized of flood damage and loss in 2009 and 2011, it showed the data of flood impact. The main concern of flood damage and loss are volume of flood, affected people and infrastructure.

TABLE III: SUMMARY THE DAMAGE AND LOSS 2009 & 2011 FLOOD

Description	Flood in 2009 [12],[13]	Flood in 2011 [9, 14, 15]
Flood volume (km ³)	299	411.4
Flood cover provinces	13	18
Death (person)	43	250
Injure people (person)	87	19
Property units affected	49,787	26,800
Property units damaged	-	13,000
House completely destroy (unit)	218	642
House severely damaged (unit)	804	-
Household impacted	-	354
Resettlement	-	52
School affected	-	1360
Rice crop lost and damaged (ha)	107,491	267,000
Rice crop destroyed (ha)	40,146	220,000
Other crops lost or damaged (ha)	-	17,300
Economic damaged (million US\$)	132	100-160
Infrastructure affected (km)	-	925

Before flood occurred between August to October, government and relatives stockholder had a preparedness plan. Flood in 2009 and 2011, NCDM had pursued the action response, was implemented in collaboration with local authorities and NGOs. During two years it could develop and actions were improved related to preparedness, emergency response, recovery and reconstruction.

TABLE IV: SUMMARIZE THE ACTION OF FLOOD MANAGEMENT

Policies	Flood in 2009 [16]	Flood in 2011 [17] [15, 18]
Preparedness		
Emergency responder network	-Training course to collect data and information before and after flood to relevant officers in each ministry. -Providing the strategies for flood prevention for before, during and after flood to local people. -Transferring officers in commune, province to participate risk management workshop	-Teachers training school Activities -Improving skills of District and Commune officials in Damage and Needs Assessment (DANA) -Strengthening the skills in safety measures by providing swimming lessons to school children.
Early warning and communication systems	-Meeting farmer to advertise flood information by markers and billboard -Advise how to prevent the insects and how to use fertilizer for plant -Prevention and advertisement of information to change rice plant in long term (6 months) to short term (3 months) after flood -Preparing to fix or maintain the rice warehouse in safety way	- Provincial Flood Preparedness Plan (FPP) and district FPP updated and published. Those FPPs have been shared information to the member of PCDM, DCDM and relevant line agencies in each target province and district. -The Training Needs completed and the set of trainers has been identified and trained
Emergency Response		
Control the risk sign	-Site visit the situation of flood area and collect the data of victims -Cooperation with	-Report the situation of flood areas -Monitor and evaluate the relief activities and provide reporting on

Policies	Flood in 2009 [16]	Flood in 2011 [17] [15, 18]
	ministry of water resource and meteorology to give information about water level	relief distributions.
Mobilization	-Evacuate victims, animals to high levee area -Support boats for transportation, ambulance and mobile clinic and health care	-Transfers and emergency health care to flood victims
Clean up, temporary service restoration,	-Medical service, mobile clinic, specialist doctor -Give vaccination to animal such as pigs, cows -Build the toilet and provide clean water	-Relief aid to families -WASH, shelter, and assistance for flood -Provision of Food, non-food Items, cash transfers and emergency health care to Flood affected populations
Damage assessment	-Visiting flood areas and estimate the number of victims, damages, losses, fatality, injured	-The survey found that avoid displacement and its associated economic losses during future natural disasters, structures
Rehabilitation and Recovery		
Rehabilitation and reconstruction of damaged	-Giving rice crops to farmers -Visiting the real affected areas to survey the damages by flood and needs of people	- Temporary repairs of canal embankments - Repairs of flood-damaged rural access roads
Rural road habilitation and construction and improvement	-Study the condition of damage road -Maintenance of the damage roads	-\$55 million loan to restore key infrastructure in the worst-hit provinces. -National, provincial and rural roads will be restored, alongside irrigation and flood control infrastructure.
Water and sanitation activities	-Maintenance or rehabilitation of the well pumps, ponds -Giving filter tank to get clean water	-Ensure sufficient water sources are installed -Construct sufficient latrine to provide the standard
Macroeconomic stabilization budget	-Giving loan -Give agricultural crop	-Economic Recovery and Market Systems, -WASH (USAID/OFDA) inclusive economic growth (IEG)
Revitalization of affected sectors		-Support by ADB Financing (\$ thousand): 3000 -Agriculture (Agricultural production, Irrigation) -Natural resources (Environmentally sustainable growth (ESG) - Rural development -Public management transportation

VI. CONCLUSION

Cambodia's unique hydrological regime and low coverage of water control infrastructure makes it vulnerable to climatic and natural disasters. Flood in Cambodia is a dangerous disaster that is occurred frequently but the management policies are still limited the capacity to respond and prepare for the flood. The lack of preparedness, systematic planning

in commune, district, provincial and national level are serious problems.

The levels of damages for 2009 flood and 2011 flood were much different, even though the severity of 2011 flood was higher and more extensive than 2009 flood. Flooding not only caused of economic impact, but also to social and environmental problems of the nation. The flood has the most negative impact on the rice and mixed crops productions. However management in 2011 flood were more improved the management strategies in preparedness, emergency and rehabilitation and recovery. First for preparedness response, before 2011 flood occurred ministry opened the training course for officers to collect the data and information to strengthening the skill. The creation of provincial and district preparedness plan was updated the methodologies to share information with relevant agencies were developed. Second for emergency response, officers have to report the flood situation and affected people. The provision of food emergency needs are sufficiently to affected people especially water supply. They could use small water filtration small tank system for drinking water. The health care mobilization gave more specialist doctors, nurses to take care patients and provided medical treatment. The last step of rehabilitation and recovery, the temporary repair of canals and road access were first demand. The developed countries supported the loan to restore the infrastructure in national, provincial and district level especially irrigation system.

However, they were clearly at different levels of development; have different realities in data collection and processing systems and different capacities to deal with floods. Hydrological and meteorological services are at different stages of development, flood forecasting tools are different. So there are different procedures and capabilities for flood warning, preparedness, emergency, rehabilitation and recovery in the country. In conclusion, the flood management in 2011 were better than 2009 flood but it was still lack of some actions. For preparedness system, government should provide more fund to support the material and program especially ministry have to transfer the officers to abroad to get more knowledge of methodology to apply in the country. Emergency response were still difficulty to control because only Red cross who could give food and emergency aid. Rehabilitation and recovery system were still big obstacles because ministry had to spend long time to study and promote to rehabilitation project.

Emergency response is to provide food distribution for vulnerable groups such as mobile clinics and health care, emergency shelter and household kits, water purification tablets, water storage containers and hygiene materials. Migration to another place becomes the popular way to generate more income. Low adaptation of the farmers is another cause of worst impact especially on rice production. Therefore, the extent of flood's impact on rice yields of farmers is the main consequence. In conclusion, flood in 2011 is the worst impact on rice production in the place study. Moreover, it is the obstacles in poverty alleviation program and in achieving the millennium development goals. Further adaptation strategy is strongly needed for local people.

The successful response to flood in Cambodia, government should have strong relation with key stakeholders. They have own responsible for elements in overall flood management activities. Flood management depend on effective integration of planning preparedness, emergency, rehabilitation and

recovery response in national, district, community level. Funds is main sources to support all these plan.

ACKNOWLEDGMENT

The authors are very grateful to Scholarship Program for Students from Neighboring Countries (SSNC) that give scholarship and financial support to study master degree in Sirindhorn Institute International of Technology (SIIT) .

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