

# **Asian Development Bank**

## **Flood Damage Emergency Reconstruction Project**

Preliminary Damage and Loss Assessment

March 2012



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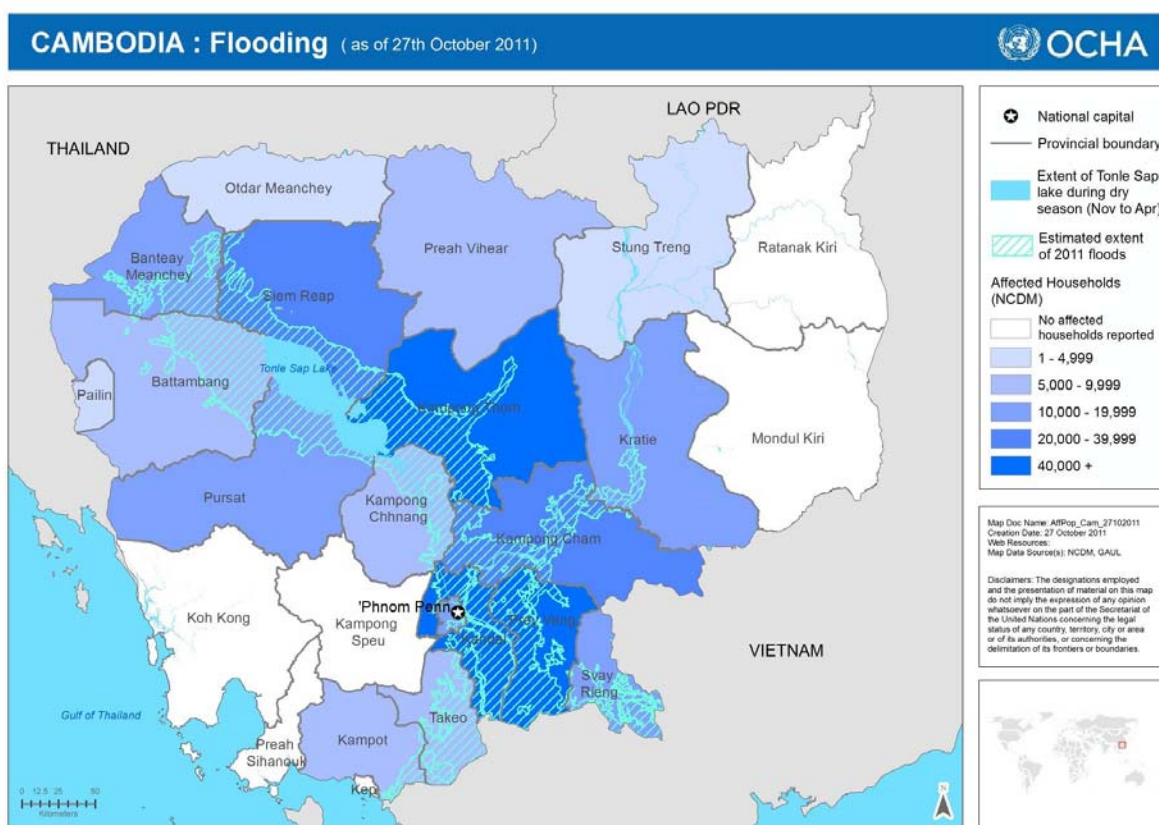
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## Main Report

### 1. Introduction

The Mekong River started to rise in early August 2011, with the water level rising significantly when Typhoons Nesat and Nalgae in late September and early October brought heavy rain. Eighteen out of 24 provinces and municipalities were inundated and over 1.5 million people affected. The damage from the 2011 flooding is expected to exceed that of floods in 1996 and 2000, both in terms of loss of life and impacts on infrastructure and agricultural crops, largely because the water rose and receded three times. This not only prolonged the period of inundation but also hindered the initiation of meaningful remedial measures.

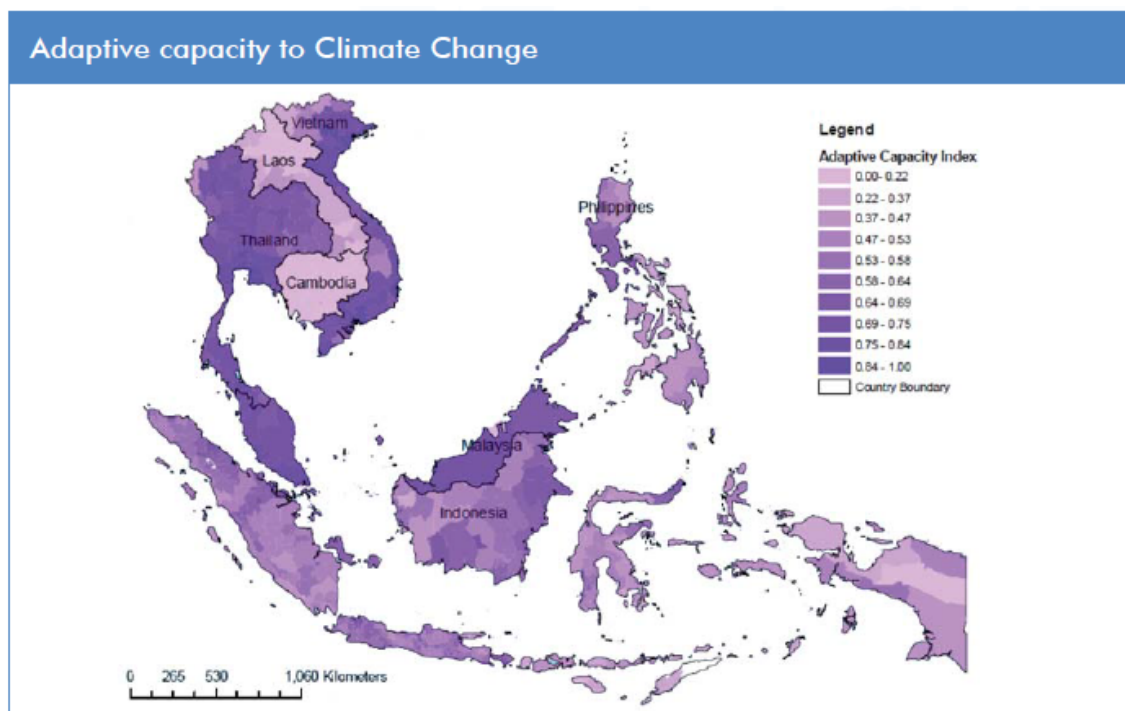
On 22 September 2011, the National Committee for Disaster Management (NCDM) of the Royal Government of Cambodia (RGC) issued an announcement to all provinces and municipalities, especially those along the Mekong, Tonle Sap, and Bassac Rivers, to be on high alert and to carry out flood emergency responses. The UN map below shows the flood affected areas.



The devastation caused by the floods as well as the continuing suffering of a large number of Cambodian people, and the impact on the economy, is clearly significant and has tested the capacity of the RGC to restore basic services and infrastructure. A summary of the immediate response to the 2011 floods is presented in Attachment 1.

**Flood Impact:** Households most affected by the floods are those who rely primarily on rice farming and live in isolated rural areas of the country. Damage to the rural road network, on which they depend for sustaining livelihoods, has severely hampered access to basic services

such as water supply and sanitation, health, education, and irrigation. Figure 1 below shows that Cambodia has low adaptive capacity to climate change, and this applies especially to rural areas where the most vulnerable households live, which have the least capacity to cope with extreme unexpected weather events. As a result, the flood had a magnified impact on the poorest people and vulnerable households, including women and children living in rural areas.



Source: ADB, Key indicators for Asia and Pacific, 2008

**Figure 1: Cambodia is vulnerable to extreme weather events**

## 2. Post Disaster Need Assessment (PDNA)

A sound estimate of damage, losses and needs following a natural disaster is critical to inform both a well-designed Government's recovery plan and to provide international assistance to implement the plan. This assessment develops a preliminary yet comprehensive perspective of the damage and losses in order to provide policy makers with a good understanding of the ways in which critical sectors, and the national economy as a whole, have been affected by the 2011 floods. The methodology adopted for the assessment is presented in Attachment 2.

## 3. Damage and Loss Analysis (DLA)

Despite the positive overall economic performance of Cambodia in 2011, the flood slowed the potential for sustained economic growth due to the devastating impact at the household and macroeconomic levels. As a result, the growth potential in different sectors of the economy was not realized. Preliminary estimates indicate that the direct damage to assets and economic losses amounted to \$624 million dollars, as shown in Table 1. Approximately two-thirds of the total negative effects of the flood are due to the damages<sup>1</sup> and one third due to the losses<sup>2</sup>.

<sup>1</sup> "Damage" (direct impact) refers to the impact on assets, stock, and property valued at agreed replacement (not reconstruction) prices. The assessment considers the level of damage (i.e., whether an asset can be rehabilitated or repaired, or has been completely destroyed).

### Cambodia 2011 Floods Quick-Facts

Fatalities: **250**

Provinces affected: **18** out of 24

Households affected: **354,217** (More than 1.7 million people)

Households evacuated: **51,950**

Infrastructure Damaged:

- National /Provincial Roads – 363 km & 177 bridges /culverts damaged (overall 925 km affected)
- Rural Roads – 1,842 km needing priority repairs (overall 4,470 km affected)
- Irrigation – 329 schemes partly damaged (includes damage to 54 km of canals and 122 km of reservoir embankment)
- Rural Water Supply – 77,544 wells and 579 community ponds contaminated (affecting more than 456,000 families)
- 1,396 schools and 115 health centers

Rice fields damaged: around **10%**, of which **6.6%** fully destroyed

Source: Compiled from many sources.

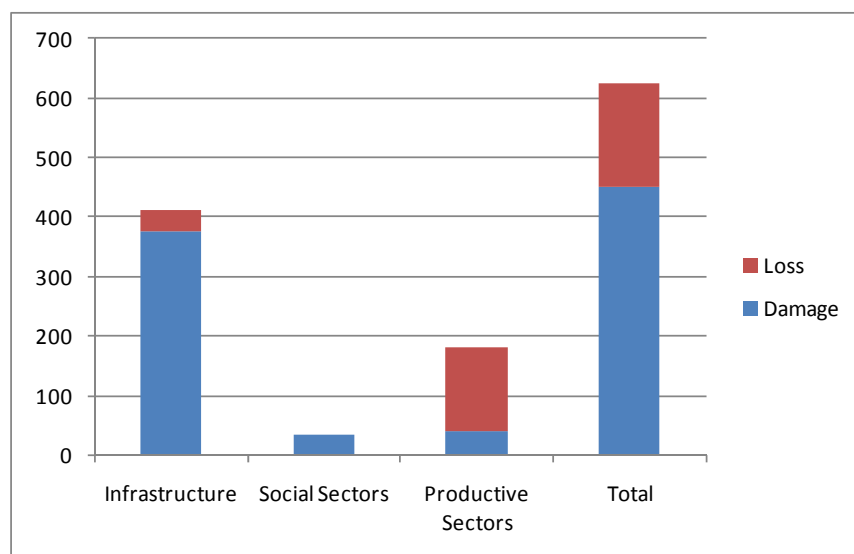
#### 4. Main Sectors Affected

With reference to Figure 2 below, the major damage and losses by sector are:

- (i) Transport – \$344.4 million or 57% of the total (89% damage, 11% loss).
- (ii) Agriculture - \$179.6 million or 29% of the total (22% damage, 88% loss).
- (iii) Irrigation and water management - \$27.1 million or 4.5% of total (this includes only damage as it was not possible to estimate the loss).
- (iv) Rural water and sanitation - \$31.4 million (64% damage, 36% loss), although the monetary impact is marginal, the present conditions of rural water and sanitation will lead to health hazards.
- (v) Agriculture - 163,377 ha of paddy rice destroyed valued at a total of \$178.8 million (\$40.8 million lost planting, \$138 million lost paddy production).
- (vi) Loss of wages in agriculture - \$7.3 million, a small but important loss
- (vii) Exported milled rice – reduced by \$43.6 million compared to potential.

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<sup>2</sup> “Loss” (indirect impact) refers to production decline, reduced incomes, and increased expenditures while the economy and assets are recovered. To calculate the losses related to the damage to the rice crop, the assessment uses the economic price of paddy using an export-parity price methodology.



**Figure 2: Total impacts of the 2011 floods**

Details of the assessment of damages and losses in each of the major sectors affected are presented in Attachment 3 which are the basis of the summary figures presented in Table 1 below.

**Table 1: Flood 2011 Damages and Losses**  
(\$ million)

Sector	Damages and Losses		Total Impact
	Damage	Losses	
Infrastructure	375.7	34.7	410.4
Transport a/	328.6	23.3	351.9
National/Provincial Roads	217.9	-	217.9
Rural Roads	110.7	23.3	126.5
Rural Water and Sanitation	20	11.4	31.4
Irrigation/Water Management	27.1	-	27.1
Canals	5.9	-	5.9
Embankments	21.2	-	21.2
Social Sectors	34.7	-	34.7
Education	20	-	20
Health	3	-	3
Housing	11.7	-	11.7
Productive Sectors	40.8	138.8	179.6
Agriculture b/	40.8	138.8	179.6
<b>Total</b>	<b>451.2</b>	<b>173.5</b>	<b>624.7</b>

a/ Losses in the transport sector are calculated for rural roads only through a VOC Model and does not include losses for national and provincial roads damage

b/ Damage in agriculture sector is calculated as the damage incurred to the assets needed, and the investments incurred for paddy production

Source: ADB staff estimates.

By way of comparison, the damages and losses incurred in the 2011 floods can be compared to those of the 2009 Ketsana Typhoon as presented in Table 2. It can be seen that in the 2011 floods, damages were about 8 times higher, while losses were more than double.

**Table 2: The 2011 Floods Compared to the Ketsana Typhoon**

	2011 Flood			Ketsana		
	Damage	Loss	Total Impact	Damage	Loss	Total Impact
Infrastructure	375.7	27.2	410.4	17	11.5	28.5
Social Sectors	34.7	-	34.7	39.5	3.3	42.8
Productive Sectors	40.8	138.8	179.6	1	59	60
<b>Total</b>	<b>451.2</b>	<b>166</b>	<b>624.7</b>	<b>57.5</b>	<b>73.8</b>	<b>131.3</b>

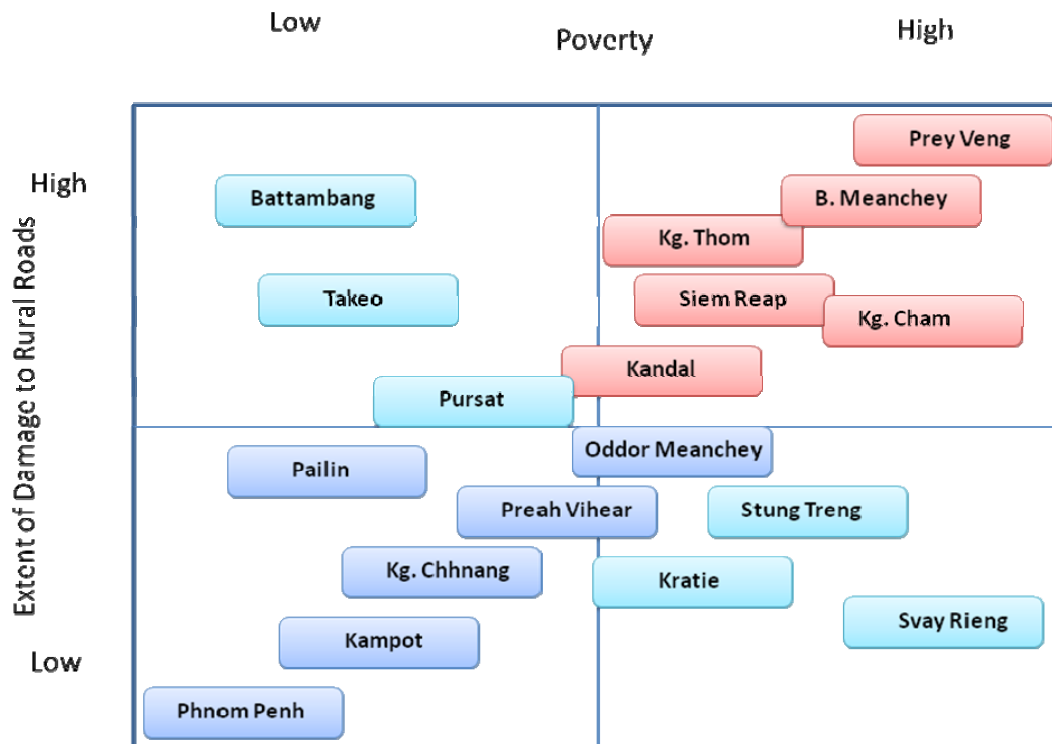
Sources: Ketsana Post-Disaster Needs Assessment; ADB staff estimates

## 5. Target Provinces

Given the limited recourses available under the FDERP compared to the total damage, a methodology was developed to prioritize and target poor and isolated rural communities that are most in need. This has been done by a simple comparison between poverty level and the extent of the damage to rural roads. The goal is to provide a meaningful proxy to assess the extent of the damage and future losses that are still likely to be incurred due to the 2011 flood.

Based on this analysis, the 6 provinces in the top right corner of the Figure 4, Prey Veng, Banteay Meanchey, Kampong Cham, Kampong Thom, Siem Reap, and Kandal, have the highest incidences of both poverty and damage. With the exception of Kandal, the other 5 provinces are targeted under the FDERP. Battambang has also been included to cover some critical irrigation repairs and to complete the connection of a provincial road that is mostly in Banteay Meanchey to a main road in Battambang.

**Figure 3: Poor, rural and isolated.**



**Figure 4: Disasters impact the poorest**

## **6. Preliminary Macroeconomic and Socio-Economic Impact**

The effects include: impact on GDP growth, structure of the balance of trade due to increased imports or reduced exports, impact on the fiscal sector (lower revenues, higher expenditures), and negative impact on employment and income at the personal and household level. In general, it is expected the macroeconomic effects will be temporary and can be overcome with a recovery program consisting of the restoration of the disrupted road infrastructure, transport links in strategic locations and relief and rehabilitation programs for the affected farming communities to resume their farming activities, especially for the upcoming dry season crops. Livelihoods in most affected districts have been adversely affected, and immediate measures need to be taken to restore their income generation capacity and coping strategies.

The impact of the floods on the overall price level is likely to be minimal given that the output loss is small relative to the overall level of output and demand, the expected good crop harvest across the country due to favorable weather and the supply of the short term dry season rice crop.

**Employment:** The informal economy is critical for the survival of many people who have become more vulnerable after the floods. Informal off-farm activities such as transplanting, harvesting, weeding, planting, clearing bush or forest, unskilled work in construction, services, and manufacturing sectors in major cities, are necessary to provide secondary support for their livings.



## **Attachment 1: Immediate Response to the 2011 Floods**

The RGC took firm leadership in the immediate relief and emergency response operations, coordinated by the National Committee for Disaster risk Management (NCDM) and its decentralized committees at the provincial, districts and communes level in the affected areas. Moreover, a large number of institutions, such as The Cambodian Red Cross, numerous NGOs, and international development partners provided emergency relief aid to satisfy the most immediate needs of the population affected. First response distributed items included rice and rice seeds, temporary shelters such as tents, emergency kits, and drinking water. In addition to humanitarian support, priorities in the immediate weeks after the disaster were to carry out quick repairs to the damaged rural roads to reconnect critical supply lines and enable relief supplies to flow smoothly. Moreover, as one of the most affected productive sector is agriculture, and in particular paddy production, it was of paramount importance in the preliminary emergency operations to provide seeds to farmers to replant short term rice before the water fully recedes. In this way, farmers could replace destroyed crops with a new short-season rice crop that would be ready to harvest in 90 days.

**ADB Response:** The President approved a \$3 million grant from Asia Pacific Disaster Response Fund on 2 November (fund disbursed on 9 Nov) to be used for:

- a) rice seeds purchase;
- b) temporary repairs of rural roads through food/cash-for-work schemes
- c) temporary repairs of dyke/canal embankments;

Other priority areas of work for ADB were the identification of possible savings from existing projects for possible re-allocating for some immediate rehabilitation activities. Moreover, responding to the government request, ADB has made significant progress on the proposed Emergency Flood Rehabilitation Project of \$55 million that will focus on roads (national, provincial, and rural), including bridges and culverts, and irrigation.

The UN allocated \$4 million from its Humanitarian Fund (Central Emergency Response Fund) for lifesaving humanitarian activities such as food, shelter, clean water and sanitation, vegetable seeds, and rehabilitation of the 150 most affected primary schools. These include: (i) WASH (UNICEF): Water purification tablets and soap and, as waters recede, will conduct a water quality assessment and provide well and water source rehabilitation and hygiene promotion; (ii) Education (UNICEF): School furniture, materials and assessment and repairs to infrastructure; (iii) Shelter (IOM and UNDP): Materials such as tarpaulins, plastic sheeting, solar kits for lighting and clay ovens; (iv) Health (WHO and UNICEF): Outreach to 151 affected health centres; (v) Agriculture (FAO): A rapid assessment to select beneficiaries, providing rice and vegetable seeds and tools and equipment, and providing farming technical assistance; (vi) Food (WFP): Rice rations and combined food rations (including sugar and oil).

**Coordination with Development Partners:** ADB has been in close contact with the United Nations Disaster Management Team (UNDMT), development partners (Japan, Australia, and Republic of Korea and others), and selected NGOs. With support from UNDMT, meetings were regularly held in Phnom Penh to coordinate the humanitarian and early recovery assistance by UN agencies, development partners, and civil society. The UNDMT has established seven key sectors to monitor the assistance efforts: WASH, Food, Agriculture, Health, Education, Shelter and Child Protection, and Reconstruction and Rehabilitation. The Reconstruction and Rehabilitation sector is designed for longer-term response, and ADB is expected to take the lead coordinating role in this area.

## **Attachment 2: Post Disaster Need Assessment Methodology**

The Post Disaster Needs Assessment (PDNA) provides a methodology to assess damages and post disaster recovery needs in a way that can provide a framework for the planning of coordinated recovery efforts across different sectors with a risk reduction focus.

The Damage and Loss Assessment (DLA) methodology<sup>3</sup>, which is the backbone of most post disaster analyses was originally designed by the UN Economic Commission for Latin America and the Caribbean (ECLAC) in the 1970s. This methodology has been used in several previous assessments by the World Bank, ADB and UN and provides a sound framework for identifying and quantifying social, economic and macro impact of the flood in Cambodia.

The assessment of damage and loss provides a basis for determining recovery and reconstruction needs. The assessment of damage provides a basis for estimating reconstruction requirements, while the estimation of loss provides an indication of the reduction or decline in economic activity and in personal and household income arising from disasters. It analyzes damage and losses at the sub-sector level as well as the overall economic and social effects of the flood in the socio-economic conditions of the country.

In addition to the damage and loss analysis at the sub-sector level, the assessment focuses on the “Economic and social effects” (sometimes called “secondary impacts”) of the flood. The analysis aims to measure the impact of the disaster on variables such as economic growth, unemployment, and poverty at the national and sub-national levels. These effects can be classified as macro and micro economic effects. Hence it is important - in addition to sector specific analysis - to analyze the effect of the flood and its impact on those affected indicators in the socio-economic situation of the country.

Macroeconomic effects are assessed through secondary data and economic modeling using national accounts to validate the losses caused by the disaster as well as through anecdotal evidence derived from a complementary household survey planned in close collaboration with other development partners. The survey aims at collecting primary data from flood-affected household and provides a credible base to make generalized assumptions needed for estimations.

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<sup>3</sup> See ADB. April 2009. *Damage, loss and needs assessment: an introduction for staff of the Asian Development Bank*. Draft Manila.

## Attachment 3: Sector Reports

### A. Infrastructure Sector

#### 1. Transport - Roads infrastructure

11,703 km of national and provincial roads are managed by the Ministry of Public Works and Transport (MPWT), and 38,931 km of rural roads (about 86% of the total road network of Cambodia) are managed by the Ministry of Rural Development (MRD) (see Table 5 below for details). A vibrant transport sector is essential to both economic growth and poverty reduction. The RGC and its development partners have made substantial efforts to improve road access. However, the 2011 floods caused significant damage to the expanding rural road system, as well as to sections of the national and provincial road network.

**Table 5: Road Classification and Management Responsibilities**

Road Classification	Length (Rate)		Number of Bridges (Length)	Management Authority
Single-Digit National Roads	2,117.0 km	5.3%	589 (17,643m)	MPWT
Double-Digit National Roads	3,145.6km	7.9%	698 (15,710m)	
Provincial Roads	6,441.0km	16.2%	904 (16,309m)	
Rural Roads	28,000km	70.5%	N/A	MRD
Total Length	39,703.6km	100.0%	2,445 (58,340m) 1764 Culverts	

Source: MPWT and MRD (2009).

Rural roads are widely distributed in agricultural areas producing agricultural crops such as rice, potato, corn and fruits. They play a very important role in providing vital access to markets, schools, farmlands, communes, districts and health centers as well as to connect to provincial and national roads for long distance trips. Access to services, especially health and education, is also limited during the long rainy season. Flooding of the land surrounding the roads and bridges damaged by floods become great threats to vulnerable villagers.

#### a. Preliminary Damage Assessment – National & Provincial Roads

As per NCDM figures dated 3 November 2011 and other information provided by MPWT, including a cost estimate of specific damage repair & cost estimates already identified, the preliminary damage assessment is as follows:

Total roads affected	925 km (NCDM)
Roads with varying damage	363 km
Bridges damaged on NR11	5
Other bridges and culverts damaged	177

Repair costs per/km based on MPWT estimates:

Item	Cost (\$m)	Source /Remark
Finished Stage 1 works - immediately to get roads working	\$20 m	as advised by MPWT, see MOU
Ongoing Stage 1 work (27 packages)	\$20 m	
NR154, 26 km @ ~\$330,000/km	\$8.6 m	
NR11, 5xbridges @ \$1.6m/bridge average	\$7.9 m	

Prov roads, 192 km, @ \$231,000 average	\$44.4 m
Prov bridges /culverts x 177, assume @\$0.3m average to repair =	\$53 m
Remaining roads with various damage 363-218 = 145 km and assume repairs @\$230,000/km	\$34 m
Assume the remaining “affected” roads 925 – 363 = 562 km involve repairing potholes and some tarmac replacement and assume average cost is \$50,000/km	\$30 m
<b>TOTAL</b>	<b>\$217.9 M</b>

#### b. Preliminary Damage Assessment – Rural Roads

Summary table of damage to rural roads:

Total rural roads affected	4,470 km (as per NCDM reports supported by MRD)
Roads for high priority repair	1,842 km (as advised by MRD)

Summary cost of rehabilitation

Item	Cost (\$m)	Source /Remark
Finished Stage 1 works - immediately to get roads working	\$9 m	as advised by MRD, see MOU
Of 1,842 high priority road, MRD is already repairing 510 km and has allocated \$9m (equates to ~\$18,000/km)	\$9 m	
Remaining high priority repairs 1,332 km (1,842 – 510)	\$53.3 m	
Assume average repair costs of \$40,000/km		
Remaining affected roads 2,628 km (=4,470 – 1,842)	\$39.4 m	
Assume average repair costs of \$15,000/km		
<b>TOTAL</b>	<b>\$110.7 m</b>	

#### c. Losses for transportation sector (rural roads)

Losses in the transportation sector refer to negative changes in the economic flows of local economic activities that arise as a result of the interruption or modification of transport and communications system.

Loss mainly incurs in the form of higher vehicle operating costs (VOC) and longer freight and passenger travel times associated with the worsened road conditions on key urban, national, provincial, and rural roads. The use of temporary means (longer alternative road routes) and improvised repairs with low standards of construction and materials in order to accommodate temporary traffic further exacerbated the losses. The higher volume of traffic is expected to continue for an extended period of time during the recovery.

The increase in VOC due to the damaged roads results in faster depreciation of vehicles and higher fuel consumption, thus creating greater demand for imports. If loss of roads is correlated to the volume of traffic, rural roads pale in comparison to urban, national, and provincial ones. Most of rural road users, however, have no choice besides using the damaged rural roads with higher vehicle operating costs. Moreover, rural road users are the most vulnerable and at risk of

being marginalized by the disruption of rural links that are vital for their daily livelihood sustainment.

In this assessment losses are calculated only for rural road because of lack of primary data related to national and provincial roads and hence the overall figure might seem quite low, because it does not account for the losses derived by disruption of major transportation arteries. However, calculation of losses incurred from damage to rural roads is crucial to understand how rural connectivity is likely to remain in critical conditions for a long time before they can be repaired, as compared to national and provincial roads. This condition exacerbates the losses at the local level, having an impact on underprivileged segment of rural population.

Loss Calculation		
	Unit	
Assumptions		
Road repaired within 9 months from floods by Government (category 1)	Km	510
Remaining high priority areas repaired within 15 months (category 2)	Km	1332
Remaining affected roads repaired within 24 years from flood (category 3)	Km	2628
Average population density of most affected provinces (ppl sq km)	Ppl/sq km	214
Average length of rural road damaged	Km	7
VOC Loss for proxy 1 km rural road per year	\$	3,193
Total VOC Loss		
A. Loss for road category 1	\$	\$ 1,221,362
B. Loss for road category 2	\$	\$ 5,316,519
C. Loss for road category 3	\$	\$ 16,782,956
Total VOC Loss	\$	\$ 23,320,837

Losses include the higher operational costs to be incurred by the users when adopting different means or modes of transport, alternative routes, increasing petrol costs, and in general having fewer facilities to commute. The most frequent losses occur when vehicular traffic must utilize alternative longer routes that result in higher costs of operation. In addition, losses may be incurred when produce cannot reach the intended markets opportunely due to damage in the normal transport routes. This especially applies in the case of perishable agricultural and fishery products if they cannot reach the markets in time. However, these losses refer to the value of the production that does not reach the market rather than to higher transport costs, and should be accounted for under the primary production sector and not under infrastructure.

**Action taken by MRD for Repair Damage.** MRD has established a technical working team of 122 staff within MRD and PDRD to manage the rural road inventory and database. The team collects inventory data periodically, particular after flood damage. The team processes the data, prepares maps, and established a geographical information system (GIS). Immediately after the floods, technical working teams carried out inspections to assess the damage and prepare cost estimates.

The table below presents the flood damage to rural road network by province showing the source of funding for the rehabilitation works:

No	Province	Total Length (km)	Damaged Length (km)	Rehabilitation Plan (km)	
				Government Budget	External Source
1	Prey Veng	3,220	175.0	56.6	118.4
2	Svay Rieng	2,430	103.0	25.5	77.5
3	Battambang	4,969	101.4	23.0	78.4
4	Kandal	2,741	201.6	81.0	120.6
5	Kampong Cham	2,749	185.7	59.3	126.4
6	Banteay Meanchey	2,564	221.0	44.5	176.5
7	Kampong Speu	2,765			
8	Siem Reap	2,261	134.8	33.7	101.1
9	Kratie	1,214	65.3	33.6	31.7
10	Takeo	3,161	25.8	25.8	
11	Oddar Meanchey	711	145.6	13.3	132.3
12	Kampong Chhnang	1,021	51.8	25.3	26.5
13	Kampot	1,581	78.8	26.3	52.5
14	Kampong Thom	2,183	95.5	7.0	88.5
15	Preah Vihear	1,041	17.2	6.9	10.3
16	Pursat	1,290	98.9	20.7	78.2
17	Preah Sihanouk	311			
18	Phnom Penh	353	12.9	12.9	
19	Ratanakiri	811			
20	Monduliri	278			
21	Stung Treng	545	2.7	2.7	
22	Pailin	194	125.0	11.6	113.4
23	Koh Kong	441			
24	Kep	98			
<b>Total</b>		<b>38,931</b>	<b>1,841.8</b>	<b>509.7</b>	<b>1,332.1</b>

MRD started to repair the damaged roads (509.7 km) approved by the government budget. As of 20 December 2011, the MRD almost completed the repair in nine provinces, Siem Reap, Battambang, Kg Thom, Kg Cham, Pailin, Phnom Penh, Banteay Meanchey, Odor Meanchey and Preah Vihear province. The entire progress of emergency repair is about 25%. The MRD will continue the repair of the damaged works in 18 provinces by the end of June 2012.

#### d. Preliminary Damage Assessment - Irrigation

Information from MOWRAM as per email dated 22 Dec 2011 (Attachment 3), damage is summarized below, and used as the basis for estimating the damages

Item	Large scale	Medium scale	Small scale	Total
<b>Canals</b>				
Length damaged	1 km	48.8 km	4.1 km	53.9 km
Repairs assumptions	Earthworks 30m <sup>3</sup> /linear m @\$6/m <sup>3</sup> for compacted b'fill (\$180/ln m)	Earthworks 18m <sup>3</sup> /linear m @\$6/m <sup>3</sup> for compacted 'fill (\$108/ln m)	Earthworks 14m <sup>3</sup> /linear m @ \$6/m <sup>3</sup> for compacted b'fill (\$80/ln m)	

Repair costs	180 x 1000 = \$0.2 m	108x48,800 = \$5.3 m	84 x 4,100 = \$0.4 m	<b>\$5.9 m</b>
<b>Embankments</b>				
Length damaged (km)	3.3 km	87.7 km	32.1 km	122.2 km
Repairs assumptions	Earthworks 52m <sup>3</sup> /linear m @\$6/m <sup>3</sup> for compacted backfill (\$312/ln m)	Earthworks 30m <sup>3</sup> /linear m @\$6/m <sup>3</sup> for compacted backfill (\$180/ln m)	Earthwork 22.5m <sup>3</sup> /linear m @ \$6/m <sup>3</sup> for compacted backfill (\$135/ln m)	
Repair costs	312 x 3,300 = \$1.0 m	180x87,700 = \$15.8 m	135 x 32,100 = \$4.4 m	<b>\$21.2 m</b>
<b>TOTAL</b>				<b>\$27.1 m</b>

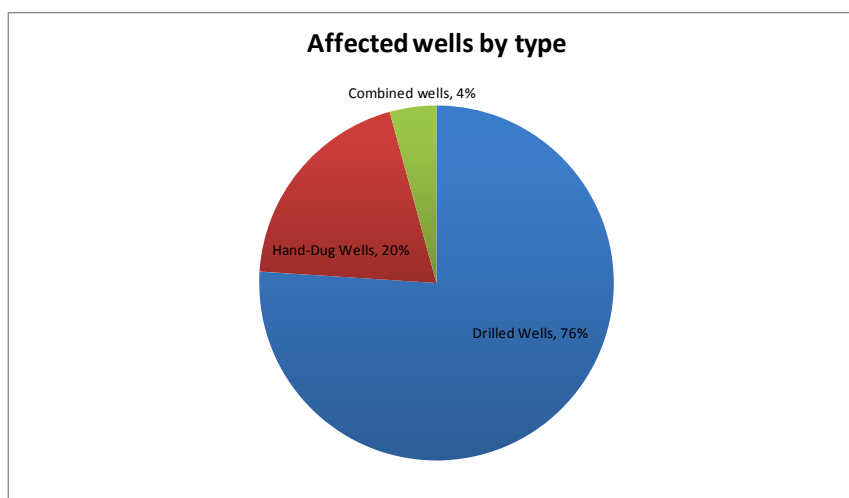
#### e. Preliminary Damage and Loss Assessment - Rural Water supply

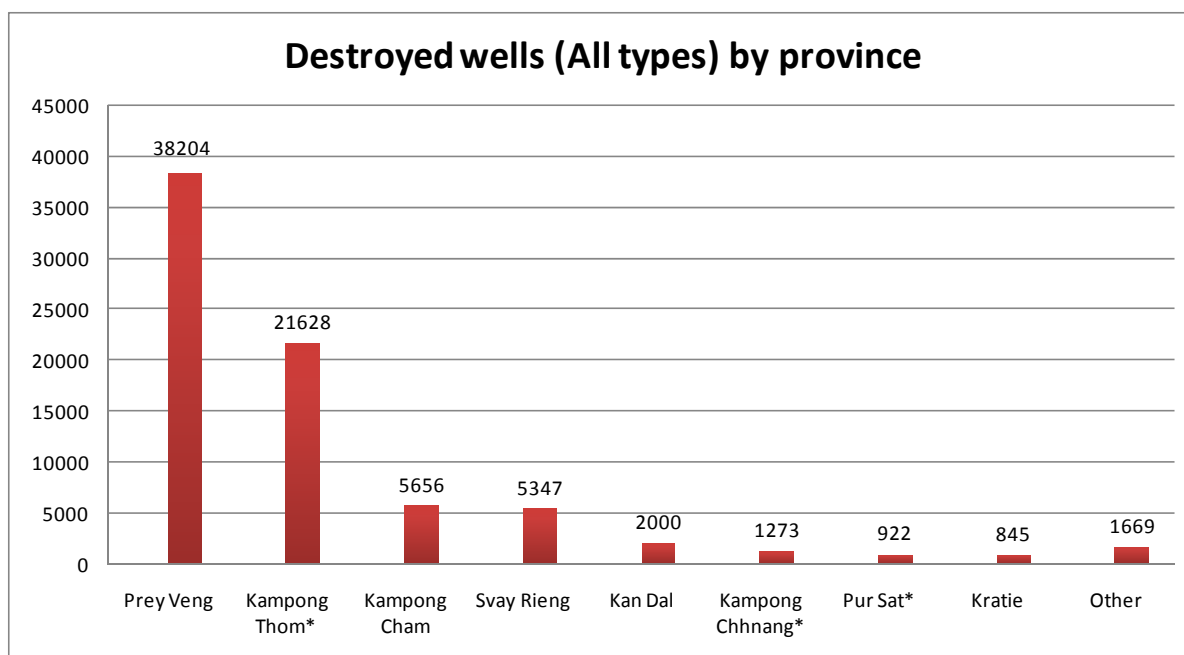
A total of 77,544 wells have been affected by the flood in 18 provinces with break down as shown in the chart below. More than 456,000 families have been affected by the lack of water as a result of damages to rural wells for a total of more than 2.3 million people affected. Estimated damage expressed as the cost for rehabilitation of all affected wells is reported below:

Description	Unit Cost (\$)	Number	Cost (\$)	Notes
Drilled Wells (Restoration)	200	50,115	10,023,000	Assumed 85% of 58,959
Drilled Wells (Repair)	1,000	8,844	8,844,000	Assumed 15% of 58,959
Hand-Dug Wells	100	15,298	1,529,800	
Combined Wells	100	3,287	328,700	
<b>Total Cost</b>		<b>77,544</b>	<b>20,725,500</b>	

The above cost does not include of rehabilitation of the 579 affected community ponds. The amount of restoration work required for the ponds is not known, but could amount to an additional \$5 million.

The main affected provinces in the rural water supply sector are Prey Veng, K. Thom, K. Cham and Svay Rieng, with Prey Veng province accounting for almost 50% of the total number of damaged wells from the flood.





Well restoration will result in relatively quick and very effective impacts by providing much needed safe water supplies directly to affected rural communities, whose need is now rather than tomorrow. The initial and short-term impact will be more significant and will be easier to measure than those provided by other better-funded sectors, such as roads and irrigation, whose impact will be seen over a longer period of time.

**Loss analysis:** The main sources of losses caused by damaged rural wells are: (i) Increased cost of transportation to reach the nearest water source; (ii) Additional cost incurred by individuals or households to water; and (iii) Additional health expenditure derived from water born disease due to hazard in usage of sub-optimal water sources and in general due to deteriorated hygiene conditions.

It is not possible to calculate the increased cost of transportation to reach the nearest water source without collecting primary data as well as establishing a correlation between the use of hazardous alternative water sources and the consequent health impact and additional health expenditures. However, the loss analysis for the rural water sector is based on a model that takes onto account the additional cost incurred by HHs in purchasing low quality water for cooking, washing and drinking. It is assumed that the water is purchased in jars and it is not safe to drink without boiling, a common alternative for poor HH to secure access to water. It costs around 10,000 riels (\$2.5)/1,000 liters including the cost of transportation to the household.



The main assumptions for the loss analysis are: (i) one rural well serves 6 HHs on average (hence about 465,000 HH affected); (ii) On average, around 25 liters of water per day are used by each person for cooking, washing, drinking; (iii) only half of the people will purchase water in the modality described above (in jars of 1000 liters) at the cost of 10.000 riels; and (iv) it will take 150 days for an average well in an average province to be rehabilitated or restored.

<b>Assumptions</b>		
Well affected	number	77,544
HHs served by one well	number	6
Average HH size	number	5.5
People served by one well	number	33
Average person daily water consumption (cooking, washing, drinking)	liters a/	25
Time to repair the well	days	150
Cost of purchased water (in jars, low quality water)	USD/1000 liters	2.4
Percentage of HHs purchasing water	%	50%
<b>Calculations</b>		
Total number of HH affected	Number	465,264
Total number of people affected	number	2,558,952
Total liters of water not available as a result of flood (1 well)	liters	123,750
Total cost of purchased water (1 well affected- 30 people- 6 HHs)	USD	\$ 294
<u>Total cost incurred by affected HHs</u>		<u>\$11,423,892</u>
Average cost per HHs	b/	\$25
a/ People in rural areas will buy low quality water in jars of an average size of 1000 liters - to be used for cooking, washing and to be boiled for drinking purposes.		
b/ to be verified with primary data collected under questionnaire question 91/92		

The total cost incurred (the loss) is therefore estimated at \$11.5 million or around \$25 /HH over 5 months.

### **Needs assessment for rural water sector**

ADB's RWSSP2 grant will partially assist with well restoration and repair in five provinces and UNICEF will also cover five provinces. Overlap is only in one province so a total of nine provinces will be covered between the two development partners. Plans are being formulated to expedite funding to assist MRD in providing safe water supplies to affected rural communities.

The Ketsana project of the World Bank will also provide for restoration of some wells, along the routes of roads for rehabilitation in six provinces, four of which overlap with ADB and UNICEF targeted provinces.

Between the three programs a total of 11 out of the 18 affected provinces will get some financial support, but full coverage in these provinces will not be possible due to limited funds. Seven provinces have no substantial funding identified to date. Therefore, other sources of funding will be required to ensure that communities get access to safe water supplies as soon as possible.

## B. Productive Sector - Agriculture

### 1. Introduction

Agriculture is one of the main drivers of the economy, although its contribution to GDP has historically decreased from 55.6% in 1990 to about 30% in 2007. If forestry and fisheries are included, it is the major employer of the country, with a total of 4.75 million workers (but also its share of employment has been declining in the last six years, down from 70.2% in 2002 to 55.9%). Cambodia has huge endowments of natural resources (land, water, climatic conditions and geographic position) which represent potential comparative advantages for agriculture. With 85% of the population living in the rural areas, and over 60% of the population directly or indirectly depends on income generated in agriculture, forestry or fisheries, agriculture is crucial to address poverty and influence on future directions of economic growth. Agriculture increasingly faces threats from climate change and erratic floods and droughts.

### 2. Disaster impact on the agriculture sector

The floods affected the rice sector (mainly paddy production) in most of the flood affected provinces. The total affected area is about 400,000 ha of which about 230,000 ha were fully or partially damaged. Of the total damaged area, around 21% was promptly replanted (50,000 ha) with assistance of the Ministry of Agriculture and MOWRAM to allow farmers to recover losses.

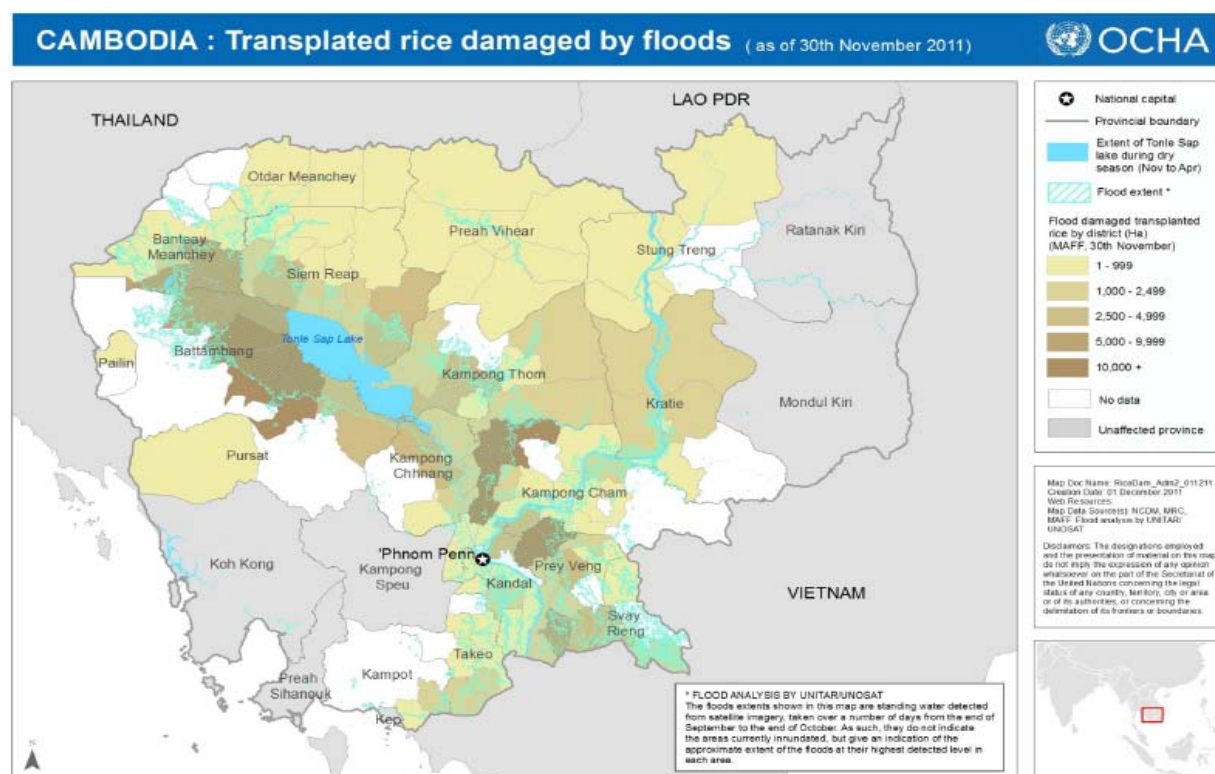
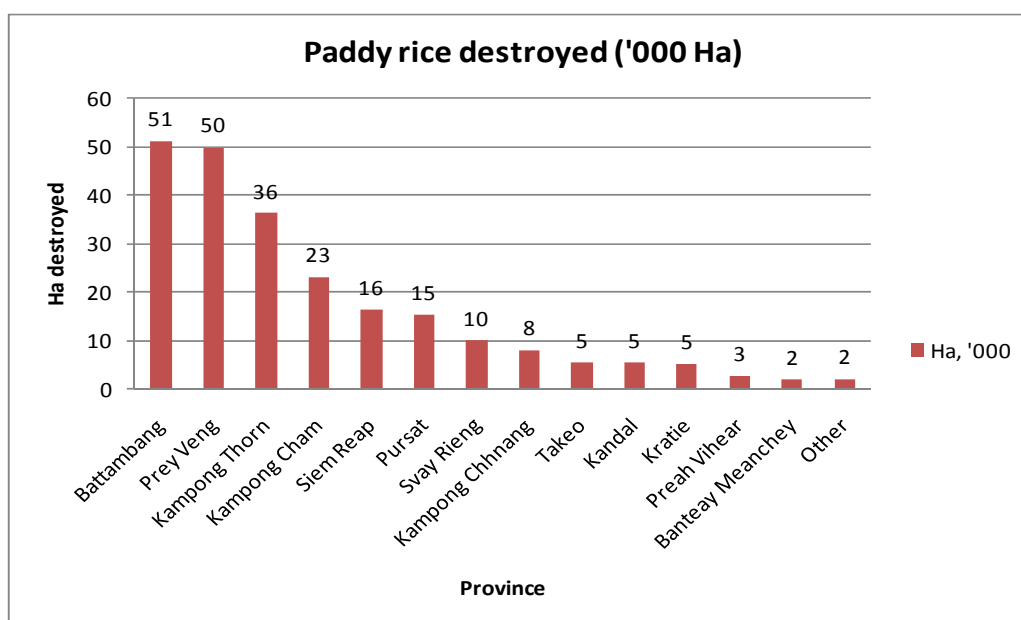


Figure 6. Damaged transplanted rice by district (MAFF, 30 Nov)

It is also important to note that the timing of the flood aggravated the negative impact since the wet season rice was almost at harvesting stage. Damages other crops other than rice were negligible, representing about 3% of the total damage and losses. The most affected provinces in terms of damaged paddy fields are shown in the figure below.

**Food security challenges.** Households who are more exposed to food insecurity need to protect themselves from natural disasters such as floods and droughts. The increasing frequency of natural calamities such as drought or floods is often compromising the source of income of the poorest or most vulnerable population, with the consequence of lowering their food intake. The present flood is not an exception.



### 3. Summary of Damage and Loss Assessment

The flood negatively impacted on agricultural production largely affecting paddy production quantities. Even though productivity and planted area were both on the rise and might offset the negative impact of the flood on overall production figures if compared with 2010, the economic impact in terms of loss is still significant. The economic DLA takes into account the following:

- (i) assessing the damage identified as the cost incurred to plant the wet season crop, including equipment, planting materials, irrigation, seed, fertilizers etc. Also these expenses are repeated for the replacement crop. A lump sum of \$300/ha has been assumed as the appropriate national average.
- (ii) assessing the loss in paddy harvest/ha by valuing the total area destroyed and the loss in ton/ha and multiplying by the farm-gate economic price of paddy rice.
- (iii) Export-parity methodology was adopted for calculating paddy economic price. This ensures that the price used in this analysis takes into account the economic cost of producing paddy rice at is captured at the farm gate and not at the retail location.
- (iv) Paddy/Rice conversion: As a large amount of paddy rice gets exported and not milled, it was considered inappropriate to calculate the loss at the nominal or real price of rice. However, in the macro-economic section of this report, an estimate of the difference

between the farm-gate price and the export price (in a certain proportion) is provided to inform the analysis relative to the balance of payments.

- (v) Average yield/ha adopted is the national average for wet season rice.

On these assumptions, the summary of calculations are shown in the table below:

Assumptions	Notes	Unit	Value
Farm-gate economic price for Paddy	a/	USD/Ton	305
Export price for rice	b/	USD/Ton	604
Average yield	c/	Ton/Ha	2.788
Affected hectares	c/	Ha	405,686
Damaged hectares	c/	Ha	232,377
Fully destroyed and not replanted area	d/	Ha	163,377
% fully damaged/planted area			6.62%
Average investment for replacement of planting tools, seeds, fertilizer	e/	USD/ha	250
Average wage		USD/day	1.5
Lost man-days (hired labor)	f/	Days	4,901,310
Usual rice loss (ha) without flood	g/	Ha	19000
Rehabilitated area (re-planted with short term rice)		Ha	22%
Paddy/rice conversion rate		%	64%
Percentage of paddy that is milled in Cambodia		%	50%
<b>Estimation of damage in the paddy sector</b>			
From damage to the fields (seeds, fertilizers, inputs, credit etc.)		USD	40,844,250
<b>Estimation of loss in the paddy sector</b>			
Lost revenues (because of destroyed harvests)		USD	138,853,113
<b>Total impact</b>			
<b>Total direct damage and losses</b>		<b>USD</b>	<b>179,697,363</b>
<b>Macro-losses: Labor and balance of trade</b>			
Wage loss (because of less work opportunity and displacement)		USD	7,351,965
Export loss (export price minus farmgate price @ 64% conversion rate and 50% of paddy becoming rice)		USD	43,629,385

a/ Calculated through the export-parity price methodology – see annex

b/ World Bank commodity price (Pinksheet). Sep-Nov. 2011 average 5% Broken F.O.B Bangkok

c/ MAFF

d/ Team calculation of fully damaged area (Damaged area-rehabilitated area - usual loss without flood

e/ Team calculation of destroyed seeds, fertilizers, tools and other planting equipments

f/ Assuming 1 hired man/day per ha \* 30 days of work \* fully destroyed Ha

Note: Not including cash crops: only less than 2% affected and marginally damaged

g/ Team Analysis

## C. Social Sector – Education & Health

### 1. Disaster impact on education

Nationwide reports from Provincial Education Offices show that 904 schools were affected by floods at the end of September, increasing to 1,369 by mid October and reducing to 374 by early November. In total 303 brick school buildings and 173 wooden school buildings were damaged by the floods. The Provincial Education Offices reports list 110 school buildings that must be replaced. It is not proposed to repair wooden school buildings because such repairs would not be cost effective. The 303 brick buildings can be repaired and the 110 buildings replaced, for a total estimated cost of \$9,156,000.

Flooding initially caused significant school closures due to school infrastructure being flooded, access to the school being limited by water, and in some cases the use of schools as safe areas. Now that the flood waters have receded, many schools have re-opened. However, the issues affecting education now are: (i) delays of 1-2 months in re-opening schools, (ii) loss of school furniture and learning materials, (iii) loss of textbooks from children's homes, which could cause children to drop out if not replaced.

The following table summarizes the number of schools that were affected by flooding as reported by the Provincial Education Offices, where a flood affected school is defined as one that was prevented from opening by flooded access roads, flooded school compounds or flooded buildings.

Flooded Schools by Province on different dates

No.	Province	Flooded Schools by date of report							REMARK
		29-09-11	01-10-11	05-10-11	13-10-11	17-10-11	18-10-11	21-10-11	04-11-11
1	Phnom Penh	22	22	18	18	18	18	18	2
2	Kandal	133	207	212	212	212	166	166	0
3	Kampong Chhnang	31	53	46	75	76	76	76	37
4	Pursat	14	18	27	33	33	33	33	6
5	Battambang	2	2	65	81	80	89	89	69
6	Banteay Meanchey	16	64	64	93	100	100	100	94
7	Oddar Meanchey	25	25	0	0	0	0	4	0
8	Preah Vihear	14	14	8	0	0	0	0	0
9	Siem Reap	65	129	74	75	75	75	75	0
10	Kampong Thom	178	191	191	210	210	130	130	69
11	Kampong Cham	230	230	242	242	263	273	273	30
12	Prey Veng	82	182	182	182	182	175	175	28
13	Stung Treng	19	19	0	0	0	0	0	0
14	Kratie	73	102	71	27	11	10	10	0
15	Svay Rieng	0	5	8	26	24	24	24	10
16	Takeo	0	0	0	46	49	49	49	20
17	Kampot	0	0	14	49	9	9	9	9
	<b>TOTAL</b>	<b>904</b>	<b>1263</b>	<b>1222</b>	<b>1369</b>	<b>1342</b>	<b>1227</b>	<b>1231</b>	<b>374</b>

## 2. Recovery framework

The Provincial Education Offices also reported on the flood damaged buildings after the floods receded in November 2011, as shown in the following table. The reports were categorized into wooden and brick constructions and estimated the percentage damaged, and the number of buildings that should be replaced.

Flooded Damaged Buildings									
No.	Province	Flood Damage							
		Brick Buildings			Wooden Buildings			Replace	
		Buildings	Rooms	% Damaged	Buildings	Rooms	% Damaged	Buildings	Rooms
1	Kandal	65	325	18%	28	93	32%	15	80
2	Kampong Chhnang	3	9	32%	3	9	100%	5	15
3	Pursat	5	25	15%	8	31	30%	5	15
4	Battambang	18	80	25%	27	109	40%	15	75
5	Banteay Meanchey	2	11	100%	19	66	48%	7	35
6	Oddar Meanchey	3	15	20%	15	50	42%	10	50
7	Preah Vihear	5	14	15%	6	30	25%	3	15
8	Siem Reap	11	52	21%	11	52	35%	11	55
9	Kampong Thom	22	185	25%	18	88	35%	16	80
10	Kampong Cham	25	112	15%	10	45	45%	8	40
11	Prey Veng	119	492	25%	4	16	100%	4	20
12	Kratie	21	84	25%	5	15	45%		
13	Svay Rieng	2	8	35%	8	31	70%	8	31
14	Kampot	2	10	100%	11	43	45%	3	15
	<b>TOTAL</b>	<b>303</b>	<b>1422</b>	<b>34%</b>	<b>173</b>	<b>678</b>	<b>49%</b>	<b>110</b>	<b>526</b>

Because of the price of high quality hardwoods, their limited availability, and the short lifespan of wooden buildings in Cambodia's tropical climate, the MoEYS no longer invests funds in the repair of wooden buildings. All wooden buildings are either repaired by local communities using their own resources, or closed and replaced with brick structures.

The cost of replacement for a school building, including safe water supply, latrines and furniture, is estimated at \$12,000 per room. This is consistent with recent bid prices for procurements managed by the International Procurement Agent.

The cost estimate for repair works is estimated at \$2,000 per room for civil works and furniture, or 16% of a new classroom. It is noted that this is half the average damage reported by the PEO's of 34%, but it is expected that much of the damage can be repaired using local resources, and only major items would be repaired under contract. The total estimated cost of repairs and replacement buildings is listed below.

Cost estimate for repairs and replacement schools.

No	Description	Buildings	Classroom	Unit US\$	Cost	Total US\$
1	New Building	110	526	12,000		6,312,000
2	Brick Building Repair	303	1,422	2,000		2,844,000
	<b>Total</b>	<b>413</b>	<b>1,972</b>			<b>9,156,000</b>

Figure: Affected schools. Furniture, books and other damage

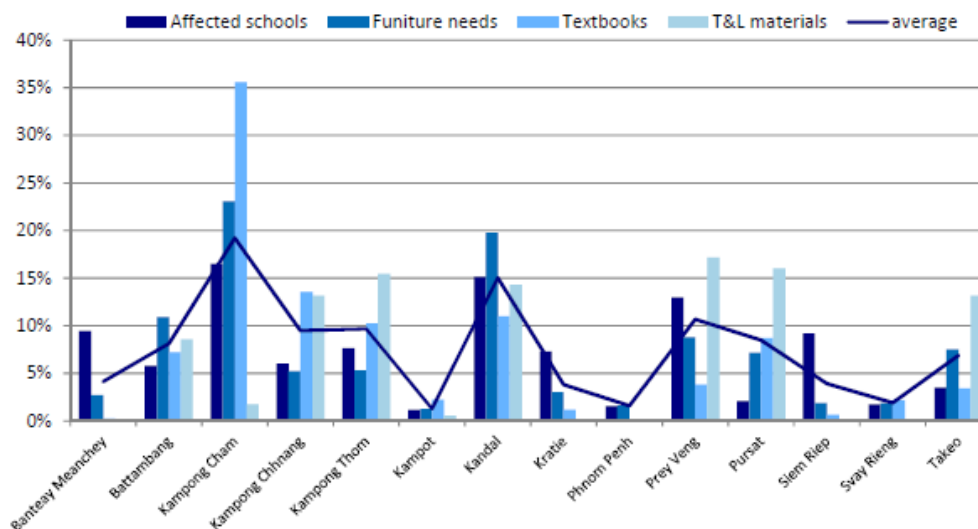


Figure 12. Education indicators by province (MoEYS/UNICEF)

### 3. Disaster Impact on Health Sector

An increased prevalence of fever, diarrhea, typhoid, dengue, and skin problems have been reported as resulting from the floods. Amongst children, the most commonly reported health problems are acute respiratory infection and malnutrition. More severe health problems are expected to materialize since basic facilities and livelihood activities in affected rural areas affected are not yet rehabilitated.

Whilst the Ministry of Health has been monitoring reports from health centers, this information is unlikely to be fully representative of the actual health situation due to the limited access to health facilities due to distance and damage to roads. Reports indicate that people are not attending health facilities and instead treating at home due to access constraints and cost. Coping strategies include: (i) home treatment using traditional medicines, (ii) purchasing medicines without prescription from local stores, and (iii) going without treatment.

Data on affected health centers compiled by MoH following the floods (17 October) is summarized by province below. MOH and WHO conducted a joint rapid assessment in ten provinces, visiting two health centers per province. Findings suggest that in the majority of cases, affected health centers were able to resume activities after a few days, and that there was little indication of losses of drugs and medical supplies, damage to medical and office equipment or loss of patient records. However, it was observed that whilst the majority of health

centers are in reasonably sound condition, the existing problems of poor access to health care by vulnerable populations have been magnified by the flooding.

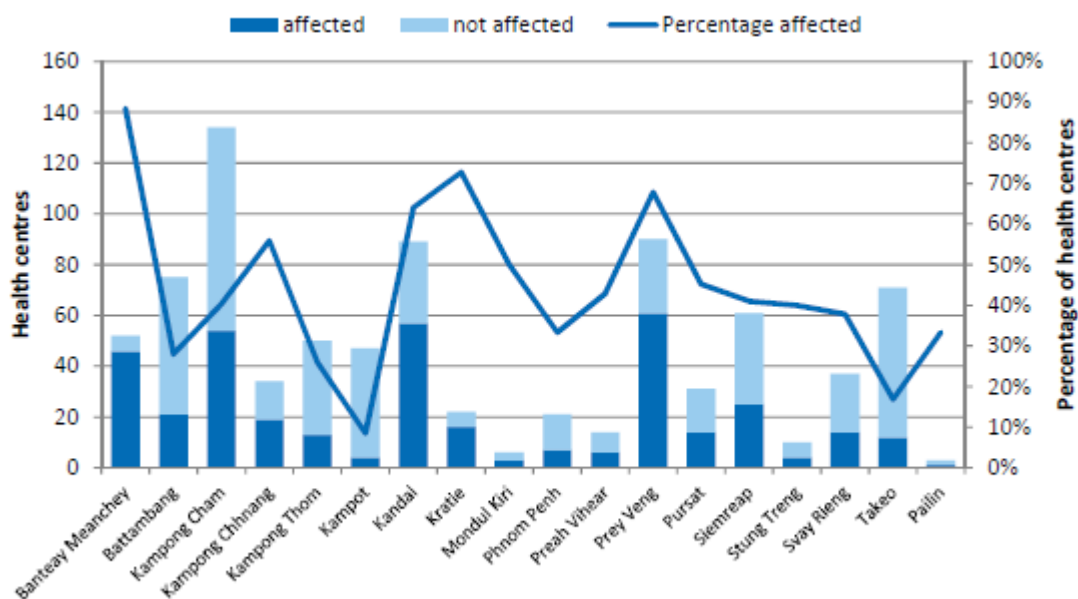


Figure 9. Affected health centres (MoH 18 Oct)

#### 4. Damage and loss assessment in Health:

The damage to health structures is estimated by assuming it is similar to education facilities. Since the number of health centers flooded was less than 1/3 of schools, the damage is estimated at \$3 million. However, it is more difficult to estimate losses for the health sector as most will materialize in the long term through indirect effect of deterioration of hygiene and in general livelihood conditions in affected areas.