

Mapping Vulnerability to Natural Disasters in Cambodia

1. Introduction

Cambodia is considered one of the most disaster prone countries in South East Asia. The country has been hit by natural disasters, especially floods and droughts in the last decades, sometimes both disasters occurring in the same year. Because many Cambodians depend upon subsistence agriculture for their livelihoods, they are particularly vulnerable to suffering hunger, poverty, or even the loss of life, when such disasters hit. This vulnerability has increased in recent years because of a series of almost consecutive annual disasters that have not allowed people the opportunity to recover from previous floods or droughts.

In response to this, the Royal Government of Cambodia (RGC) met with donors, UN agencies mainly WFP and FAO, and NGOs to formulate a response to the situation. Under the coordination of the National Committee for Disaster Management (NCDM), concerned agencies at national and provincial levels got together to develop joint responses to the needs of the affected population.

To better prepare and respond to disaster, disaster-prone areas were identified. The main objective of the study was to identify areas prone to natural disasters, mainly floods and droughts. The outputs of the analysis will contribute to the improved targeting of assistance to the most severely affected areas and the most needy members of the population so as to bring about maximum precision in the planning of effective and efficient interventions. These outputs will also provide valuable information for decision makers and planners at all levels.

1.1 The exercises on "Poverty and Vulnerability Analysis Mapping in Cambodia"

In order to have a better understanding of poverty in Cambodia, the Ministry of Planning (MoP) of the Royal Government of Cambodia (RGC) and the United Nations World Food Programme (WFP) undertook a series of exercise, from October 2002 to March 2003, to analyse and map Poverty, Malnutrition, Educational Need, and Vulnerability to Natural Disasters in Cambodia.

These exercises are the products of close collaboration between the Royal Government of Cambodia (RGC), specifically the Ministries of Planning, Education Youth and Sports, Health, the National Committee for Disaster Management (NCDM), and the United Nations World Food Programme Cambodia (WFP) with support from the Italian Cooperation and International Fund for Agricultural Development (IFAD).

The purpose of creating vulnerability maps is to allow policy makers to target interventions designed to address vulnerability as accurately as possible, to allocate scarce resources effectively and efficiently by directing them to the areas that need them most. The maps will serve as a basis for formulating targeting plans for various interventions carried out by the RGC and the WFP. It is also expected that the maps will be used by international donors, NGOs, and other organizations concerned with the development of Cambodia.

2. Data and Methodology

2.1 Data

2.1.1 GIS Data

The flood and drought vulnerability maps for Cambodia were used as a set of tools for vulnerability assessment. These maps were prepared with the help of various geographical indicators.

The essential Flood related indicators were mainly derived from the Rada Sat inundation vectors of 2000 and 2001 which were produced by the Mekong River Commission these were later on used to produce the flood vulnerability atlas. The flood atlas shows the overall flooded areas, especially around the Tonle Sap Lake and along the Mekong River.

In order to prepare the drought atlas, a set of Drought related indicators were generated from geographical data (remote sensing images). Some of the most important drought related indicators are the long-term monthly average precipitation at community level and the Normalized Differential Vegetative Index (NDVI) taken from an AVHRR (Advanced Very High Resolution Radiometer) Satellite. The AVHRR is taken in color bands that are ideal for quantifying vegetation. The NDVI is highest in areas that are very green and lowest in non-green areas. As the NDVI is largely dependent on the time of the year, increasing during the wet season and decreasing during the dry season, an image representing the 20-year average between 1981 and 2000 is used. This indicator is used as a proxy of agricultural productivity.

2.1.2 Crop Assessment Data

Several crop and food supply assessments have been conducted in Cambodia within the last 10 years to help ensure food security for the affected population in response to the aftermath of the disaster. The main objectives of the assessment are to obtain an estimation of the agricultural production and to evaluate the food outlook and food security situation for the following year.

WFP and FAO in cooperation with the Ministry of Agriculture, Forestry and Fisheries (MAFF) conducted the assessment, which included data collection at the lowest possible administrative level, i.e. the commune level. The assessment covers nearly 80-90% of communes/provinces in the country depending on the magnitude of the destruction resulting from droughts and floods. The results of the assessments represented about 90% of overall production in the country, and hence indicated national food security in terms of production.

The main data collected in the surveys using standard assessment form (Appendix A) included: (at commune level)

- Areas and production of wet season rice;
- Areas and production of dry season rice crops;
- Population
- Number of rice growers;
- Areas of crop damage caused by floods and droughts; and
- Areas of other crops.

These data are used to estimate the rice surplus or deficit for the next year and to determine the level of crop destruction in the most affected areas as well as to identify the needs in those areas (with respect to the most vulnerable areas and the population living there) This information is then used for allocation of WFP food aid in the time of need.

WFP has conducted four crop assessments in the last 10 years, in 1995(floods), 1996 (floods), 1998 (drought), and 2000 (drought).

2.2 Methodology

2.2.1 Defining Priority Areas Vulnerable to Floods

To determine areas that should be priorities for flood related interventions, three issues are taken into account: flood affected areas, rice dependency, and food security. The degrees to which each commune is affected by flood waters, dependent on rice production, and unable to produce enough food to feed itself during flood years are taken together to categorize communes into different levels of priority.

i. Flood affected areas

Cambodia has rich water sources in Mekong and Tonle Sap Lake. The lower Mekong, the Bassac, the upper Mekong and the Tonle Sap River, which flows from the Tonle Sap Lake, are the four main rivers, which meet at the Chatomouk Junction in Phnom Penh.

During the dry season the Mekong River flows from the north to the south and finally empties into the South China Sea in Viet Nam. During the wet season, however, the Mekong water partly reverses their flow, and flows through the Tonle Sap River into the Tonle Sap Lake, which serves as a giant reservoir absorbing the excess wet season water. Millions of people live along the bank of the rivers, growing seasonal crops on the surrounding fertile lands. When flood hits Cambodia these people are affected by the two distinct types of flood patterns – the flash floods and the central area floods.

Flash floods result from heavy downpours upstream on the Mekong River and affect the provinces along the Mekong and in the southern areas of the country. The most recent flash floods occurred in 2001. Central area floods are large floods that result from a combination of runoff from the Mekong and heavy rains around the Tonle Sap Lake. The waters affect the provinces around the lake, but also flow heavily down the Tonle Sap River and the lower portion of the Mekong to flood the southern provinces. Floods of this nature occurred in 1996, and in 2000, when the country saw the worst flooding in 70 years.

To produce the vulnerability maps, the satellite images of inundation vectors were used in combination with crop assessment data. Figure 1 shows flooded areas in Oct 2000 and September 2001 during peak water levels. For the purposes of the analysis, communes are defined as severely flood affected in a given year if the satellite imagery shows they were inundated, and if the crop data shows that the flood destroyed 20 percent or more of the rice growing area.

The images clearly indicate that the areas around the Tonle Sap Lake and along the Mekong are affected the most. Unfortunately, the satellite images do not allow the identification of two critical indicators of flood severity: depth and duration. Therefore, to better identify areas severely affected by floods, crop assessment data collected after the floods of 1996, 2000 and 2001 have been used in combination with the satellite images. In Figure 2, the severely affected areas are illustrated by year. It is clear that southern parts of the country including Kampong Cham, Kandal, Prey Veng, Svay Rieng, and Takeo provinces, are the most flood prone provinces in the country.

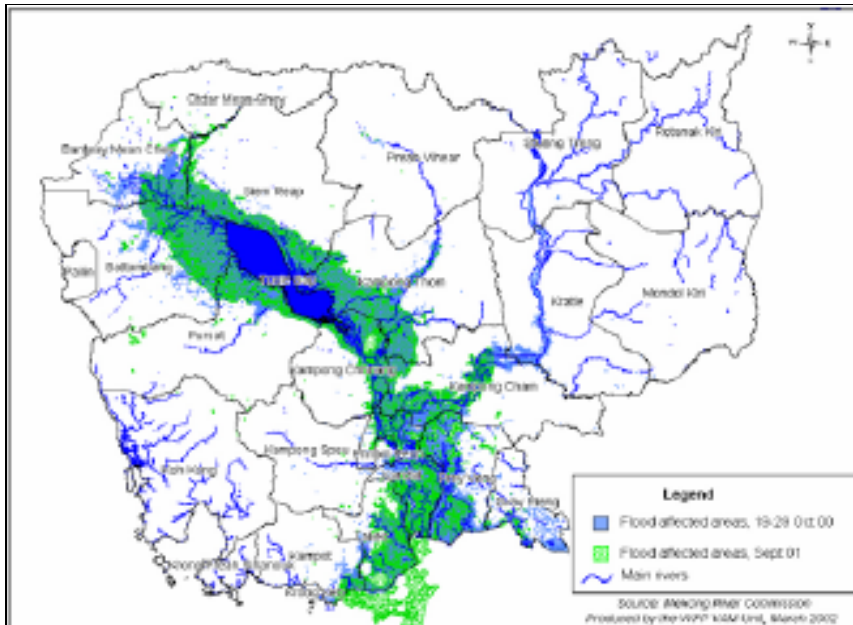


Figure 1: Flood Affected areas inundations vectors Oct 2000- Sep 2001

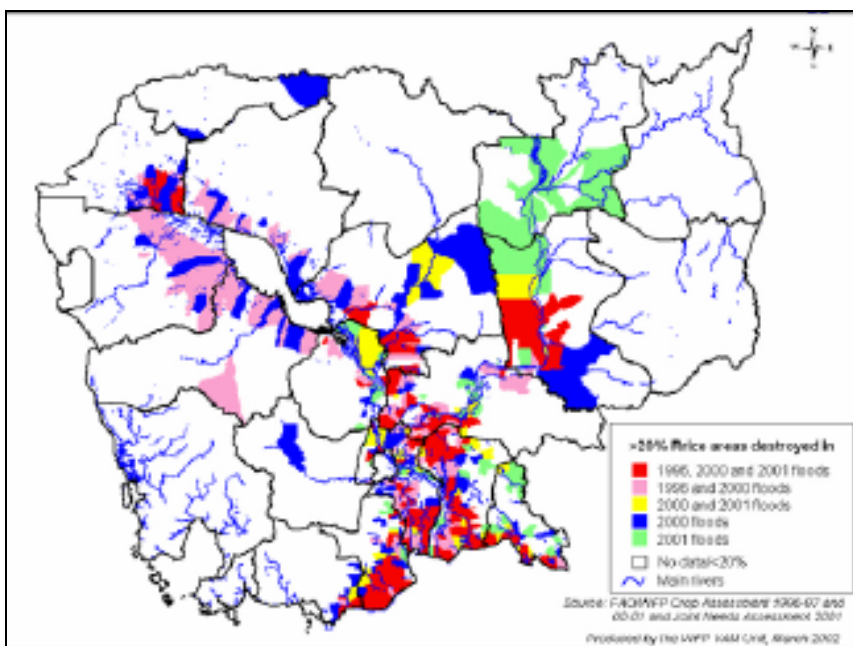


Figure 2: Wet Season Rice Areas destroyed by Floods 1996-2001

ii. Rice dependency

The majority of the Cambodian population livelihoods depend mainly on agricultural production, especially in the lowland areas around the Tonle Sap Lake and along the Mekong. Hence these people are particularly highly vulnerable to losing their livelihoods during floods. The lessons learned from the previous floods show clearly that the destruction resulting from floods depends largely upon the ability of the affected population to cope with the unfavorable situation. Crop assessment data has been used to identify concentration of rice farmers who live in flood prone areas and whose livelihoods depend largely upon rice production.

Communes are considered highly rice dependent if more than 80 percent of households are fully engaged in rice production.

iii. Food security, based on rice production/availability

There is a large dependence on self-production of rice to ensure family food security in Cambodia because of the limited off-farm income earning opportunities; this dependence is highest in the rural areas. Due to the insufficient information for assessing family food security at disaggregated levels, rice production at the commune level was used as a proxy to estimate food security for this study.

Crop assessment data are used to calculate the food deficit or surplus for each commune based on a per capita need of 152 kg of milled rice per year. A commune is classified as being food insecure if there are more than two months of rice deficit per capita per year. Data for the flood years of 1996 and 2000 are used.

The above three indicators (Flood affected areas, Rice dependency, food security, based on rice production/availability) can be combined to give a composite measure of flood vulnerability, disaggregated to the commune level. The vulnerable communes can be classified into three categories, first priority, second priority and third priority, as shown in the Table 1 and Figure 3. *First priority communes* were severely affected by floods in 1996, 2000, and 2001, were food insecure in 1996 and 2000, and are highly rice dependent. *Second priority communes* were severely affected by central area floods in 1996 and 2000, were food insecure in these years, and are highly rice dependent. *Third priority communes* were severely affected by the flash floods of 2000 but not the central area floods. They were food insecure in 1996 and 2000 and are highly dependent on rice production.

Table 1. Criteria for identifying Priority Areas for Assisting Vulnerable Population in Flood prone areas.

Criteria	First Priority Areas ¹	Second Priority Areas ²	Third Priority Areas ³
High Rice dependency	Yes	Yes	Yes
Rice deficit in 1996 and 2000	Yes	Yes	Yes

Flooded in 2000 & 2001	Yes	Yes	Yes
> 20% rice areas destroyed in 1996	Yes	Yes	No
> 20% rice areas destroyed in 2000	Yes	Yes	No
> 20% rice areas destroyed in 2001	Yes	No	Yes

¹ Areas have been flooded in 1996, 2000 and 2001 with greater than 20% rice planted areas damaged

² Areas have been flooded in 1996 and 2000 with greater than 20% rice planted areas damaged

³ Areas have been flooded in 2001 by flash floods with greater than 20% rice planted areas damaged

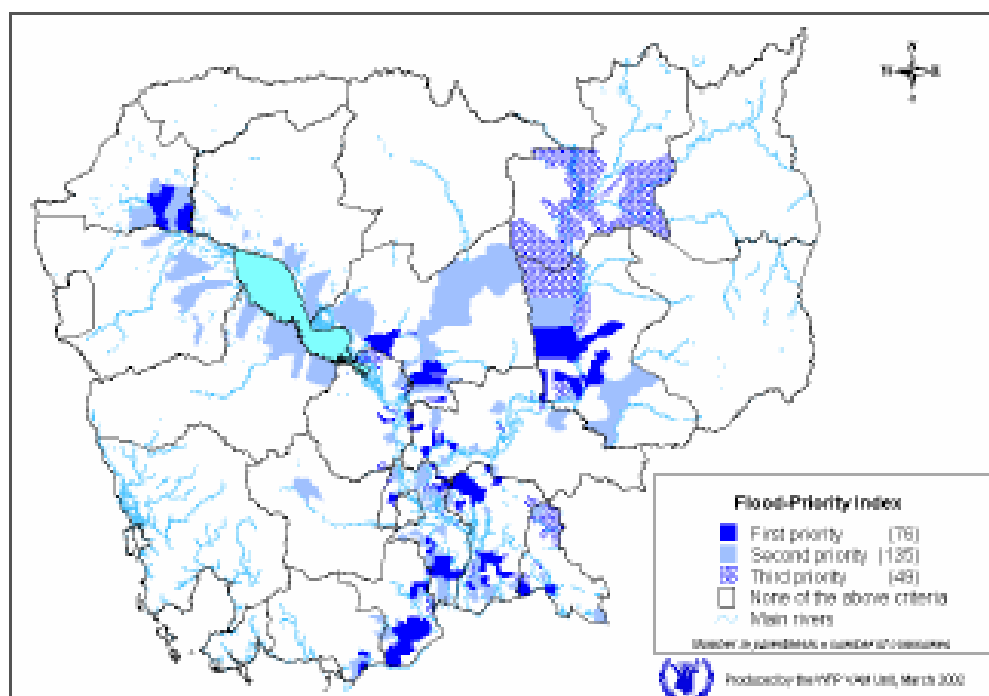


Figure 3: Priority Areas for Flood Interventions Feb 2003

All the three categories require that 80% of households (for samples) are fully engaged in rice farming, and hence there is a very high degree of dependence upon rice production. The indicators that were used here for producing the map were the rice areas destroyed after the floods, the dependency of the population on Rice production and the total flood that occurred during that particular year.

These classifications essentially cover three different kinds of areas that are vulnerable to floods. The first priority group is severely affected by any kind of flood, the second group is only affected by the big central area floods, and the third group is only affected by flash

flooding of the Mekong. Thus, when a flood of a particular type hits the country, policymakers immediately know where to start prioritizing their relief efforts.

2.2.2 Defining Priority Areas Vulnerable to Droughts

The methodology used for defining areas vulnerable to drought is similar to that discussed above. The issues analysed were: drought affected areas, rice dependency, and food security.

i. Drought affected areas

Geographical data sets were used to identify the drought prone areas due to the lack of historical records at the disaggregated levels. Data sets of long-term average precipitation and Normalized Differential Vegetative Index (NDVI) were used in this analysis. The maps generated for all communes in Cambodia are at a very low resolution.

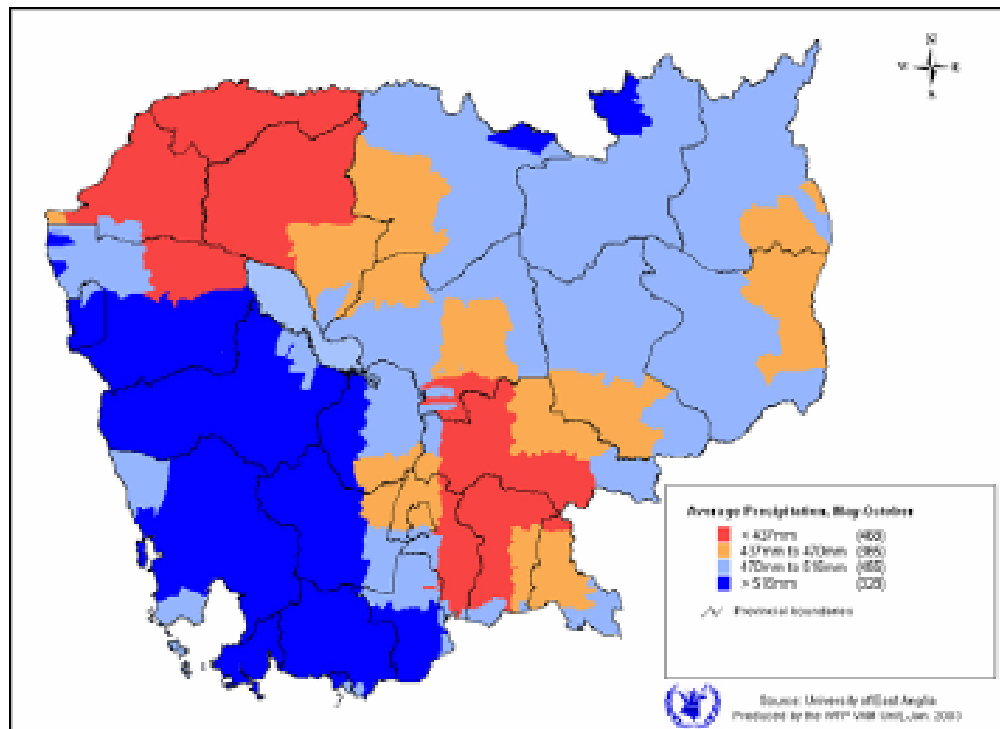


Figure 4: 30-Year Average Precipitation, May- October

The figure 4 gives an idea of the average precipitation in different parts of the country in the month of May till November. The crop production and productivity are predominantly determined by rain distribution and NDVI, which captures the greenness of the ground and is often used as a proxy to measure agricultural productivity, varies accordingly. Its scale ranges from negative 1 for the least green areas, to positive 1 for the greenest areas. Precipitation was considered low if the 30-year wet season average was less than 470 mm per annum. NDVI was considered low if the 20-year wet season average was less than 0.4 on a scale that runs from -1 to 1. Within high average rainfall areas, NDVI

is high, indicating higher crop productivity, with the opposite true in dry areas. Figure 5 shows 6-month average NDVI between June and November.

Cropping intensity changes from month to month during the wet season, and monthly NDVI reflects these changes. Because the wet season normally starts in May, NDVI is generally lower in June than in later months and the highest in November. Figure 6 shows monthly NDVI over the wet season.

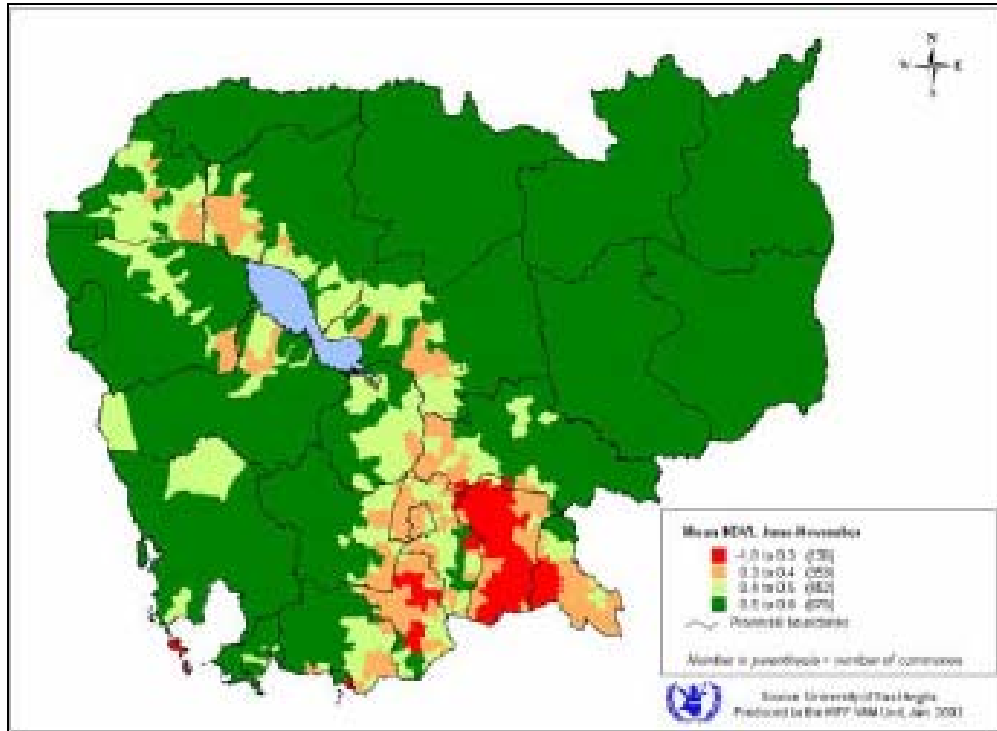
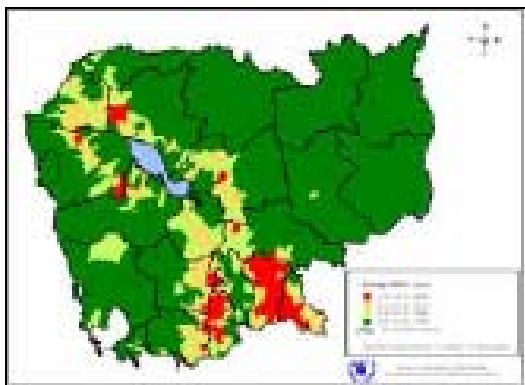
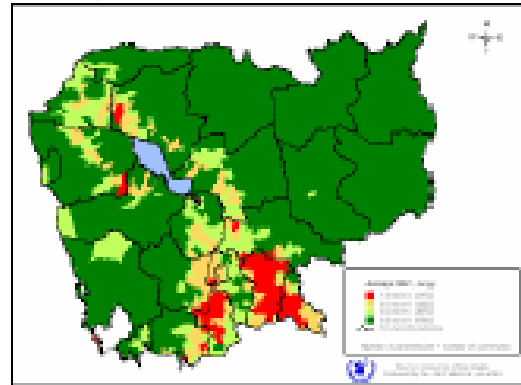


Figure 5: 20 Year Average NDVI during Wet Season, June - November 2003

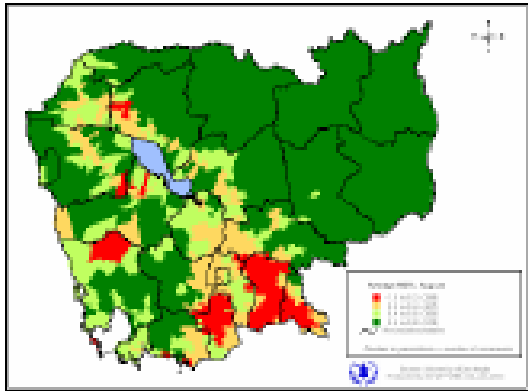
(a) June



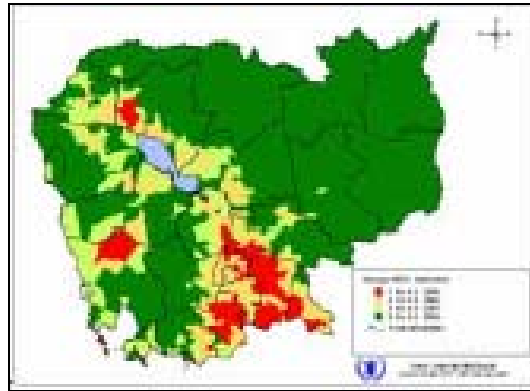
(b) July



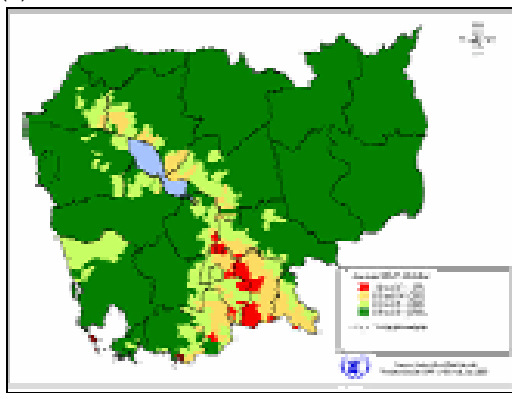
(c) August



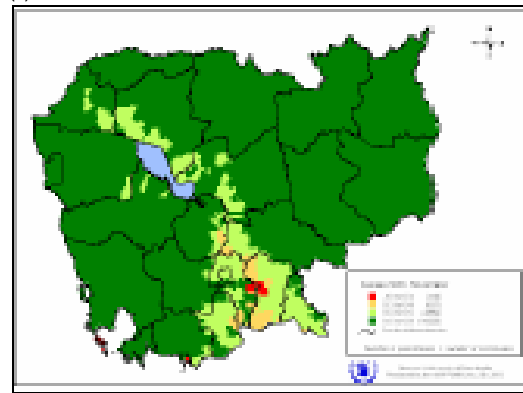
(d) September



(e) November



(f) December

**Figure 6: 20 Year Monthly NDVI**

ii. Rice dependency

Droughts have a great impact on Cambodian rice farmers, who depend extensively on rainfall for their crop production. Therefore, annual precipitation is taken as a determinant of rice productivity and rural food security. To identify concentration of rice farmers who live in drought prone areas, data of crop assessments in 1998, a drought year, have been used. Communes with greater than 80% of households fully engaged in rice production are considered to be high rice dependency communes.

Communes were again defined as highly rice dependent if more than 80 percent of households are fully engaged in rice production. Food insecurity was measured as above (more than two months of rice deficit per capita per year) for the drought year of 1998.

iii. Food security situation

To assess family food security at a disaggregated level, rice production at commune level was again used as a proxy. Crop assessment data from 1998 were used to calculate the food deficit/surplus at commune level based on a need of 152 kg milled rice per capita per

year. A commune is classified as being food insecure or rice deficient if there are more than two months of deficit per capita per year.

By combining the above three indicators (Drought affected areas, Rice dependency and food security situation), the priority areas for assisting vulnerable populations in drought prone areas can be identified and classified into three groups, as shown in the Table 2 and Figure 7.

Table 2: Matrix of Priority Areas for Assisting Vulnerable Population in Drought Prone Areas

Criteria	First Priority Areas	Second Priority Areas	Third Priority Areas
30 year average precipitation in 1 st and 2 nd lowest quintiles, less than 0.40	Yes	Yes	Yes
20 year average NDVI in 1 st and 2 nd lowest quintiles, less than 0.40	Yes	Yes	Yes
High rice dependency, over 80% of population fully engaged in rice farming activities	Yes	Yes	No
Rice deficit in 1998, over two months of rice shortages per capita per year.	Yes	No	No

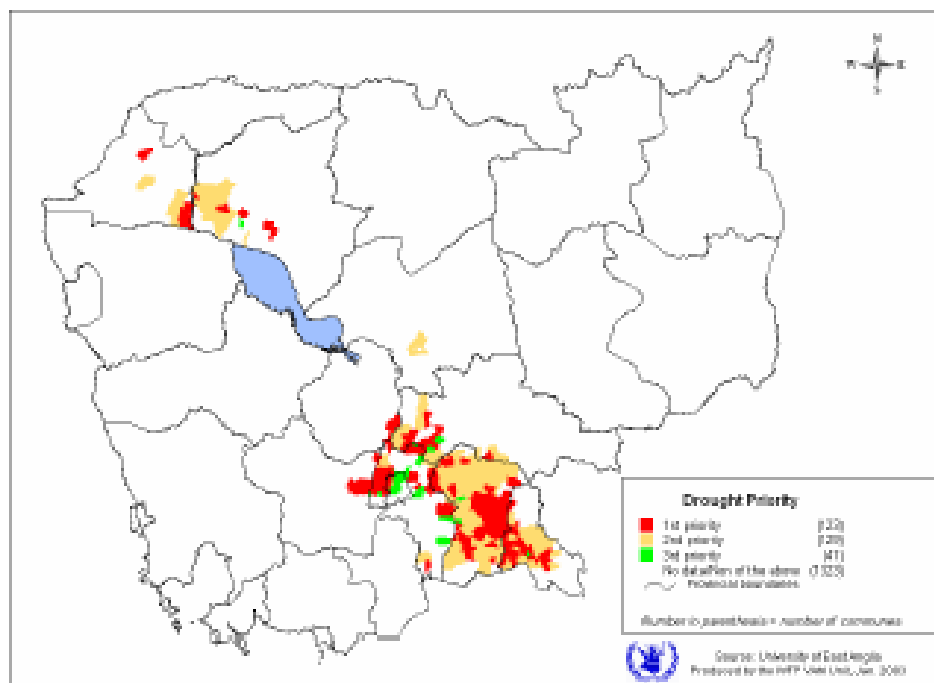


Figure 7: Priority Areas for Draught Interventions

Definitions for three levels of priority were again developed. *First priority communes* were defined as those with low precipitation and NDVI, high rice dependence, and food insecurity in 1998. These are communes where droughts are likely, and where they will have the worst consequences. *Second priority communes* have the same criteria as the first priority communes, but were not food insecure during the 1998 drought year. *Third priority communes* have low precipitation and NDVI, and are thus drought prone, but are neither highly rice dependent nor food insecure.

4. Limitations

This study focuses mainly on food security and floods and droughts, and ignores other related factors such as infrastructure, health and sanitation, which should be taken into considerations when decisions are taken to provide interventions in time of crisis. For example, using rice production at the commune level as a proxy of food security in the communes might not accurately reflect the real food security situation. More sophisticated measures of household-level food security could improve the analysis. Detailed information on market access and the purchasing power of the affected population might be incorporated, as and when the data becomes available and combined with the above analysis to get a better access to food security.

3. Current Activities

Collecting and analyzing data is an on-going activity for WFP. On annually basis, WFP collects data to make WFP annual contingency plan to prepare for coming natural disasters in a year. It also collects and analyzes necessary data such as crop assessment and food deficit according to the situation in order to meet the needs on each occasion.

4. Source of Information

- i. NCDM, WFP, (March 2003) *Mapping Vulnerability to Natural Disasters in Cambodia*, with support from Italian Cooperation and International Fund for Agricultural Development (IFAD).
Available online: <http://www.foodsecurity.gov.kh/docs/ENG/FullDoc-Mapping-Vulnerability-to-Natural%20Disasters-ENG.pdf>
- ii. WFP, (March 2003). *Summary Report of Poverty and Vulnerability Analysis Mapping in Cambodia*.

5. Additional Web Resources

- United Nations World Food Programme (WFP)
www.un.org.kh/wfp

6. For more information contact

World Food Program

The United Nations World Food Programme Cambodia
House 250, Street 63, Sangkat Boeung Keng Kang I, Khan Chamcar Morn, P.O. Box 937,
Phnom Penh, Cambodia
+855-23-210-943

National committee for Disaster Management (NCDM)

National Committee for Disaster Management (NCDM) - Cambodia
No. 274, Monivong Boulevard
Phnom Penh, Cambodia

Appendix A: Crop and Food Supply Assessment Form

Ministry of Agriculture, Forestry and Fishery in cooperation with FAO and WFP 2000 Rice Crop Assessment (Commune Level Form)

Name of district officer: _____

Name of Commune officer: _____

Date of Completion: _____

District: _____

Commune: _____

Commune Code: _____

1. Number of Villages _____
2. Population of the Commune _____
3. Number of Households _____
4. Number of households growing rice in 2000 _____
5. Area of land planted to paddy this wet season _____
6. Area of early wet season paddy: Planted / Harvested
7. Area Planted to the following types of

Rice in the main 2000 wet season

	PLANTED	HARVESTED
Early Maturing	_____	_____
Medium Maturing	_____	_____
Late Maturing	_____	_____
Floating Rice	_____	_____

- | | |
|-----|---|
| 8. | Estimate of average yield for 2000 of all varieties _____ |
| 9a. | Planned area to be planted for dry season rice _____ ha |
| 9b. | Estimate of average dry season yield |

- | | FLOOD | DROUGHT | PEST |
|-----|------------------------------|---------|------|
| 10. | Area of rice affected _____ | | |
| | Area of rice destroyed _____ | | |

- | | FLOOD | DROUGHT | PEST |
|-----|----------------------------------|---------|-------|
| 11. | Area of rice affected by variety | | |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |

- | | FLOOD | DROUGHT | PEST |
|-----|-----------------------------------|---------|-------|
| 12. | Area of rice destroyed by variety | | |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |
| | _____ | _____ | _____ |

13. Area of other crops grown during this agricultural year

	Ha
Maize	_____
Cassava	_____
Vegetable	_____
Mungbeans	_____
Soyabeans	_____
Sweet Pot	_____
Groundnut	_____
Sugarcane	_____
Tobacco	_____
Sesame	_____
Others	_____