CAMBODIA COUNTRY REPORT ON FLOOD INFORMATION IN CAMBODIA

1. SUMMARY

Flood information in Cambodia attempts to provide information related to floods occurrence in major flood prone areas in the country as the beginning of an effort to build a standard annual report related to flood and drought occurrence in the country. The report intends to provide hydrological characteristics at major key stations along the Mekong mainstream and Tonle Sap Great Lake and the major recent flood events. The flood situation of the current year characterized by its peak, runoff volume and frequency altogether with flood damage and losses as well as information on benefit from flood are put together to build an overall knowledge on flood and droughts. It is expected that the report will be improved with the improvement of the knowledge on floods and the capacity being built in the year to come. In addition, positive impact of many initiatives being implemented including the improvement of the forecasting, early warning and flood preparedness that could be evaluated in the light of after flood intensive data collection. Unfortunately such a data after flood have not been fully collected and standardized yet. Only limited data were collected by MRC during a very short period of time. So far hydrological and meteorological made available for analysis is far from satisfactory. It is hoped that such data and information would be made available by respective line agencies in the coming years and standard report format could be improved.

In general, the 2005 flood could be described as a mild flood which in normal terms brings benefit to the people living in the flood plain and the economy of the country. Due to rapid rise of water along the Mekong mainstream some limited losses on properties and crop have been reported, with some 20 people killed, 9 of them were children. The loss could have been higher if there was no warning system put in place by MRC financed by OFDA and other donors in cooperation with NGOs, American and Cambodian Red Cross. Another reason might be the infrastructures which have been rehabilitated after the 2000 floods could resist flood of this magnitude.

Fresh water fish capture has been estimated as 26% more than 2004. The Dai fish capture which is considered as most accurate and use as fresh water fishery capture reference has been increased by 100% as compared to 2004.

2. INTRODUCTION

Flood is a recurrent event in Cambodia affecting a large part of the territory. For many generations people have been living with floods, taking advantage from floods, from time to time suffer from high and destructive floods and adjust themselves to it. Since 1920 a number of road networks were built and subsequently improved over the years every time after being damaged by flood water across many parts of the flood plains, river levees were repaired and raised a bit higher almost every time after damage caused by extreme floods including housing compound. Many cities and towns including Phnom Penh are expanding more and more into the flood prone areas. Only Phnom Penh and a few other towns are protected against floods by dikes and embankments systems and equipped with excess rainfall drainage system. Since 1990 the endeavor for national reconstruction has been to a great extent hampered by floods through out the country, the most severe one was the flood of the year 2000. Commonly people call seasonal variation of flood period as ‘rising water season’ and flood receding water as ‘water falling season’ to characterize the rhythm of fluctuation of water flow in and out of the Mekong-Tonle Sap-Great Lake and the Bassac river systems and their surrounding flood plains. The Mekong flood plays an important role in socio-economic development of the country, it carries and distributes fertile silt into the flood plain feeding important food chain for fisheries and fertility for agricultural production, provide water supply for people living along the river side, provides navigation route and environmental cleaning function.

Generation of people have adapted themselves to the rhythm of the Mekong flood, and have built their houses, cities, towns and roads along the river levees. Their lifestyle is also organized according to the rhythm and magnitude of floods such as house on piles, boats for fishing and use during high water. A subsistence farming system consisting of a combination of crops around the house, river banks and in the flood plain, fishing activities and other economic transactions is common.

However extreme floods have caused severe damage and suffering to millions of people living in low lying areas. Communication infrastructure such as roads and bridges are disrupted during floods. It has been observed that floods have increased in frequency and magnitude in recent years and flood damage costs have risen with them. Flood recovery has been slow and increasingly inefficient.

In parallel with flood increasing climatic variability and droughts are also major risks to crop failures for rain fed rice cropping in surrounding regions above the flood limit. Cambodia is a country with highest risk to flood and droughts in Asia, as high as 57% as compared to 24% only for Thailand.

Flood and droughts in the Mekong River Basin are affected globally, regionally and locally by climate change and human intervention leading to increase in magnitude, frequency and unpredictability since the last few decades. Whereas flood management capacity of the country remain weak, reliable and timely flood and droughts information leading to flood preparedness, flood warning, flood response and flood recovery are lacking, including competent public services at national , provincial and commune level. In addition to this very limited structural and non structural flood management measures have been established over the years. None of the multi-purposes projects (for hydropower, irrigation and flood control such as the Prek Thnot Project) planned in the early 1970s have been implemented. Some form of flood forecasting services have been established at national level but major flood events which had occurred remain unwarned to people. Only after the 2000 flood that initiative on flood warning has started to bring flood information to the provincial, district, commune and village level in most vulnerable provinces of the country. Efforts are to build the capacity for people to rely on themselves to reduce risks.

With increasing population and infrastructure development and more exposure to flood risk due to settlement expansion into the flood prone areas, flood information needs immediate improvement and proper flood management is required in a more integrated way. This paper intends to present floods and droughts characteristics of the country and reports on the lesson learned from 2005 flood. The 2005 flood based on available hydrological data could be considered as a mild flood causing only some damage to infrastructure, but killed as many as twenty people. With respect to flood information improvement, efforts have been focused on the provision of a three days forecast to people in 40 villages located in the flood prone areas with the intention to support the community self reliance on flood preparedness programs. Accuracy, lead time, area coverage, technical, managerial and legal aspect of floods warnings are issues for the years to come.

3. DATA AVAILABILITY

There are insufficient data and information to make comprehensive analysis on flood conditions in the country. Table 1 compiles the 2005 flood characteristics along the Mekong mainstream and Tonle Sap Great Lake systems. Hydrological time series data[1] on tributaries are patchy and incomplete to provide a statistical analysis, one of the stations with longest time series, the Stung Sen at Kampong Thom was not made available for analysis. Only flow data on one of the

[1] Rain fed low land rice ecosystem in Asia, Wade et al., 1999

mainstream station at Stung Treng could be considered as of acceptable quality, other stations such as Kratie need more measurements at high stage to confirm previous measurement during the sixties which seems exaggeratingly too high.

For meteorological data only mean monthly of five years from a very limited number of stations are made available. This limits possibility for interpretation on flood events such as Battambang flood in 2005 and others. Ideally at least isohyets of monthly rainfalls should be presented as standard reports with indication on areas of excess or deficit as compared to normal. An abstract on report of the year 2005 weather conditions should also be presented. Data and information compiled should be sufficiently comprehensive to enable reconstruction of storm events for hind cast studies to improve knowledge on flood behaviors and capacity in flood forecasting and management. Extreme events are rare every effort should be made to collect every piece of data and information to reconstruct such an event.

4. HYDROLOGICAL CHARACTERISTICS IN CAMBODIA AND THE 2005 FLOOD

4.1. The Mekong Mainstream

Floods in Cambodia are dominated by the Mekong flow regime, under the influence of the monsoon and have a clear and distinct wet and dry season. However flood peaks can occur anytime between August and October. Floods of the same magnitude but occurring at different periods produce different impacts on the flood plain ecosystem and the infrastructure.

Three types of floods affect Cambodia: (i) the Mekong flood is caused by cumulative rainfall in the upper catchments throughout the rainy season and most severe floods are the results of tropical storms and depression affected by typhoons, the Mekong flood is slowly but steady built in rising level especially near the peak and last for several days ; (ii) flood caused by heavy rainfall from tributaries, those floods are swift and have flash flood characters that could last only for a few days but often cause severe damage to crops and infrastructure especially in tributaries around the Great Lake and eastern tributaries of the Mekong; (iii) when the Mekong flood level is high and backup water floods deep into the tributaries and coincide with heavy rainfall in tributaries. The same situation occurs for the tributaries around the Great Lake.

Floods in Cambodia are mainly caused by the Mekong flow from upstream. The Stung Treng hydrological station in Cambodia records flow of the Mekong from a total catchments area of 635,000Km2. The Sekong, Se San and Sre Pok Rivers are the last powerful left hand side tributaries meet the Mekong mainstream just above Stung Treng hydrological station. The sub-catchments of the three tributaries are frequently affected by typhoon from the South China Sea which can cause heavy rainfall in the basin and subsequent increase of flood magnitude of the Mekong.

The Stung Treng station is the key station for flood forecasting on the Mekong mainstream and in the flood plain in Cambodia. This station has the longest time series of observation in the country, from 1910 to date. After Stung Treng the Mekong flow is distributed between a number of branches and crosses a series of rapids, the most important one is the Sambor rapids. The Stung Treng station has an apparent best channel control on flow; the rating curve at this station seems stable. It is the last MRC station free from backwater effect after Pakse. Every effort should be made to assure high quality of water level and discharge at this station to be the entry point of the flood forecasting and flow management in Cambodia. Previous hydrological works was hampered by bad road accessibility. Current road improvement will help to reduce significantly the operation cost for data collection from this station and in the surrounding areas.

Figure 1 below provides relationships of annual runoff versus annual peak discharge during the 96 years of observation period. Plotted points are arranged according to their frequency of non-exceeding:

Dry years, less than 25%; mean years are subdivided into two parts: between 25% and 50%; and 50% and 75% and the wettest years for years with frequencies above 75%. The year with most important flood events are highlighted, namely wettest years with the highest flood peaks (1939, 2000, 2001) highest flood volume, mean, lowest flood peaks and flood volume (1988,1998). The year 2005 has a distribution frequency of 71% or in terms of distribution frequency (2.2 years) is just above the upper limit of the mean flow year groups. From this graph it is important to note that flood years with highest peak are not necessary producing highest volume and vice versa. (e.g.) flood of the year 2000 has the biggest flood volume in the time series but has a rather lower peak discharge as compared to other years such as the 1996, 1978 and 2001. The most destructive flood could be the 1996 flood with its peak occurring during the 4th week of September.

For other stations along the Mekong mainstream due to difficulties in discharge computation, only water levels were analyzed and presented in table 1, which shows the 2005 flood as a mild flood year.

The Stung Treng town is not protected against flood, at water level above 11.40 m, the Mekong water begins to spill over bank and flood part of the town, but in addition to the Mekong water penetrating into the lower point of the city through a number of small streams draining the town. Above 12.0m water level, sheets of overland flow extend over large areas at both sides of the river. Detail topographical data is required to assure higher accuracy for the estimation of rare flood events (e.g. above 100 years return period)

The Kratie station controls the Mekong flow draining a total catchment area of 648,000 Km2.

At the water level approximately above 18.0m when part of the flow begin to spill over into the flood plain and series of islands downstream of Kratie begin to be flooded, the downstream control at this station cease to be effective and backwater effects start to move upward affecting the relationship between water level and flow at this station.

If the peak flood at this station is lower than 19.0m there will be limited overland flow downstream and shortage of water for flood receding rice cropping shall be expected, case of the driest years of 1988 and 1998 where maximum water level were respectively 17.82m and 17.82m only. When the water reaches the level of 22.00m, the town and surrounding village will be flooded.

Similarly the Kampong Cham town has not been protected from flooding yet despite the last recent flood events of the year 2000. Many localities along the Mekong stretch between Kratie and Kampong Cham are prone to flood. Flood flow distribution in this stretch is complex due to the presence of many river branches and their connecting lakes and flood plains. The Kampong Cham hydrological station does not control all the Mekong flow from upstream. Part of the flood flow from upstream is naturally transited directly to the Tonle Toch River and the Mekong below Kampong Cham. New roads, dikes and embankment development have increased, to some degree, flood risks for the Kampong Cham town and its surrounding. Floods start to cause damages to villages and field crops earlier than the flood warning level at Kampong Cham.

After Kampong Cham when discharge reaches the level of 30,000 m^3/s, or approximately at the water level between 12.0 and 13.0 m, the Mekong water begins to spill over large flood plain. Recent studies by WUP JICA have found that approximately 30% of the discharge at Kampong Cham is diverted into the flood plain between Kampong Cham and Phnom Penh Chroui Changvar during flood season. And of this amount 60% flow through the left bank and 40% to the right bank. When the discharge at Kampong Cham is between 30,000 m^3/s and 42,000 m^3/s, 50 % spill to the left and right bank; when the discharge at Kampong Cham is between 42,000 m^3/s and 52,000 m^3/s spill over the left bank change from 50% to 60% and the right bank from 50% to 40%. For the year 2000 the distribution between left and right bank is up to 65% and 35%, respectively[2].

The storage capacity of the flood plain is as much as between 15-20% of the volume of the Great Lake and associated plain. The flood plain between the Mekong and the Great Lake shows slower released of flood water than the other part. Isolated bridges and embankments are main control of the flood plains. Change of these facilities has large impact on flow distribution on the flood plain.

People live along the river banks on high levees, often upgraded to a provincial or rural road, growing their perennial crop trees and crop around their houses, cultivating subsistence rice in the flood plain behind the village, cash crop along the river banks and fishing in the rivers and surrounding lakes. The exposure to risks is high as combination of flood and droughts due of the low level of water control infrastructure development. Their dependence on natural resources will be also increasingly higher if no proper development being established while potential of natural resource for development is high and non renewable resources such as forestry are depleting very fast. Future development require optimum infrastructure to safeguard properties and development efforts. Even with proper land use planning and management this area needs information on floods and droughts including its associated risks to enable a wise and well informed decision-making process.

The Mekong stretch between Khone Fall and Kampong Cham has many important features supporting exceptional productivity of fishery ecosystem of the Great Lake-Mekong-Bassac Rivers. Numerous deep pools and rapids along the major tributaries and the Mekong mainstream are vital fish sanctuaries, and fish spawning and feeding grounds. Flood pulses of the Mekong play a major role in the reproduction process; it carries sediment rich in nutrient essential for fish food chain development. The low lying areas[2] and the flooded forest, in the flood plain are important feeding grounds for fish and are important flood recession rice cultivation areas. Controversial issues between the conservation of flooded forest as vital habitat for fisheries and forest clearance for flood receding rice production is increasingly expanding countrywide which require comprehensive planning supporting by effective law and regulation. Flood information should be extended to cover areas of day-to-day natural resources operation and management as supporting tools to planning and decision making process and operation at farm level. The region behind the flood plain is sparsely inhabited and has good potential for development, alternative and options for a balance development should be found based on well informed studies and strategies.

[2] Consolidation of hydro-meteorological data and multi-functional hydrologic roles of Tonle Sap Lake and vicinities, flow simulation models, MRC, 2004.

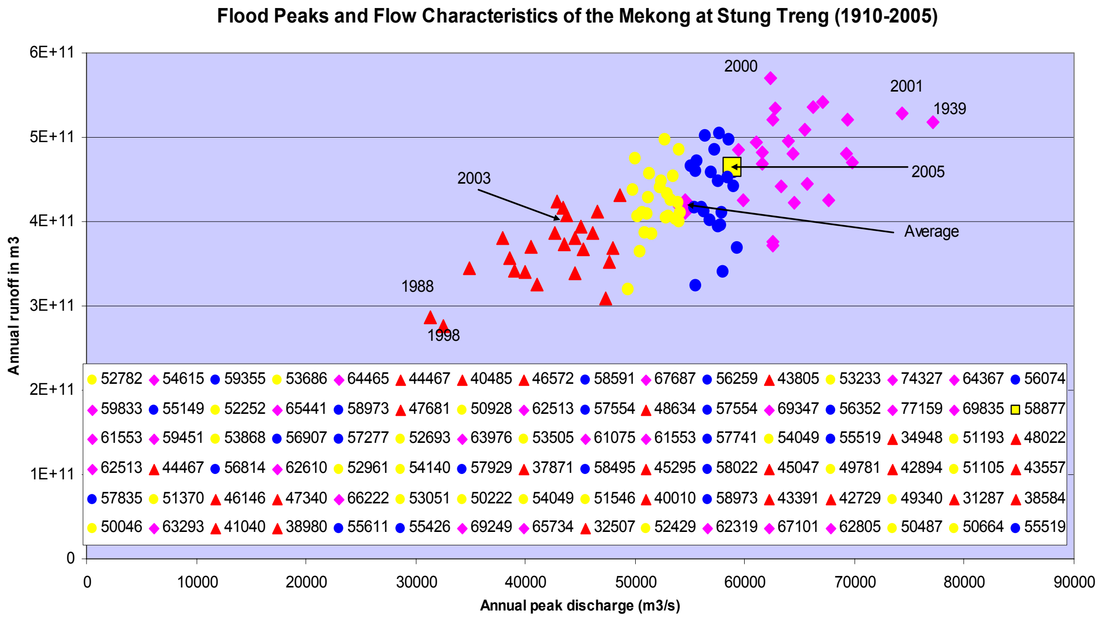


Figure 1 Peak floods and annual flow distribution for the Mekong at Stung Treng.

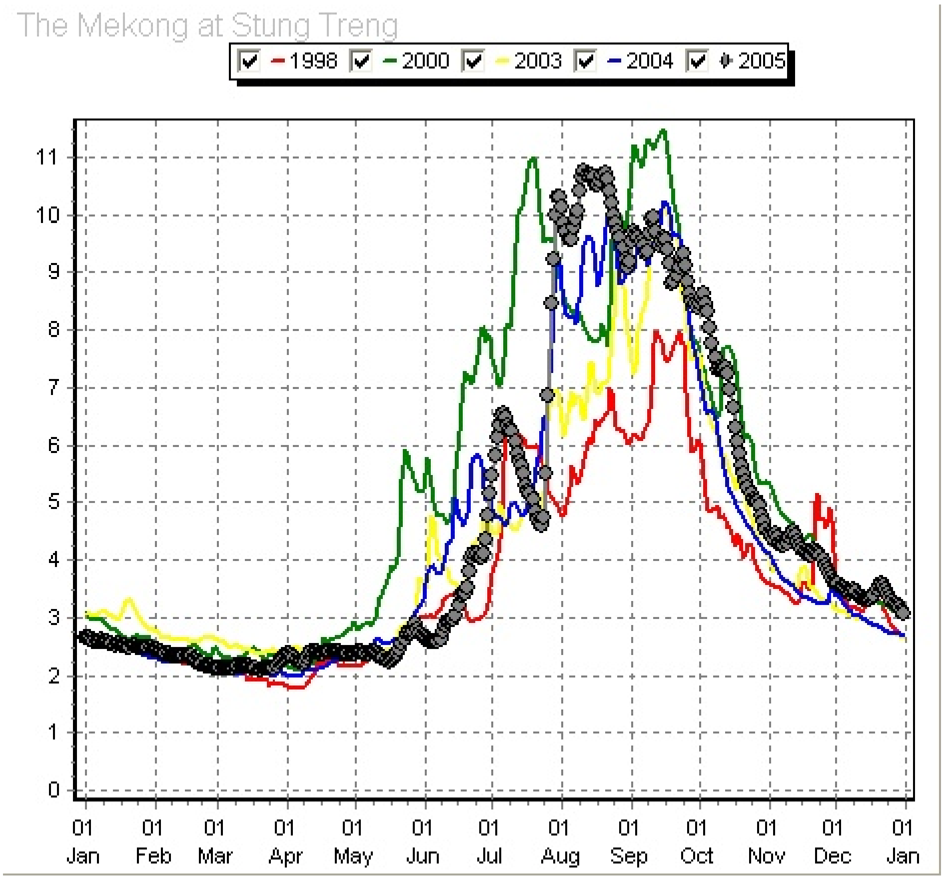


Figure 2 Hydrograph of the Mekong at Stung Treng showing the 2005 flood as compared with the wettest year 2000 and driest year 1998.

Table 1. Maximum water level at major stations along the Mekong mainstream and some tributaries

N	**Stations**	Observation periods	Max, Min, Mean and STD	The flood of 2005
	Main stream			
1	Stung Treng	1910-2005	Max:13.0m Min:7.8m Mean:10.56m STD:1.009	WL:10.76m T: 2.2 Years
2	Kratie	1934-2005	Max:24.28m Min:17.46m Mean:21.12 STD:1.24m	WL:21.62m T: 2.6 yeas
3	Kampong Cham	1934-2005	Max:16.11m Min:12.24m Mean:14.726m STD:0.803	WL:15.34m T: 4.2 years
4	Chroui Changvar	1960-2005	Max:11.21m Min:7.96m Mean:10.018m STD:0.653m	WL: 10.24m T: 2.3 years
6	Neak Leung	1960-2005	Max: 8.43m Min:5.42m Mean:7.209m STD:0.582m	WL: 7.33m T: 2 years
	Tributaries			
1	Stung Sangker	1997-2005	Max:13.40m Min:10.09m Mean:12.47	WL:13.39m T: N/A

			STD:1.122m	
3	Stung Prek Thnot	1960-1973 and 1991-2005	Max:8.88m Min: N/A Mean: N/A STD: N/A	No data

4.2. The Great Lake

The Tonle Sap Great Lake is fed annually by the Mekong reverse flow and by its own tributaries. The Lake plays an important role in flood peak attenuation and flow control to the Mekong delta. The lake volume and flooded areas fluctuate on annual basis between the extreme of a maximum (2000) and a minimum (1998) shown in Figures 3 and 4, the 2004 hydrograph shows earlier and faster recession of the Lake. In 2005, the lake water level reached the peak level which could be considered as normal as compared to other years and the 2004 the lake water level peak earlier by one week. Mostly the maximum water level in the lake coincides with the period of heavier rainfall in the Great Lake sub-catchments; this makes low lying areas along major tributaries including areas outside the limit of influence of the lake food extent (upstream part of the road RN6 and RN5) particularly prone to flood risk. The lake backs water in the tributaries up deep in land, reducing their drainage capacity. To date, there is no comprehensive established plan to provide forecast coverage for those areas which is considered as having high potential for rice crop production of the country but vulnerable to droughts and floods. It is understood that flood occurrence of this region is swift having a flash flood characteristic. Limit comprehensive data collection for the purpose is very limited. A hind cast exercise based on existing data could lead to a better preparation for the start of the forecasting and early warning for the region.

The Mekong, Tonle Sap, Great Lake and the Bassac form a unique and complex rich inland ecosystem, one of the most productive in the world. The Mekong flood water feed the flood plain and its productive ecosystem by spreading sediment rich in nutrient sustaining important fisheries and agricultural resources. People living

4.3 The 2005 Flood

For comparison, Figure 2 shows the 2005 hydrographs plotted with other years characterizing flood of the Mekong at Stung Treng, the wettest year 2000, the driest year of 1998 and the previous years 2003 and 2004. The 2005 flood having received the residual flow from the year 2004 which is considered as one of the driest year with sharp and rapid recession due to early end of rainfall than normal throughout the whole Mekong Basin. The flood starts with a slow rise in water level until the 23rd of July at water level of 4.58m, followed by a spectacular rise to reach the first peak of 10.31m on 30th of July with a speed of rise of 0.95m per day. The second peak was reached on 11 August, earlier that other years (usually sometime in September), and was the peak of the 2005 flood. The sharp rise of flood level is critical piece of information in flood forecasting. The storm which has caused this sharp rise have not been identified and reported in this report. For the Tonle Sap Great Lake, Figure 3 and 4 shows that the volume of the Great Lake is slightly higher than that of the 2004 but the 2004 hydrographs show steep recession similar to Stung Treng station.

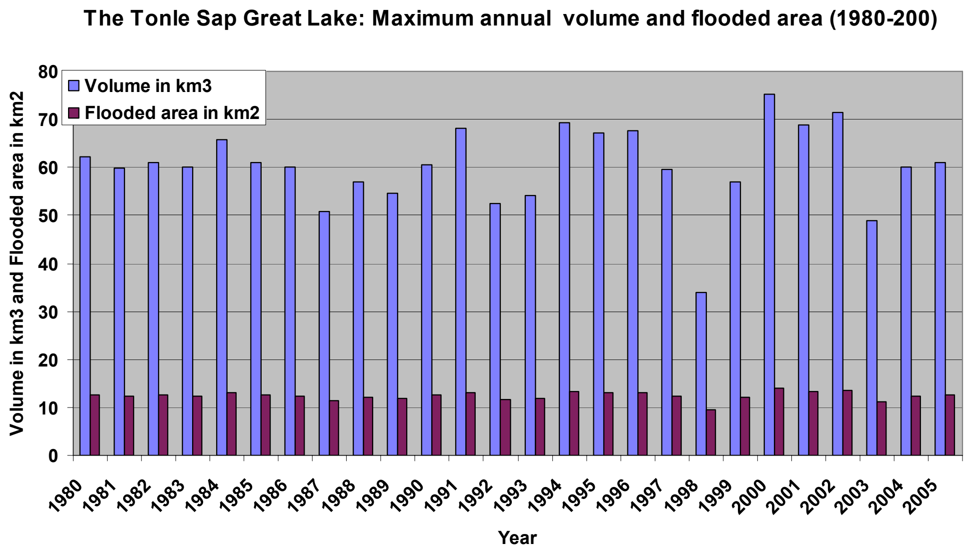


Figure 3: Maximum volume and flooded areas of the Great Lake Tonle Sap Great Lake

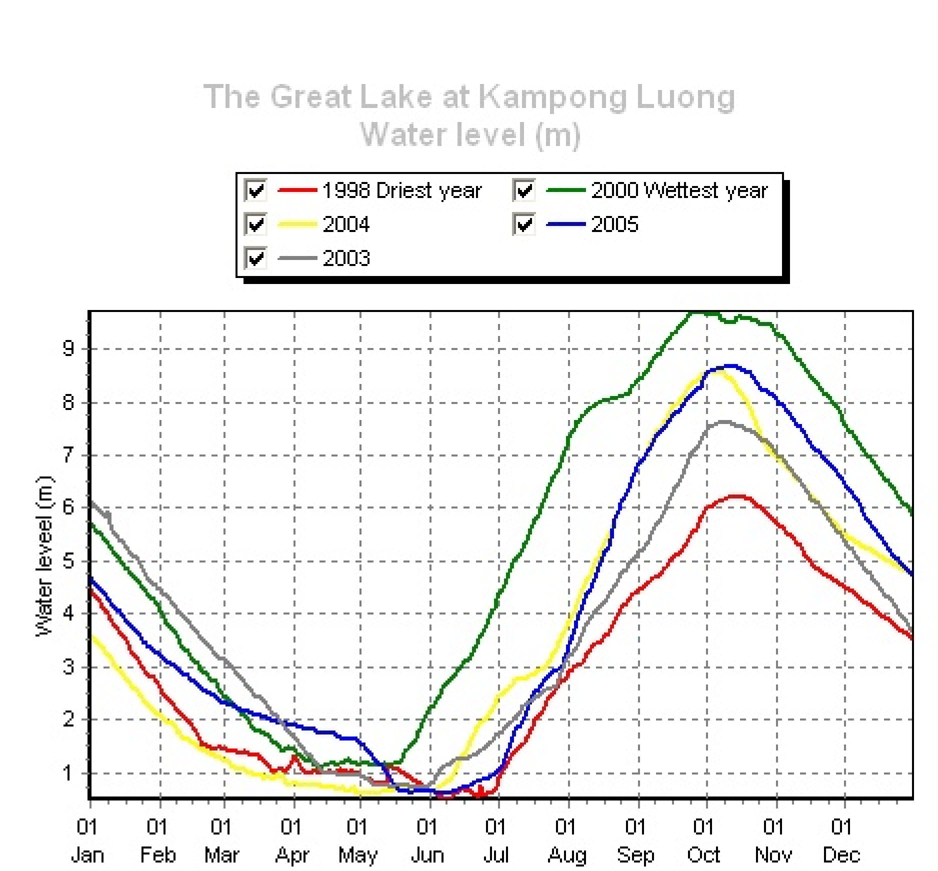


Figure 4. The Hydrographs of the Great Lake at Kampong Luong

5. IMPACT OF 2005 FLOODS

Damages from the 2005 have been recorded in four provinces of Cambodia: Stung Treng, Kratie, Kampong Cham and Kandal. At Kratie and Kampong Cham 361 and 429 people have been evacuated to safer place, this indicates the degree of severity at the affected location. Twenty people died from flood of which 9 are male children mostly from bathing accidents. According to the 2005 MRC flood report there were a number of houses damaged or destroyed during the flood. The destroyed house were mostly built on the river bank and washed away by bank erosion

The impact on agriculture was estimated as 6.7% of cultivated areas have been destroyed; the district of Serei Santhor and Tbaung Khmum are the hardest hit. No loss of life stock was reported. It is believed that the preparedness programme put in place begin to produce some results, the population has evacuated their animal to a safer place before the water has reached a critical level.

The damage to infrastructure was quite limited, which might have been because most destroyed infrastructure have been rehabilitated and upgraded after the 2000, 2001 and 2002 floods and could resist floods of the same magnitude of the 2005 flood.

The 2005 fish catch was considered as relatively modest as compared to other years. With respect to 2004, the total catch of 2005 is estimated to have 26% increase totaling to 410,300 tons, in 2004 with a total catch of 325,560 tons. The Dai fishery catch which is considered as the most accurate fisheries data is estimated at 30,000 tons in 2005 as compared to 15,000 tons[3].

For rice cultivation the following table shows the 2005 countrywide rice crop production as compared to previous years:

Table 2: Rice crop production during 2005

Items	Harvested (tons)	Cultivated areas Ha	Crop damage (ha)
2004 (Total)	4,171,000	2,347,500	
Wet season	3,132,300	910,000 (5 years average)	
Dry season	1,037,000		
2005 (Total)	5,986,000	2,443,500	29,000
Wet season	4,734,000	2,121,600	28,000
Dry season	1,251,000	321,000	

6. THE MODELS FOR RIVER FORECASTING

The Department of Hydrology and River Works is in charge of river forecasting. Three days forecasts are made in collaboration with the MRC Regional Flood Management and Mitigation Centre in Phnom Penh. During the years leading up to 2005 the forecast has been expanded from the provision of the forecast of water level for stations along the Mekong mainstream to cover 40

[3] National report by ministry of Agriculture

villages in the flood plain to support the joint effort for providing warning to flood prone communities along the Mekong River from Stung Treng to Kampong Cham, and in the flood plain on the left hand site of the Mekong between Kampong Cham and Neak Leung. The activities are supported by the FMMP under an OFDA project, where most field works was implemented by the American Red Cross in collaboration with the Cambodia Red Cross and a NGO, Action Contre la Faim.

A regression model was developed and used for a three day forecasts using observed water level data at reference stations along the Mekong mainstream and reference stations in each of the vulnerable village. The results has shown that deep knowledge at each station used in the regression equation are required, polynomial regression has limitation in water level prediction, especially for hydrographs with multi peaks, inflexion point should be defined and updated all the time, one single curve could not fit the whole hydrograph for most of the station. Flood attenuation effects, series of natural reservoirs in the flood plain make single regression curve application difficult. Other technique is required. Revisiting reference station for their representativeness is also necessary.

Field works consists of building the capacity of the vulnerable communities to enable them to rely on their own capacity in flood preparedness, and response and rehabilitation by using flood information provided through the village flood report board, radio and TV. Some village maps have been produced for easy reference to all villagers.

Weather forecasting and rainfall data was not used in the forecasting or included in the in formation of the output. There is room for improvement to achieve acceptable standard in modern flood forecasting and early warning system.

The spatial and subject coverage are far from satisfactory in addition to limited forecasting time of only three days. Many communities and town are still left without any warning especially areas around the Great Lake, the flash floods will continue to threaten Prek Thnot and other areas. The available three days forecast might be too short for warning preparation in the former case. In order to extend the forecasting time it is obvious that effective weather forecasting activities need to be included in the forecasting activities. The forecasting methods should be based on the propagation of the flood wave from Stung Treng which could provide sufficient lead time to other forecasted stations further downstream. To achieve this objective there is a need to improve and assure high quality of data, processed hourly data recorders should be used, as recording devices with such capabilities has been installed already along the Mekong mainstream (Ban Chanta Ngoy on the Sekong, Ban Kamphun on the Se San, Stung Treng, Kratie, Kampong Cham and Phnom Penh Chroui Changvar. Currently in the forecasting team, there are no staffs trained in flood forecasting, there is a lack of basic knowledge in river forecasting.

The shortcoming of this report is the description of important weather condition occurring in the region during the year 2005.

To be effective in flood forecasting, the country needs to establish a Flood Forecasting Center integrating specialists from all concerned line agencies, mainly the Meteorological Department and the Department of Hydrology and River Works to work closely with the National and Provincial Disaster Management Committees.

An integrated flow of data and information is essential, as well as documentation of weather information and rainfall forecasts, and currently observed data for model operation and forecasting system development and improvement.

The long term need for the Mekong mainstream and related flood plains should ideally be to predict, with the highest accuracy and the longest lead time as possible at the Stung Treng Station, so that from Stung Treng other downstream station could be predicted with sufficient lead time and accuracy. For tributaries, systematic and intensive data collection should be carry out as soon as resources are made available including hind cast exercise based on existing data, provincial capacity should be built accordingly.

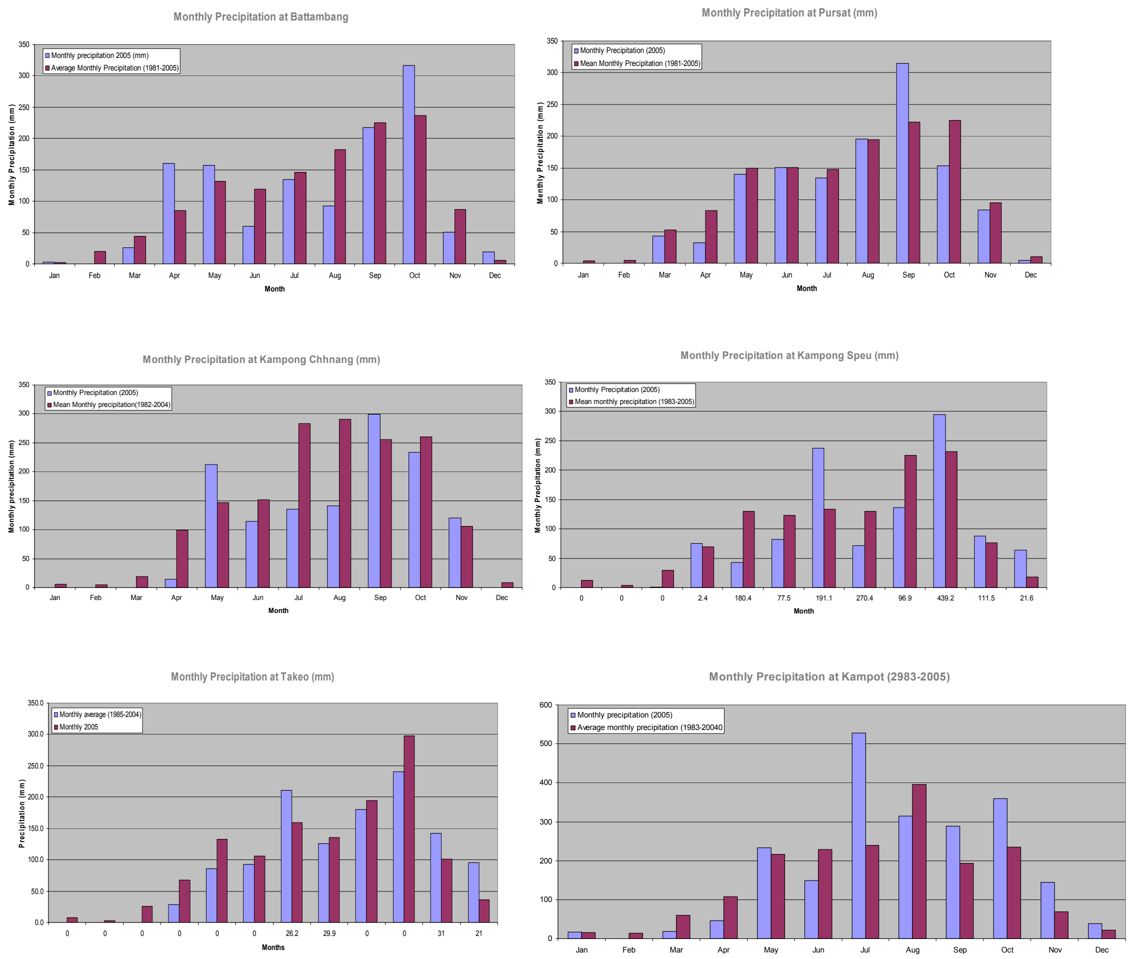
7. FLOOD IN TRIBUTARIES

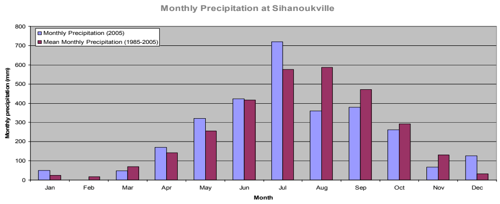
Only limited data has been provided for the analysis, the flood in Battambang has occurred in August

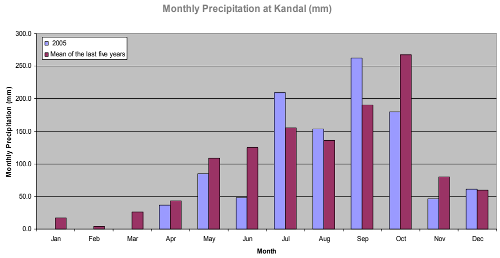
8. PRECIPITATION IN 2005

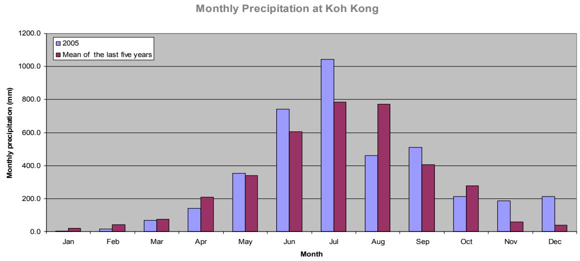
While the 2004 many parts of the country are affected by severe droughts due to insufficient rainfall especially for the last part of the growing season, the 2005 rainfall seems relatively well distributed, except some provinces namely Prey Veng and Svay Rieng, Battambang, Kampong Chhnang and Kampong Speu where deficits have been observed in the mid of cropping season but have received good rainfall near the end. In this case parts of the crops are affected by disease. The Figure 5 provides monthly distribution as compared to long term mean. The Battambang and Pursat station in October indicate higher rainfall. The severe flood of Battambang on 2nd and 3rd of August 2005 and Pursat in 2003 were not forecasted and warned.

Figure 5 Monthly precipitation of 2005 against mean monthly




Monthly Precipitation at Sihanoukville
Monthly Precipitation (2005)
Mean Monthly Precipitation (1985-2005)
Monthly precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Kandal (mm)
2005
Mean of the last five years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Koh Kong
2005
Mean of the last five years
Monthly precipitation (mm)
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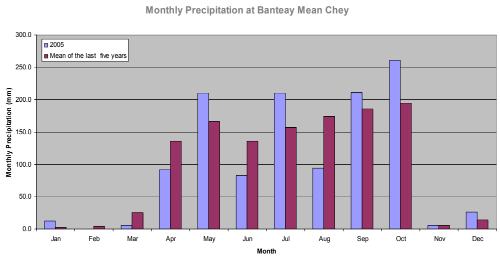
Monthly Precipitation at Banteay Mean Chey
2005
Mean of the last five years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
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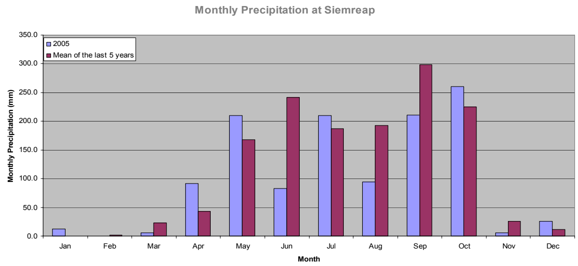
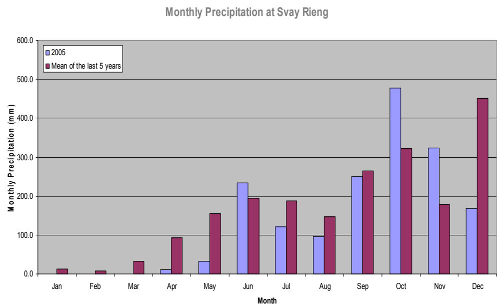
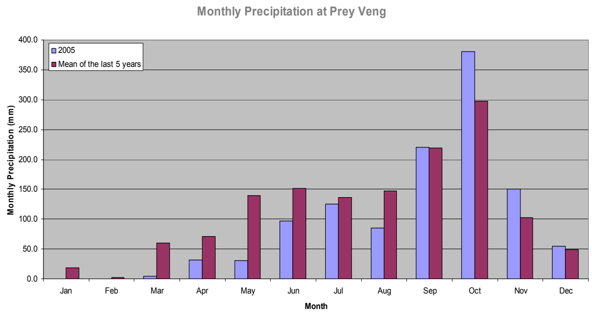
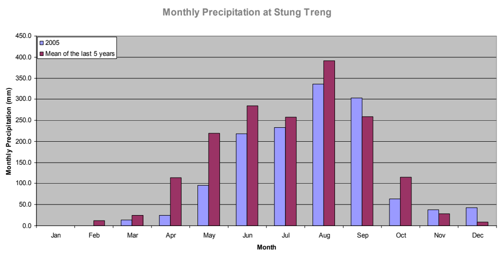
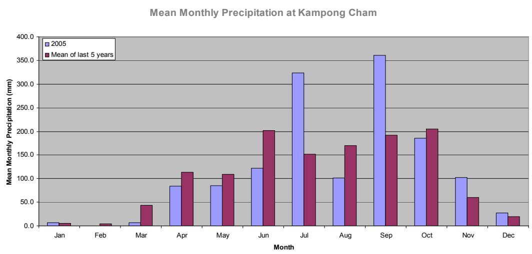
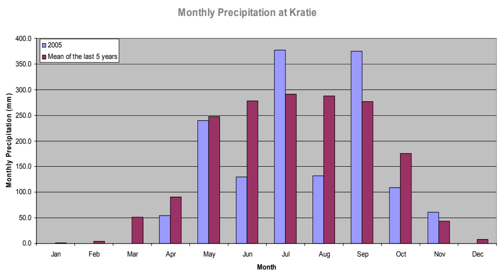

Monthly Precipitation at Siemreap
2005
Mean of the last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

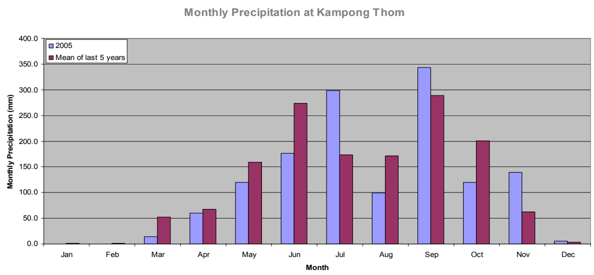

Monthly Precipitation at Svay Rieng
2005
Mean of the last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Prey Veng
2005
Mean of the last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Stung Treng
2005
Mean of the last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Mean Monthly Precipitation at Kampong Cham
2005
Mean of last 5 years
Mean Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Kratie
2005
Mean of the last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Monthly Precipitation at Kampong Thom
2005
Mean of last 5 years
Monthly Precipitation (mm)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

9. CONCLUSION AND RECOMMENDATION

With increasing flood and droughts risks due to global and regional climatic variability and with rapid infrastructure development and greater mobility of good and services, flood management and mitigation is well placed in modern planning and operation to reduce risk of flood damage and casualties.

For Cambodia, the need is huge, covering from structural and non-structural measures of flood management and mitigation to capacity building at all level from forecasting and warning at national, provincial to commune level, from data collection, processing to model development and operation. Financial capacity for data collection and forecasting operation are limited.

The National Flood Forecasting Center has not been established, the Department of Hydrology and River Works carries out river flood forecasting and the Depart of Meteorology is responsible for weather forecasting, there is little cooperation between the two departments in flood forecasting activities. There is a need for the two departments to joint efforts in building the National Floods and Droughts Forecasting Center, taking the advantage that the country is hosting the Regional Flood Management and Mitigation Center (RFMMC) to build its own capacity by focusing first on major vulnerable tributaries. For mainstream forecasting, a joint effort should be made with the RFMMC to make the Stung Treng forecast to be the most accurate as possible for the mainstream forecast. For flood plain forecast a comprehensive review is required for the referencing data collection system including additional water level station along the mainstream.

10. REFERENCE

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