Mekong River Commission

Flood Management and Mitigation Programme

Seasonal Flood Situation Report for the Lower Mekong River Basin

Covering a period from 1st June to 31st October 2009

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1. Overview of flood season 2009

1.1. Rainfall situation

The rainfall situation along the Mekong River Basin, as previous years, concentrated during July – September, a period of critical Southwest Monsoon activity, storm and typhoon's appearances in South China Sea. In term of total seasonal rainfall, the general picture is one of the average years (see figure 1). The spatial variation of rainfall is high indicating that the intensity of heavy rain situations along the Lower Mekong Basin from upstream to downstream took place by the time (Annex A: 1. Table and graphs of monthly observed rainfall distribution in flood season 2009):

- The wet season started in early June, the heavy rain mostly occurred in upper and middle reaches of LMB.
- During July - August, the intensive and continued rain covered entire LMB and appeared more frequently.
- From September to October was the time of intensive rainfall in middle and lower reaches, especially from Strung Treng to Kon Khel/Neakluong.

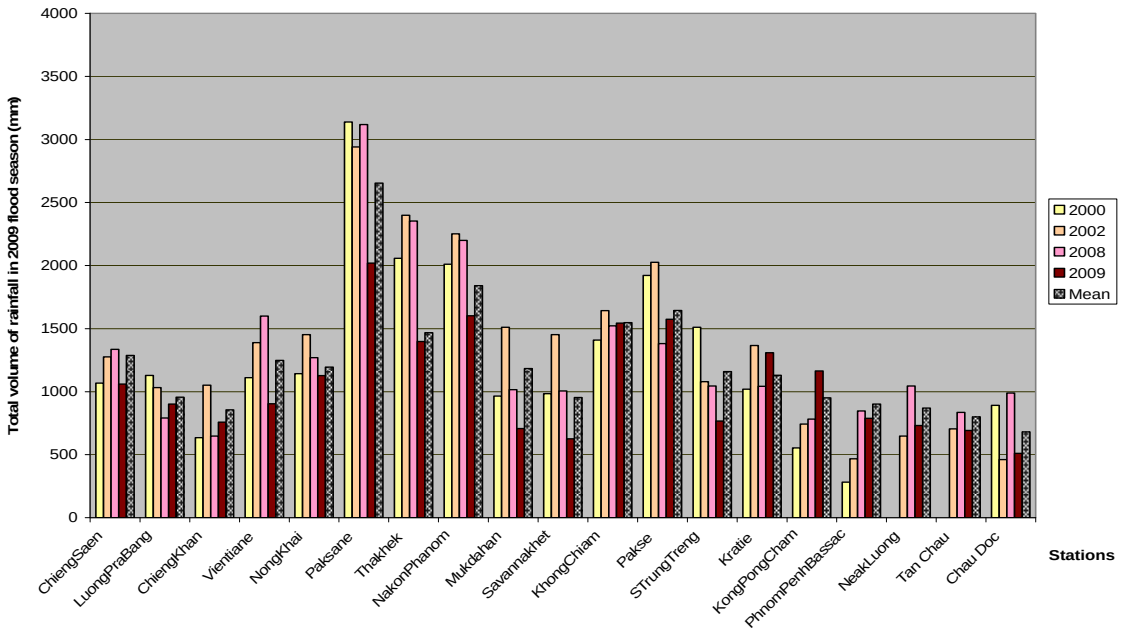


Figure 1: Total volume of rainfall in flood season of the years 2000, 2002, 2008, 2009 and Long-term average flood seasonal rainfall

In 2009, three main weather patterns caused heavy rains, which are presented below:

- Southwest monsoon: influence on the Mekong river basin from last June to middle of October, the critical activity mostly occurred during early July to mid August. Typically, heavy rain event from June 27 to July 8 in the upper and middle part of the LMB, which caused rapid rise in water level. From mid September, there was moderate to weak SW monsoon, which prevailed over Indochina Peninsula as a common phenomenon.

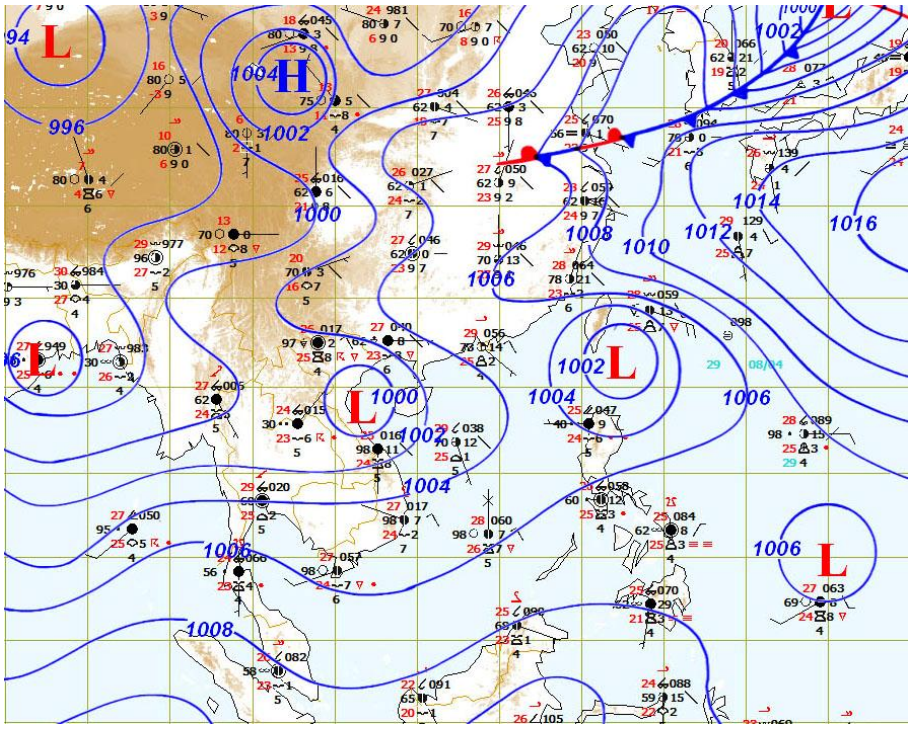


Figure 2: Weather map for Southwest Monsoon in mid July

- Tropical Low Pressure and Inter Tropical Convergence Zone (ITCZ): periodically appeared from last July and maintained on average of 3 to 7 days. During mid August to mid September, the frequent appearances of low pressure and ITCZ were one of the major results that caused continuous heavy rain and flood events in the upper and middle reaches of LMB.

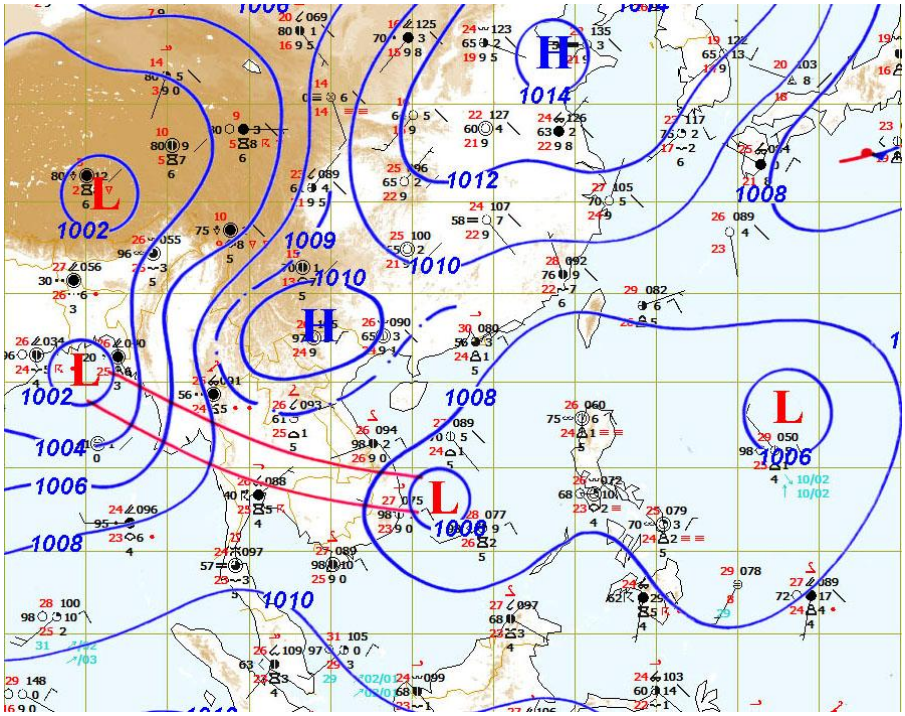


Figure 3: Weather map for ITCZ in the mid of August

- Tropical depressions (TD), tropical storms (TS) or typhoons (TY): there were about 11 tropical depressions, storms and typhoons came to South China Sea and affected to the Mekong river basin with different levels. The most notable storm was Ketsana, which was formed in the east Philippines on 26th September, caused extensive damages in Liuzong Island of the Philippines, and then upgraded into Typhoon when travelling through South China Sea, and landed over Central of Vietnam on 29th September and arrived at the Southern part of Lao PDR, Northeast part of Cambodia. It downgraded into low pressure on 30th September when it hit north-eastern Thailand. The Ketsana typhoon generated heavy rain, which led to the rapid rises of about 12 metres on some tributaries in 24 hours causing significant damages, and also significantly increased water levels at main stations on the main river from Khong Chiam to Kampong Cham and flooding on the left bank tributaries in the LMB's middle reach at Se Kong, Se San and Sre Pok. Figure 4 and 5 presents the recorded tracks of TY Ketsana, the position and the time landing over Viet Nam coastline.

Figure 4: Ketsana Storm Track

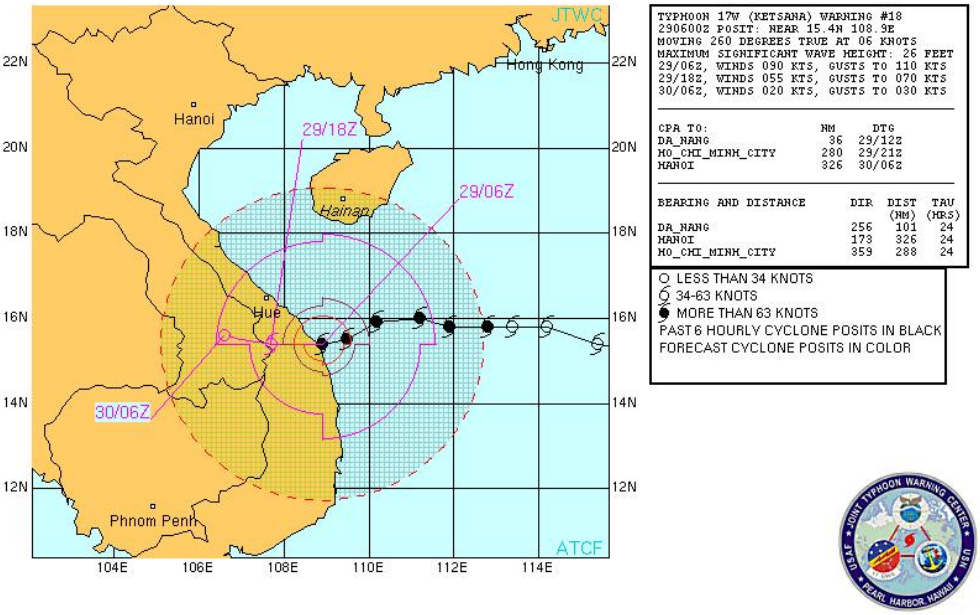


Figure 5: The location of Ketsana Storm when landing in Viet Nam

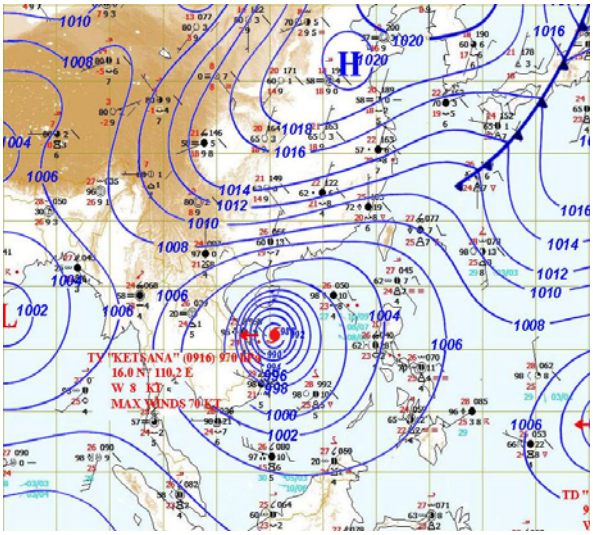


Figure 6: Weather map for Ketsana Typhoon on 28th September 2009, before landing

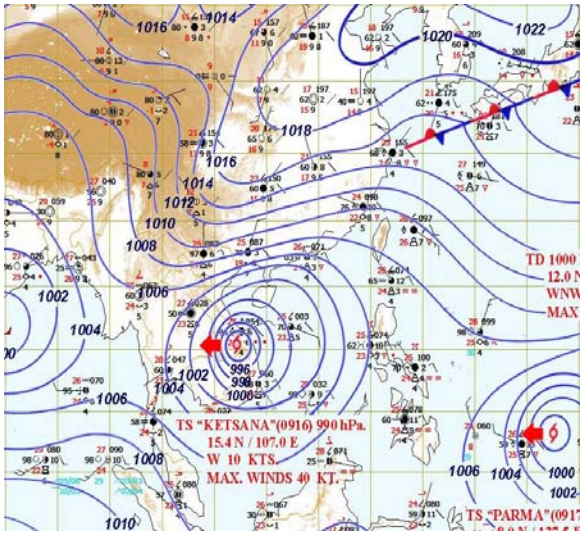


Figure 7: Weather map for Ketsana Typhoon on 29th September 2009, after landing

1.2 General Behaviour of the Mekong River and Seasonal Flood Situation

World wide the terms of flood and flooding may have different meanings. Therefore the definitions as used in this report are basically adopted from the Mekong Annual Mekong Flood Forums:

- ***Flood:*** *natural abundance of water in response to storm, rainfall, snowmelt, etc ... ergo the flood season on the Mekong ..... however, this does not necessarily lead to flooding;*
- ***Flooding:*** *the inundation of areas, which usually are not submerged.*

The 2009 flood season started more or less the same as previous flood years. The first flood event occurred in early July, many locations on the Mekong mainstream reached flood peaks of the year in this period of time. Generally, there was about the long-term average of water levels along the Mekong River in 2009 and lower than previous years, particularly in the upper and middle reaches of the Lower Mekong River (LMB).

In the downstream of the Mekong river from Phnom Penh Bassac to Tan Chau/Chau Doc, the water level was around the long-term average in which water level at Chau Doc was above flood level of 3.5m (as defined by the national agencies) during 13 - 17 October, water level at Tan Chau was above alarm stage of 3.0m from the early September and maintained about 2 months. (Annex C presents hydrographs of 22 main hydrological stations along the Mekong River).

In 2009, flood season has distinct characteristics compared with previous years:

- The rapid rise of the flood peak of the year was observed in early July at many main stations in the upper and middle reaches of the LMB.

- By the Typhoon Ketsana influence, a flood event with large amplitude of 3 to 5 meters occurred on the mainstream from Khong Chiam to Kampong Cham from late September to the beginning of October. The situation on the tributaries was more extreme.

The table 1 shows the flood peaks of main locations along the Mekong mainstream during the 2009 flood season. The table 2 shows the appearance time of flood peaks at main stations from Luang Prabang to Paksane in flood seasons 2000 - 2009.

Table 1: Flood Peak of 2009

ID	Station	Alarm level	Flood Level	Day/Month of Peak	Hmax (m)	Comment
010501	Chiang Saen	11.50	11.80	26-August	7.19	Below alarm level
011201	Luang Prabang	17.50	18.00	07-July	13.84	Below alarm level
011903	Chiang Khan	17.32	17.40	08-July	12.36	Below alarm level
011901	Vientiane	11.50	12.50	09-July	9.23	Below alarm level
012001	Nong Khai	11.40	12.20	09-July	10.1	Below alarm level
012703	Paksane	13.50	14.50	18-July	11.72	Below alarm level
013101	Nakhon Phanom	12.60	12.70	14-August	10.01	Below alarm level
013102	Thakhek	13.00	14.00	14-August	11.1	Below alarm level
013402	Mukdahan	12.50	12.60	15-August	10.17	Below alarm level
013401	Savanakhet	12.00	13.00	14-August	8.99	Below alarm level
013801	Khong Chiam	16.00	16.20	15-August	11.95	Below alarm level
013901	Pakse	11.00	12.00	15-August	9.22	Below alarm level
014501	Stung Treng	10.70	12.00	05-October	10.56	Below alarm level
014901	Kratie	22.00	23.00	06-October	21.44	Below alarm level
019803	Kampong Cham	15.20	16.20	07-October	15.16	Below alarm level
020101	Phnom Penh Port	10.50	12.00	10-October	9.93	Below alarm level
033401	Phnom Penh Bassac	9.50	11.00	10-October	9.03	Below alarm level
033402	Koh Khel	7.40	7.90	09-October	7.53	Above alarm level
019806	Neak Luong	7.50	8.00	10-October	7.23	Below alarm level
020102	Prek Dam	9.50	10.00	10-October	9.06	Below alarm level
019803	Tan Chau	3.00	4.20	12-October	4.09	Above alarm level
039801	Chau Doc	2.50	3.50	16-October	3.52	Above flood level

(Alarm level, flood level are defined by the national agency)

Table 2: Appearance time of flood peak at main station Mekong river mainstream from Luang Prabang to Paksane in 2000 - 2009

ID	Station	Day/Month of Peak									
		2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
011201	Luang Prabang	07-Jul	13-Aug	09-Sep	14-Oct	19-Aug	18-Sep	09-Sep	19-Aug	05-Aug	06-Sep
011903	Chiang Khan	08-Jul	14-Aug	N/I	N/I	20-Aug	13-Sep	12-Sep	20-Aug	06-Aug	09-Sep
011901	Vientiane	09-Jul	15-Aug	10-Sep	01-Sep	21-Aug	13-Sep	13-Sep	21-Aug	08-Aug	08-Sep
012001	Nong Khai	09-Jul	15-Aug	10-Sep	01-Sep	21-Aug	13-Sep	13-Sep	21-Aug	08-Aug	08-Sep
012703	Paksane	18-Jul	16-Aug	11-Sep	03-Sep	22-Aug	23-Sep	15-Sep	09-Aug	14-Aug	09-Sep

(N/I: No information)

The main hydrological situations along the Mekong river are presented more detail as below:

For stations from Chiang Saen to Vientiane/Nong Khai

Most of the time in 2009 flood season, water levels of stations were somewhat below the long-term average except the period of the first half of July. There were two notable rapid rise in water levels with the amplitudes about or over 2 meters occurred at those stations (see more detail in Annex A, table A2).

Due to the critical SW monsoon together with the occurrences of low pressure troughs (LPT), heavy rainfall over China, Northern Thailand, Northern Viet Nam from 28 June to 7 July, some recorded rainfalls were over 200mm such as Chiang Saen (214mm); Luang Prabang (209mm); Pak Beng (207mm), Muong Ngoy (380mm). Therefore, water levels rose at all stations from Chiang Saen to Vientiane/ Nong Khai, in which most of water levels of those stations reached the flood peak during this time, with exception of Chiang Saen (Table 1: Flood peak of 2009). It should be noted that flood amplitudes for stations Luang Prabang, Chieng Khan, Vientiane and Nong Khai were over 7m and flood amplitude for station Pak Beng, upstream of the Luang Prabang, was 13.54m (Figure 8).

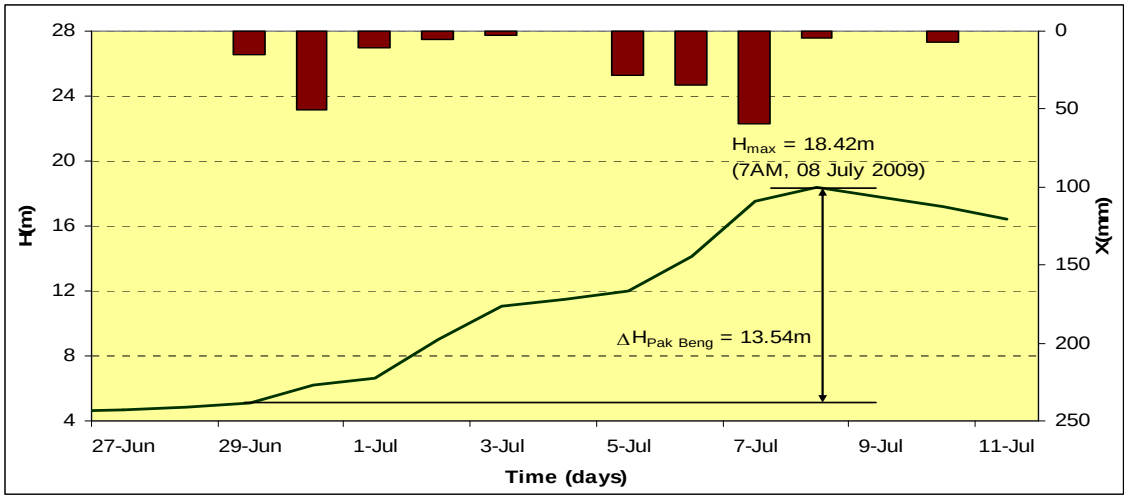


Figure 8: Flood on Mekong river at Pak Beng

Otherwise, intensive rainfalls and flood on left bank tributaries of Lao PDR were main contribution to flood on the Mekong mainstream downstream of Luang Prabang station, especially Nam Ou river, which is illustrated through hydrograph and rain chart at Muong Ngoy station (Figure 9).

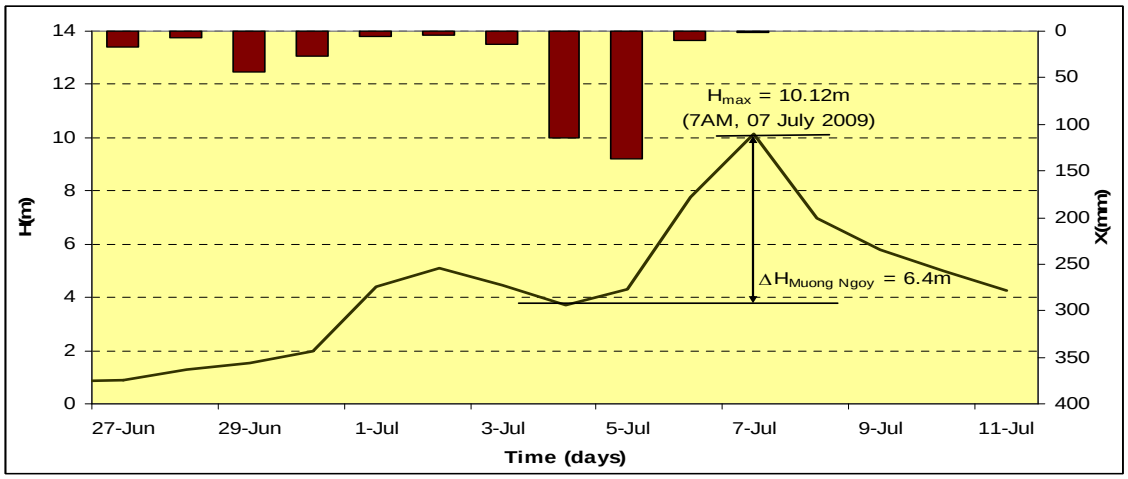


Figure 9: Flood on Mekong river tributary: Nam Ou at Muong Ngoy

From late July to the first half of August, critical strong SW monsoon and Tropical Depression ***"GONI"*** (0907) activities, which resulted in intensive rainfalls in Thailand, Lao PDR, Northern Viet Nam, moderate rain in Cambodia and Southern Viet Nam. The amount of rainfall from 31st July to 16th August was recorded at Chiang Saen (366mm); at Luang Prabang (369mm); at Vientiane (201mm). A flood event occurred at those stations with flood amplitudes over 2m.

For stations from Paksane to Pakse

Water levels of most stations are somewhat around the long-term average from June to mid August and below the long-term average from the second half of August to the end of October.

By the rapidly increasing of water levels for the LMB's upstream stations, water levels for stations from Paksane to Pakse rose quickly from 4th to 14th July. The flood amplitudes were estimated from 3.5 to 5.5m.

During the first half of August, there was intensive rainfall occurred in this region particularly from Paksane to Nakon Phanom/Thakhet with recorded rainfall at Paksane (267mm); at Nakon Phanom (393mm); at Thakhet (666mm). The flood amplitudes were around 2 to 2.5m.

For stations such as Khong Chiam and Pakse, by Ketsana Typhoon circulation from 27th September to 2nd October, the amount of rainfall were recorded at Khong Chiam (106mm); at Pakse (227mm). Water levels at these two stations increased quickly with average water level rising intensity of 0.46m per day. The flood amplitudes were 3.19m at Khong Chiam and 3.28 at Pakse station.

For stations from Stung Treng to Kampong Cham

Almost stations recorded water levels that are somewhat around the long-term average for the time of flood season in 2009.

As a result of Ketsana TY and strong SW monsoon activity, from 27th September to 2nd October, heavy rain covered Thailand, Viet Nam, Lao PDR and Cambodia which was over the Mekong river basin especially the part of middle reach of the LMB. Recorded rainfall at stations was 75mm at Strung Treng, 156mm at Kratie and 71mm at Kampong Cham. However, intensive rain occurred in Central highland of Viet Nam resulted in flooding at a number of stations on the left bank tributaries of Lao PDR which are illustrated through hydrographs at Veunsai of Se San river, at Lumphat of Sre Pok river and at Veun Khen of Se Kong river (Figure 10) and the rainfall value at the raingauges located at the Se San, Sre Pok, Se Kong catchments (Figure 11).

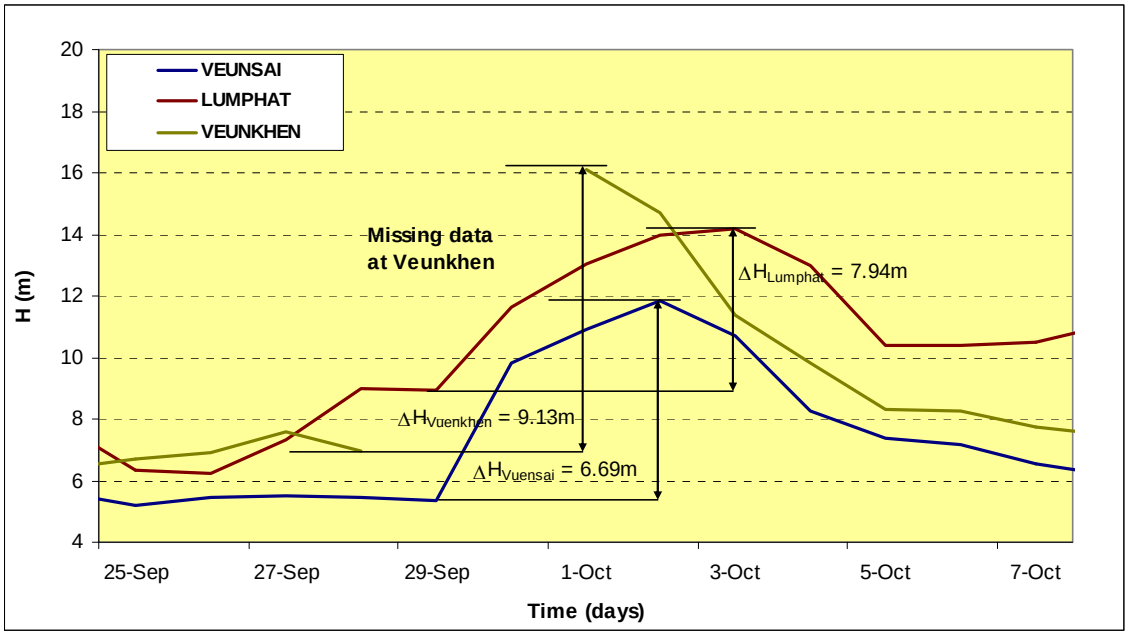
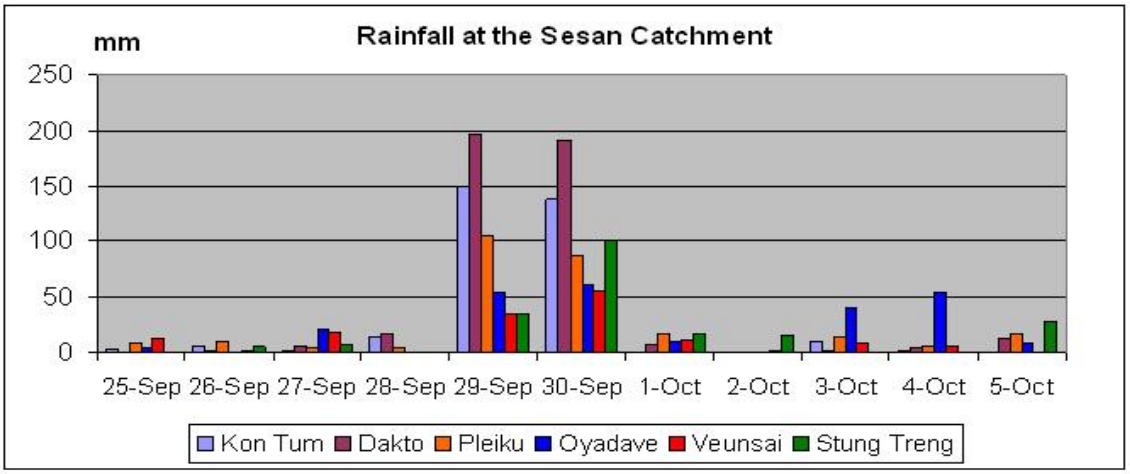
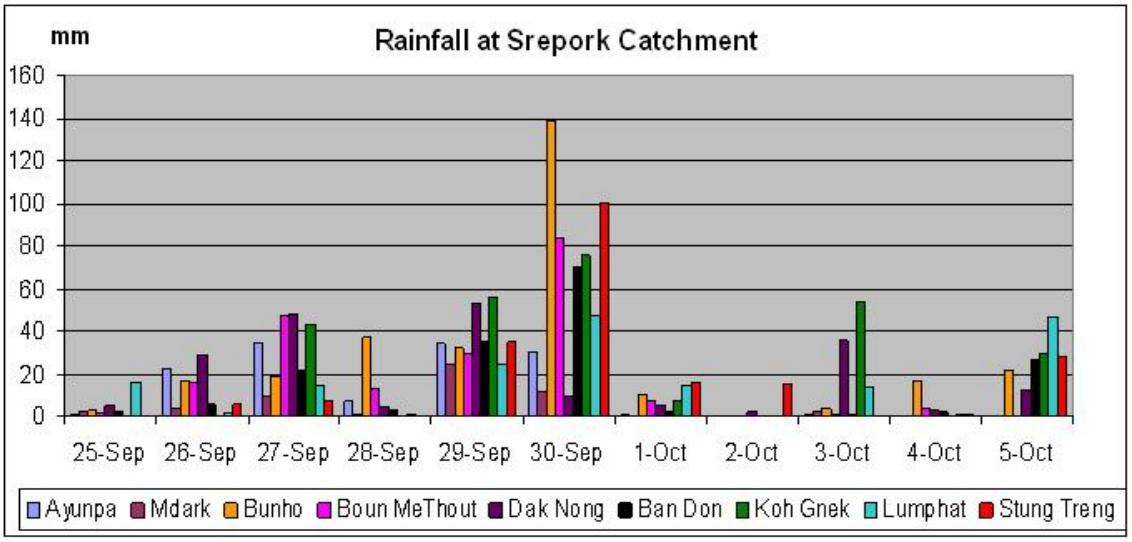


Figure 10: Flood on tributaries: Se San at Veunsai, Sre Pok at Lumphat, Se Kong at Veunkhen





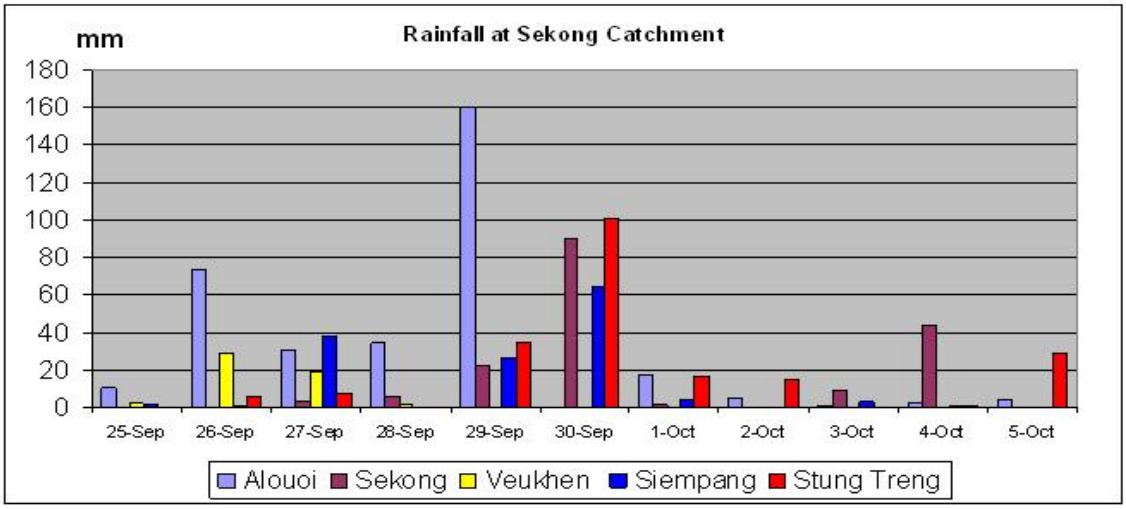


Figure 11: Rainfall at Se San, Sre Pok and Se Kong catchments

The amount of rainfall in highland area of Viet Nam was recorded at Ban Don: 132mm; at KomTum (319mm); at DakTo (427mm); and at Pleiku (220mm).

By the flood from the upstream of the LMB and contribution of tributaries of Se San, Se Kong and Sre Pok, water levels at stations from Strung Treng to Kampong Cham increased rapidly with average

intensities of 0.43m/day at Strung Treng; 0.54m/day at Kratie; 0.34m/day at Kampong Cham. All stations reached flood peak of the year during this time. The flood amplitudes were 3.89m; 5.1mm and 3.44m, respectively.

For stations from Phnom Penh to Koh Khel/Neak Luong

Most stations were recording levels that were somewhat around the long-term average for flood season 2009.

During the beginning to mid July, and by flood water from the upper and middle reaches of the LMB, water levels of stations at downstream rose with average intensity of 04 - 0.5m/day. The flood amplitudes were about 2.5m to 3.2m.

From 27th September to 10th October, water levels of those stations increased steadily by the influence of flood from middle reach and reached the flood peak of the year during 9th to 10th October. Water level at Koh Khel was above alarm level during 6th to 14th October.

Tan Chau and Chau Doc

Both stations recorded water levels that were somewhat about the long-term average for this flood season. Tan Chau and Chau Doc were the stations that remarkably affected by tidal regime, that is one of the main reasons as water level at Chau Doc was above flood level and remained in 5 days (from 13th to 17thOctober). Water level at Tan Chau was above alarm level from the second week of September as the long-term average for this time of the year.

Note: for areas between forecast stations, please refer to the nearest forecast station.

2. Flood Forecast in 2009

2.1 Data collection for models and flood forecast bulletin dissemination

Daily data collection was hydrological and meteorological data (observed water level and rainfall) by HydMet from Line Agencies and Satellite Rainfall Estimate (SRE) and Numerical Weather Prediction (NWP) obtained from NOAA as the input to the Mekong Flood Forecasting System (FFS). The performance indicators are shown in the table and graphs of forecast achievement, Annex B. Through the result of evaluation, the data from LAs is normally arrived before 9 AM, therefore, forecaster-in-charge had a period of 1 hour for analysing flood situations, weather conditions, adjusting and sending forecast bulletin before 10h30 AM, which is a prescribed time in the Operational Manual.

The data collected by HydMet was checked by LAs; hence, the quality of data is fairly good in general. Of course, during five months of flood season from the beginning of June to the end of October, the late transfer of data, errors and missing data are unavoidable. Unfortunately, those situations often occurred in the period of high water levels and during weekends. Hence, it resulted in some difficulties for forecasters in analysing and adjusting forecast results because of limited time (see more detail in table and graphs in Performance, Annex B). To address this shortfall an evaluation report on data collection and transfer from Las to the RFMMC has been produced in which the main causes of the problem were indentified and corresponding solutions and actions proposed. This issue will be one among others to be discussed and addressed with concerned LAs of the MRC member countries during Annual Gathering the MRC Flood Forecasters and Data Handlers to be organised in late March 2010.

As inputs for the URBS/FEWS, SRE and NWP were the most important factors to determine forecast results. Quality of the SRE was specifically analysed and evaluated for flood season 2008 in the report “2008 Flood Forecasting Accuracy”, MRC_RFMMC, February 2009 and even up to now the accuracy of the SRE provided by NOAA is still questionable. Following the investigations and comments of the forecaster-in-charge in the weekly reports throughout 2009 flood season, it is found that the NWP always provided overestimation of forecast rainfall during normal climate situations, especially at stations in the upstream of Mekong river. This led to forecast results of water levels at stations as Chiang Saen, Luang Prabang and Chiang Khan showing unreasonable increase while in the actual situation opposite trends were recorded.

Performance indicators of bulletin delivery (table B3 and figure B4, Annex B) shows that the flood bulletins containing flood situation information were disseminated timely to the registered national line agencies, MRC website, and other interested users before 10h30 AM except the following cases:

- Significant flooding situation, when there is a need to have additional time to organise forecast team for discussion and adjustment
- Data from LAs is sometimes coming too late. It is anticipated that with on-going improvement of hydro-meteorological network and telecommunication system in each MRC member states the situation would be improved especially the operational of the MRC hydromet network (AHNIP and M-Hycos).

2.2 Accuracy and limitations in forecasting

During this 2009 flood season, the degree of accuracy varies from stations to stations. The shorter of lead time, the more accurate of the forecast (see Table B1: Achievement of daily forecast against benchmarks, Annex B). In general, the forecast errors for all lead time at stations in the upper reach and middle reach of the LMB were not large differences except at Luang Prabang and Kratie.

Forecasts at Luang Prabang station in the upper reach and at Kratie station in the middle of the Mekong River showed lower accuracies in which the errors on 5-day forecast at Luang Prabang is higher than 1.0 m. Moreover, forecasts at Luang Prabang are least accurate compared with all stations for all lead times (Figure B1: Average flood forecast accuracy along the Mekong mainstream, Annex B). It is a notable problem in this flood season that accuracies for all lead time at Kratie were less than expected if following the benchmarks of success, the evaluation of forecast achievement is presented in table B2 by indicating the % of successful days against a respective benchmark.

It is easily seen that forecast performances at stations in the lower reach of Mekong River where a regression model is used are quite promising and much better than those in the upper and middle reaches, with exception of Strung Treng and Kratie, where the errors on 3-day to 5-day forecast are higher than others. Stations in downstream from Phnom Penh Bassac where average errors on 1-day and 2-day forecasts are lower than 0.03 m. and 0.10 m respectively while average errors on 5-day forecasts are lower than 0.25 m and even lower than 0.2 m at stations downstream from Koh Khel.

Based on investigations and forecasting experiences of the RFMMC, the main factors influenced forecast accuracy can be summarized as below:

1. *Internal model functionality which is due to limited parameters for model calibration:* The limitations in developing URBS models were mentioned and analysed by Terry Malone in the report “Sensitivity Analysis and Evaluation of the MRC Mekong Flood Forecasting Systems”, April 2009, in which the main factors, which influenced the results of model calibration can be found as rating curves, inventory of dams, reservoirs and operational regulations, future development of dams. At the same time the sparse gauge network is another reason leading to poor results for forecast at stations in the upstream of LMB. The forecast results at Luang Prabang are a specific illustration of this.
2. *Poor satellite rainfall estimate (SRE):* SRE rainfall is used instead of observed rainfall, however due to time lag and time spent for acquisition and processing for both SRE and NWP data, data from the latest NWP is used for yesterday’s and today’s observed rainfall. As presented in the paragraph 2.1, rainfall inputs from SRE were evaluated for flood season 2008. Throughout the flood season 2009 the output for the URBS model, as can be seen from the results of daily forecast, is really sensitive to SRE rainfall. SRE can be either under or over estimated if compared with the observed rainfall, and therefore affects the forecast accuracy. This is not difficult to identify by weekly investigation of the forecasting team.
3. *The quality and accuracy of forecast is also determined by the quality of forecast adjustment, which is usually performed by forecasters-in-charge so his or her knowledge, expertise and experiences is also the prominent determinant of the final result of the forecast*.

2.3 Lesson learned and actions to be taken

The following lessons have been learned from the 2009 flood season, which can be served as the main factors that need to be taken into account by the flood forecasting team of the RFMMC in improving the forecast results:

- The availability and quality of both hydrological and meteorological (rainfall) data as inputs for models are always the highest priority because these are deciding factors for forecast results and accuracy. The RFMMC is planning to engage a Senior International Satellite Precipitation Expert for the development of methodology/tool and implementation of bias correction for SRE. It is anticipated that with the result of this exercise the flood forecasting team of the RFMMC will be able to increase the accuracy of the SRE input, which will lead to the improvement of the quality of input rainfall SRE and forecast accuracy as well.
- Improvement of forecast rainfall by using data from different sources may provide higher frequency and better accuracy. The flood forecasting team is testing forecast rainfall data from Regional Integrated Mutilhazard Early warning System (RIMES) provided by Asian Disaster Preparedness Centre, AIT Thailand.
- The data from stations in the upstream of Mekong river system in China is necessary for analysing and forecasting in the upper reach of the LMB as well as in the whole LMB. As much as possible the hydrological and meteorological data from stations belong to China territory need to be collected.
- Strengthening the relation and cooperation with Line Agencies in exchanging and collecting observed water level and rainfall data at stations on the Mekong mainstream in order to collect daily data on time and to minimize the missing and incorrect data.
- Improvement for model calibration by updating the rating curves and other parameters at stations along the Mekong mainstream to be supported by LAs, especially at main forecast stations.
- The forecaster-in-charge needs to find out more about sub-basin characteristics, flow regime of left bank tributaries in the middle part of the LMB where frequently intensive rainfall and flooding occurs.

Aside from above-mentioned lessons learned and its corresponding actions and in order to improve the accuracy of flood forecasting for next flood season 2010, a number of additional actions need to be under taken as follows:

- Performance of the ISIS model in the Cambodian Floodplain and the Delta should be compared with that of the Regression Model during the 2009 flood season. It is found that the discharges generated in ISIS are not consistent with the observed levels.
- Using efficiently water level and rainfall data at stations of China, two existing stations: Jinhong and Manan. Analysing the impact of water release from dams by water level at Jinhong on water level changes at stations in the upper part as Chiang Saen and Luang Prabang.
- Watching closely situations of heavy rainfall in Central Highland of Viet Nam through the rain gauges particularly Ban Don, Kon Tum, Dak To, Pleiku, Buon Me Thuot and the sudden increasing water levels of left bank tributaries in the middle part of the LMB such as Sre Pok river at Lumphat, Se Kong at Vuen Khen and Se San river at Vuen Sai when the weather patterns would inflict intensive rainfall such as Typhoon or Tropical Depression occurrences in South China Sea, the creations of low pressure trough line and Inter Tropical Convergence Zone (ITCZ) and sometimes the critical activity of South West monsoon.
- Through the flood season in 2009, forecast results of water levels at stations in downstream of the LMB by using Regression method were evaluated as fairly good, however the error for 4-day and 5-day forecast at hydrological stations affected by tidal from Neak Luong to Tan Chau/Chau Doc are quite high, based on benchmarks of success (table A2, Annex A). Therefore, additional reference of tidal regime forecast documentation in 2010 provided by National Centre for Hydro-meteorology of Viet Nam can be referred to in improving the accuracy at those stations.
- Learn more about the weather products of rainfall forecast published on the websites of the world's meteorological agency.

- Study the possibility of having 2nd run of daily flood forecast and medium-term forecast (6-10 days) – data availability and other requirements of the system by having further evaluation of the system's performance by using historically similar rainfall patterns.

For more details see the following annex:

- table and graphs for monthly observed rainfall distribution for flood season 2009 in Annex A
- graphs for monthly rainfall in flood season from 2000 to 2009 and long-term average along the Mekong River in Annex A
- tables of flood event characteristics along the Mekong River in Annex A
- a graph for accuracy in Annex B
- a table of forecast achievement in Annex B
- tables and graphs for performance in Annex B
- the graphs showing the observed water level and rainfall for the season in Annex C

Annex A:

1. Graphs and Tables for monthly observed rainfall distribution in flood season 2009

Table A1: Monthly observed rainfall in flood season 2009

Unit in mm

2009	Jinghong (*)	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nongkhai	Paksane	Nakhon Phanom	Thakhek	Mukdahan	Savannakhet	Khong Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Phnom Penh (Bassac)	Phnom Penh Port	Koh Khel	Neak Luong	Prek Kdam	Tan Chau	Chau Doc
June	37.3	110.5	73.3	133.4	110.3	266.7	367.4	238.2	134.0	206.0	158.3	196.9	348.1	47.8	150.2	131.2	129.9	No data	89.7	82.9	77.4	6.4	14.4
July	277.0	308.8	241.4	93.6	230.3	257.6	1026.4	509.4	569.2	159.8	156.1	504.2	559.8	149.1	371.6	349.2	71.0		198.6	88.8	135.3	180.0	155.5
Aug.	191.3	383.8	414.0	130.5	309.7	267.7	268.6	374.1	629.0	150.2	102.3	317.3	291.6	120.5	189.5	155.1	69.8		112.5	94.8	162.7	162.2	163.3
Sep.	139.0	177.4	122.8	322.0	169.9	243.3	307.9	221.3	214.5	97.7	132.1	491.6	388.4	308.8	442.6	278.9	367.4		227.7	140.3	248.0	128.8	97.0
Oct.	9.9	80.5	49.8	77.9	84.4	91.9	48.9	55.4	54.0	94.1	78.2	33.1	77.3	140.8	155.2	249.8	151.6		253.6	323.7	268.4	214.7	80.8
Season	**654.5**	**1061.0**	**901.3**	**757.4**	**904.6**	**1127.2**	**2019.2**	**1398.4**	**1600.7**	**707.8**	**627.0**	**1543.1**	**1665.2**	**767.0**	**1309.1**	**1164.2**	**789.7**		**882.1**	**730.5**	**891.8**	**692.1**	**511.0**

(*) Observed data for Jinhong from 15th June to 15th October

Figure A1: Monthly rainfall distribution for Jinghong, Chiang Saen, Luang Prabang and Chiang Khan

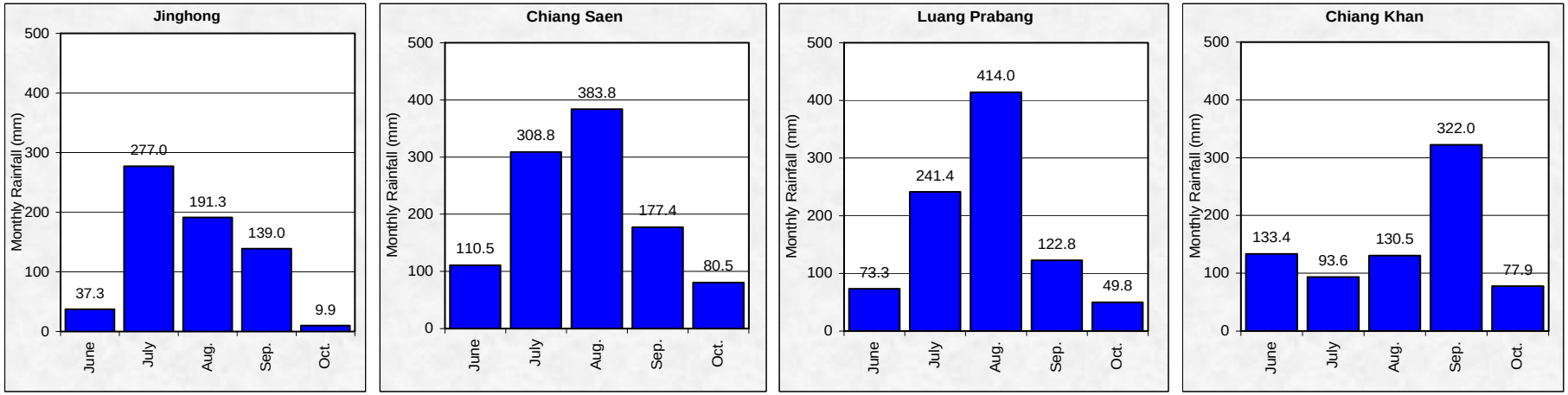


Figure A2: Monthly rainfall distribution for Chiang Khan, Vientiane, Nongkhai, Paksane and Nakon Phanom

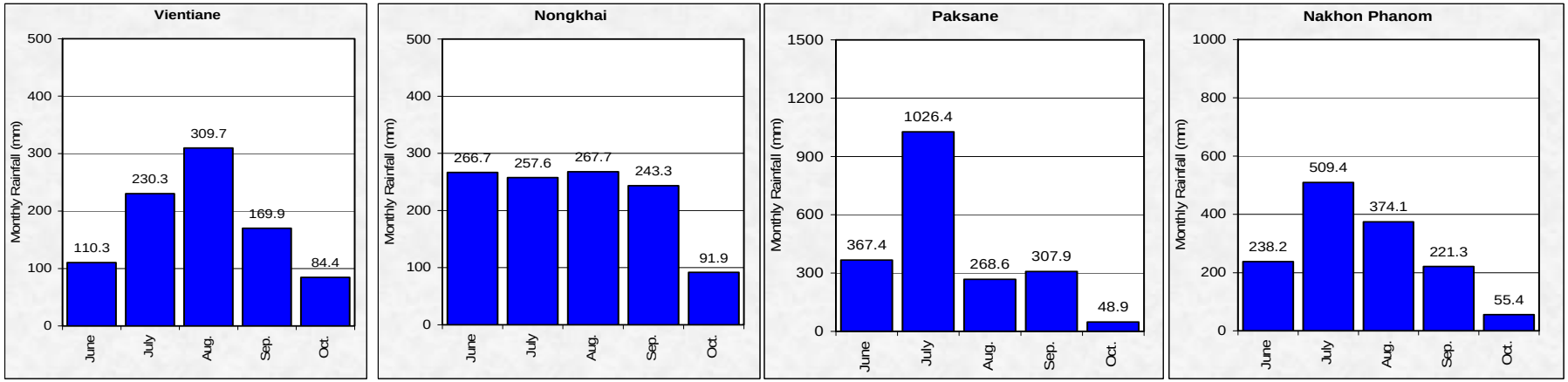


Figure A3: Monthly rainfall distribution for Thakhek, Mukdahan, Savannakhet and Khong Chiam

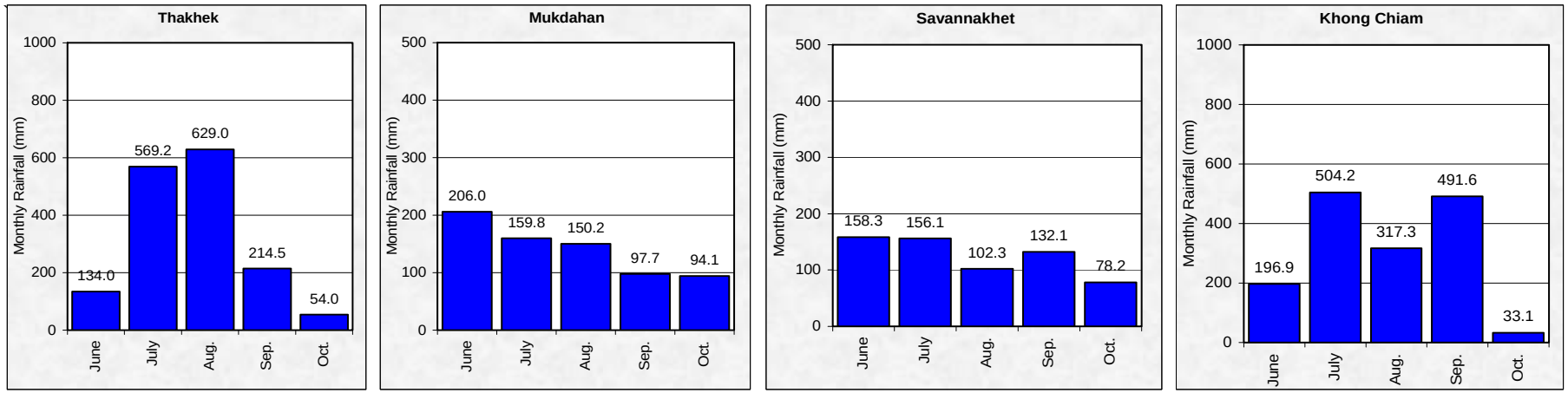


Figure A4: Monthly rainfall distribution for, Pakse, Stung Treng, Kratie and Kampong Chiam

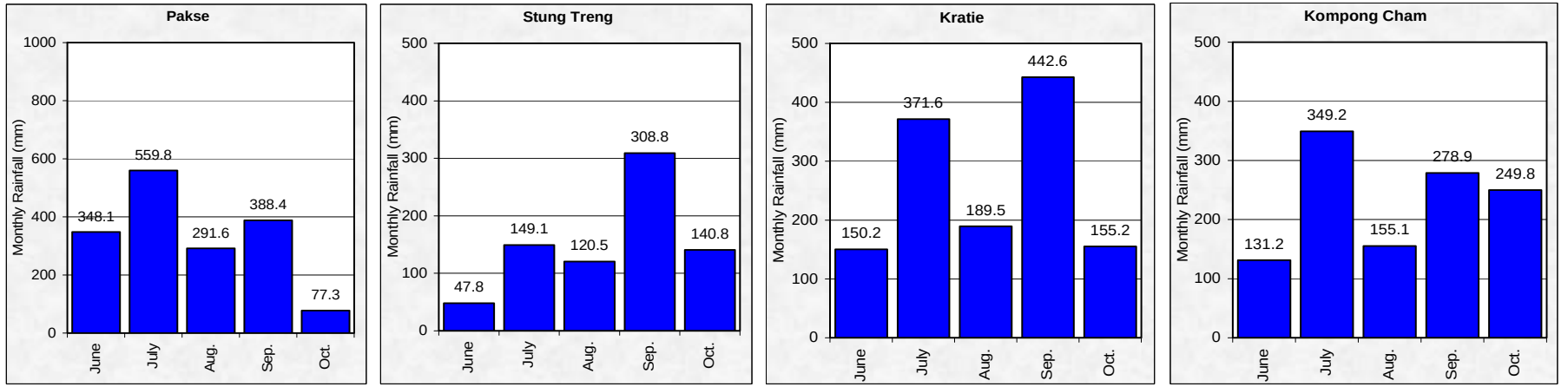


Figure A5: Monthly rainfall distribution for Phnom Penh (Bassac and Port), Koh Khel and Neak Luong

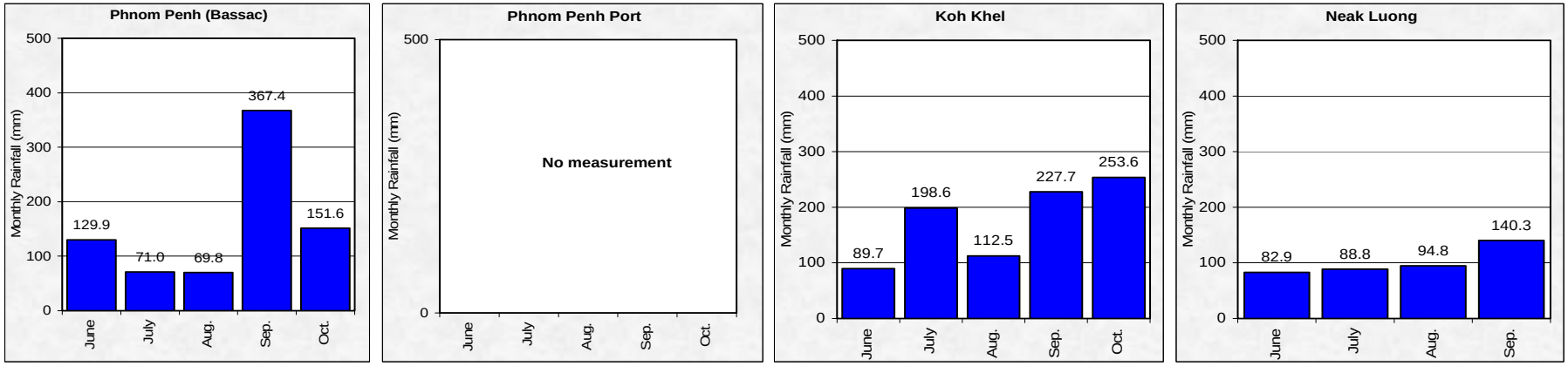
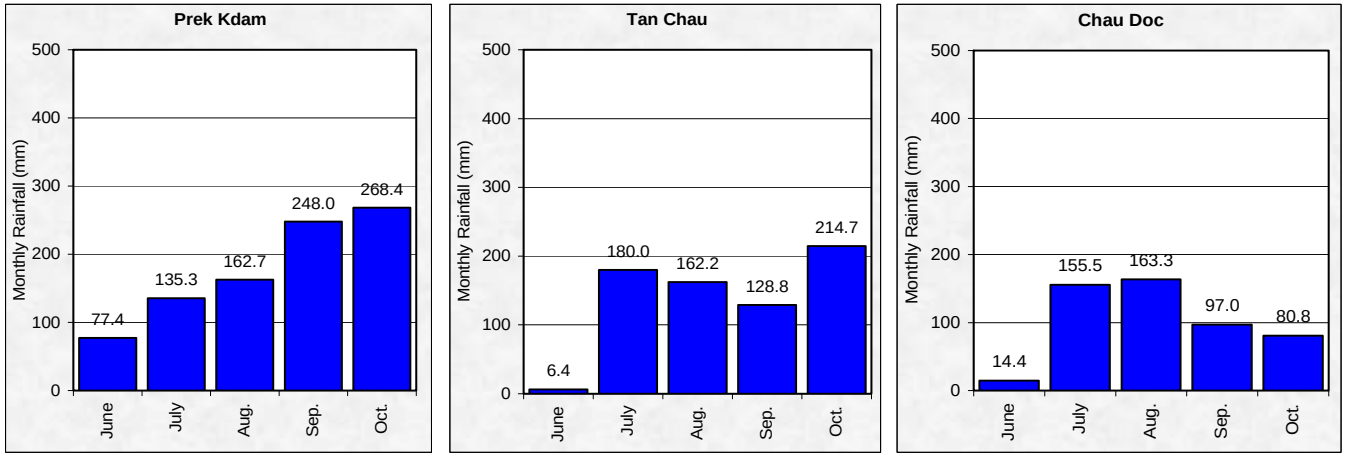


Figure A6: Monthly rainfall distribution for Prek Kdam, Tan Chau and Chau Doc



2. Graphs for monthly rainfall in flood season from 2000 to 2009 and long-term average along the Mekong River

Figure A7: Monthly rainfall in June for main stations along the Mekong River

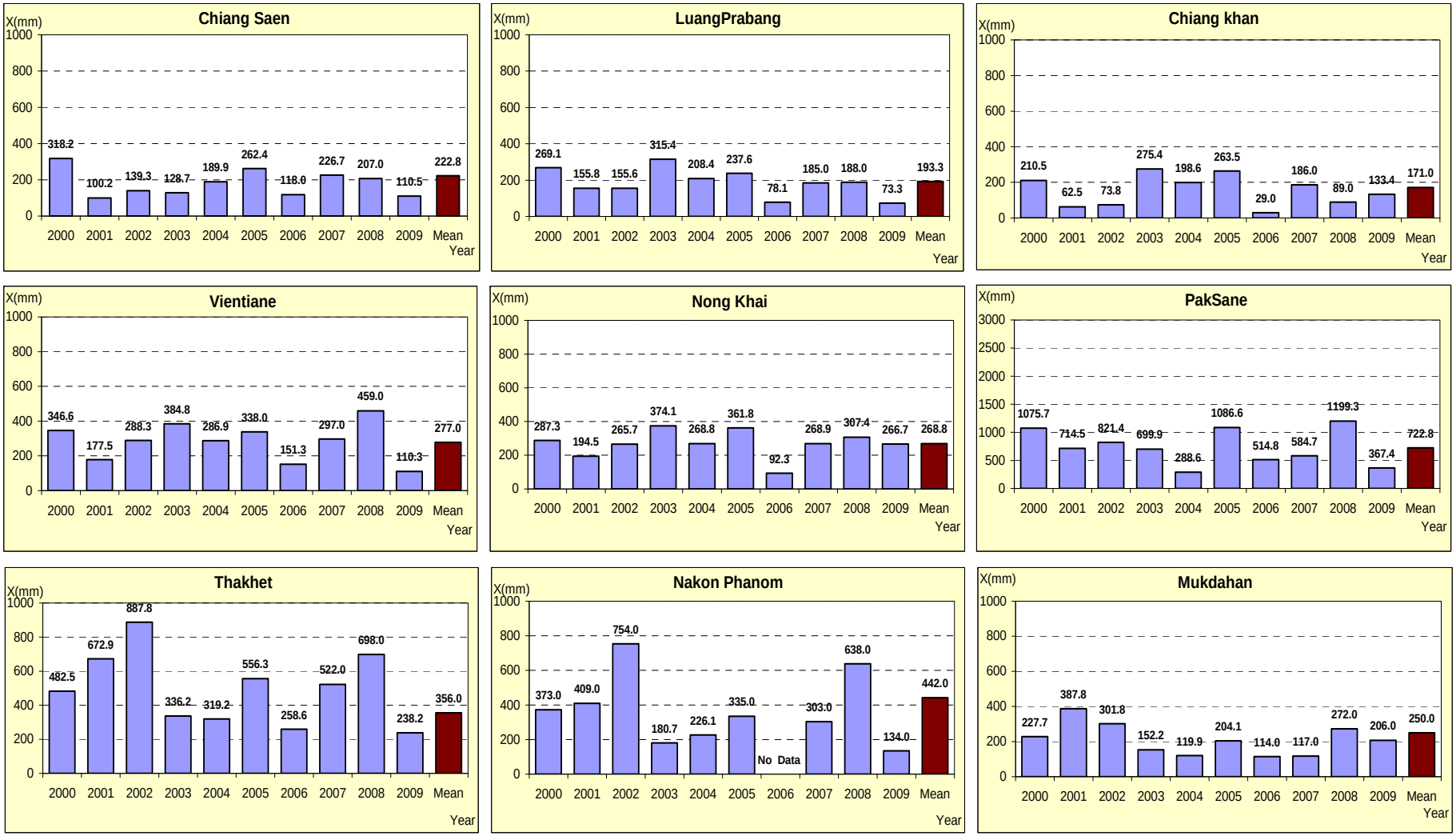


Figure A7 (cont.)

Figure A8: Monthly rainfall in July for main stations along the Mekong River

Figure A8 (cont.)

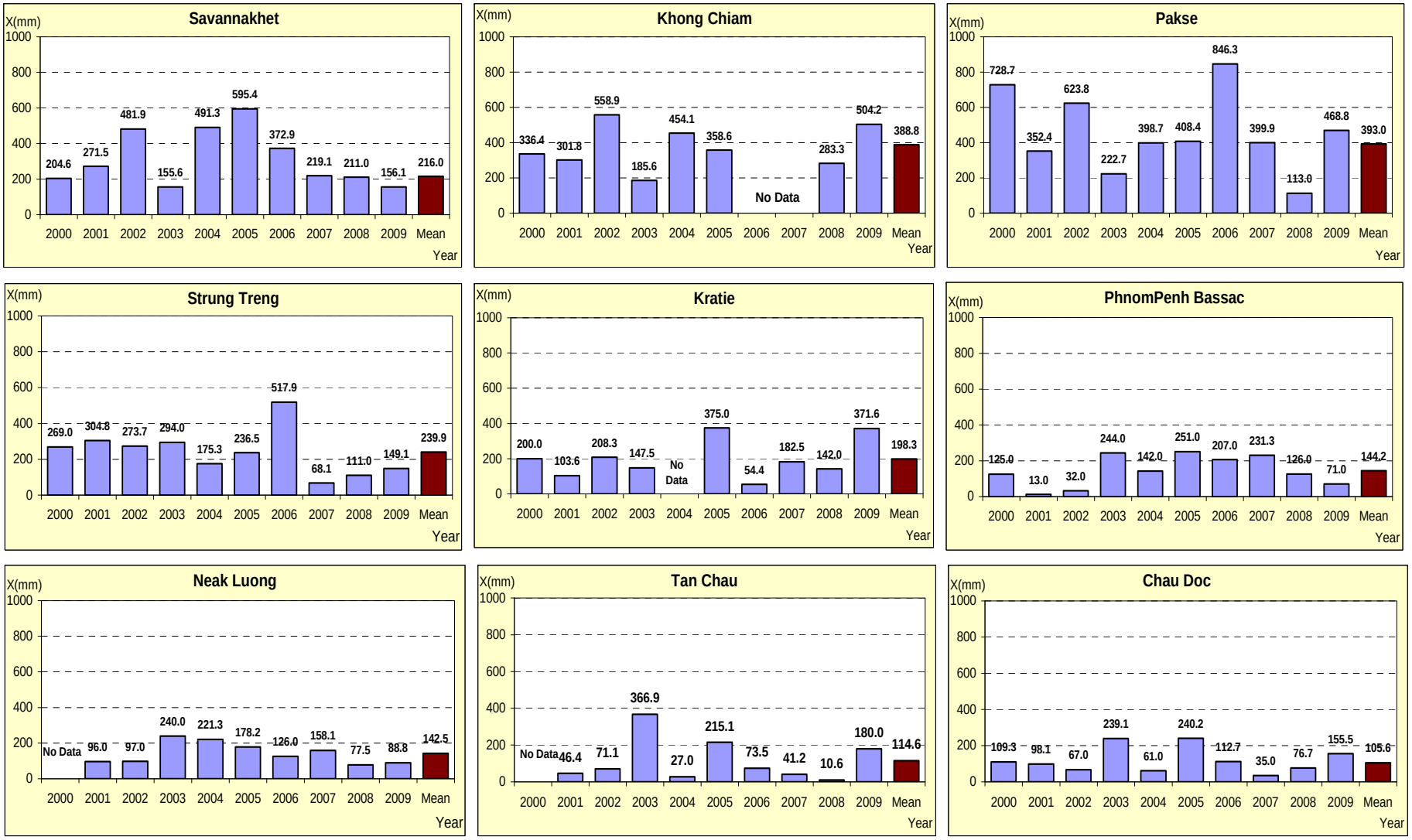


Figure A9: Monthly rainfall in August for main stations along the Mekong River

Figure A9 (cont.)

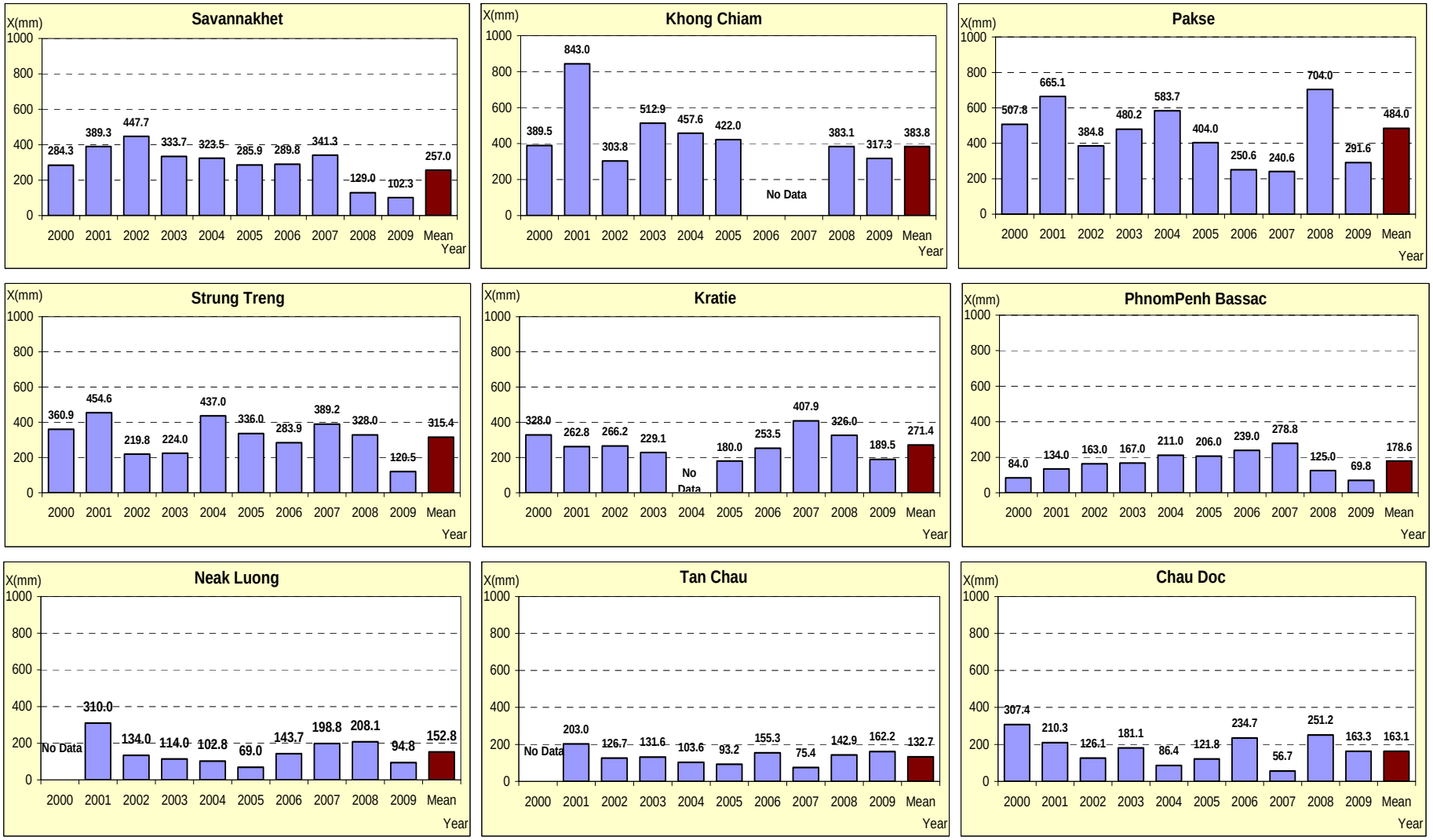


Figure A10: Monthly rainfall in September for main stations along the Mekong River

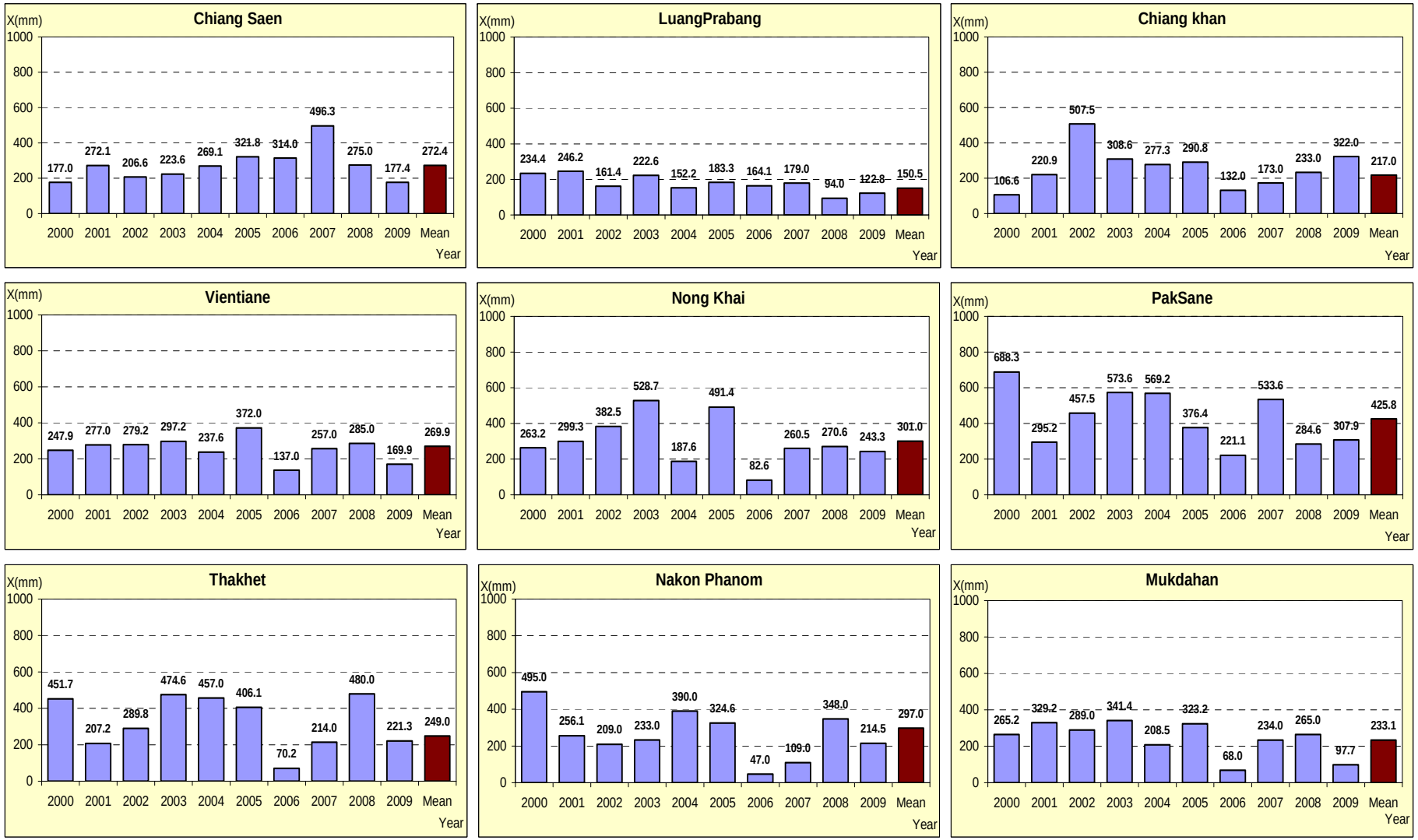


Figure A10 (cont.)

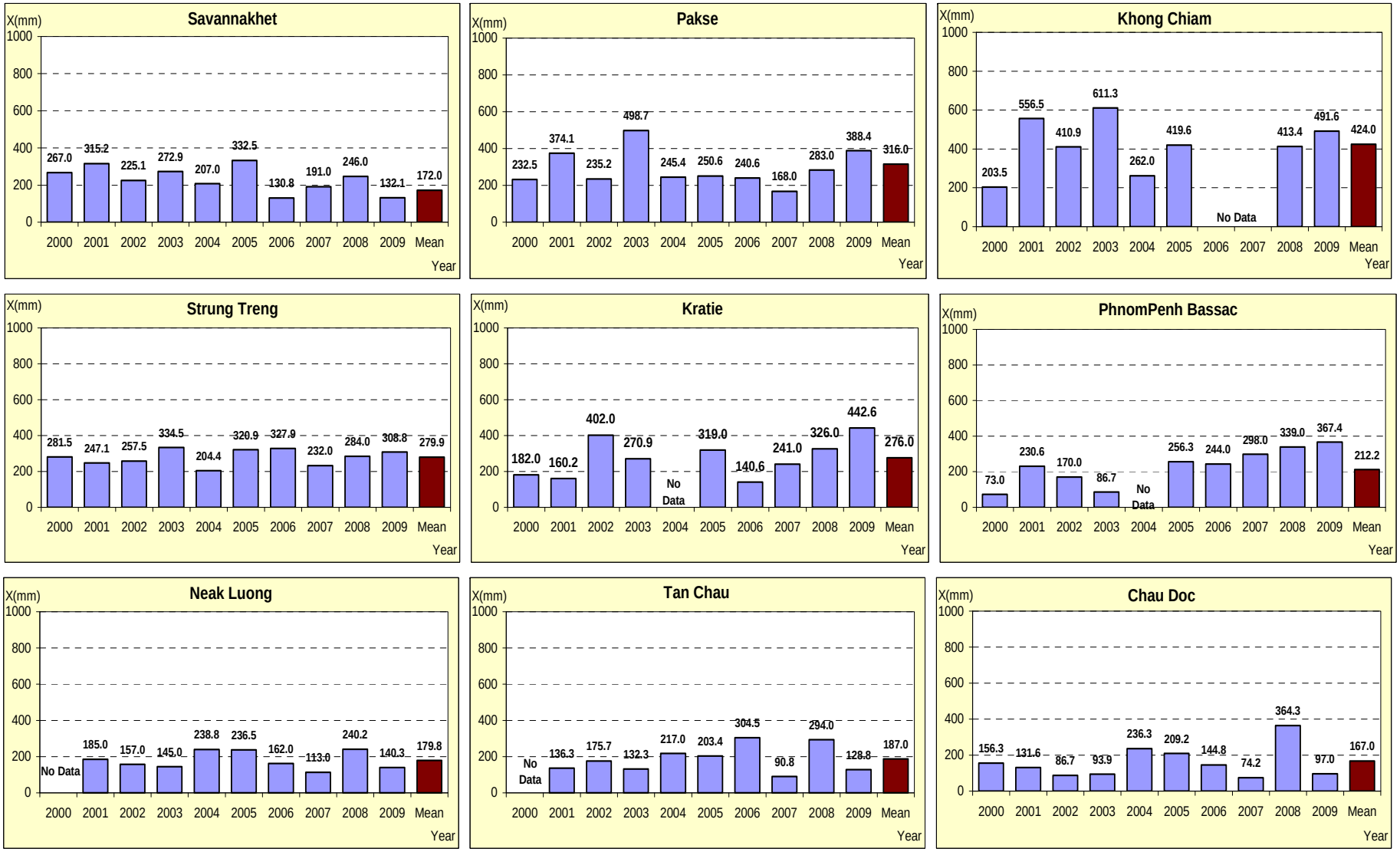


Figure A11: Monthly rainfall in October for main stations along the Mekong River

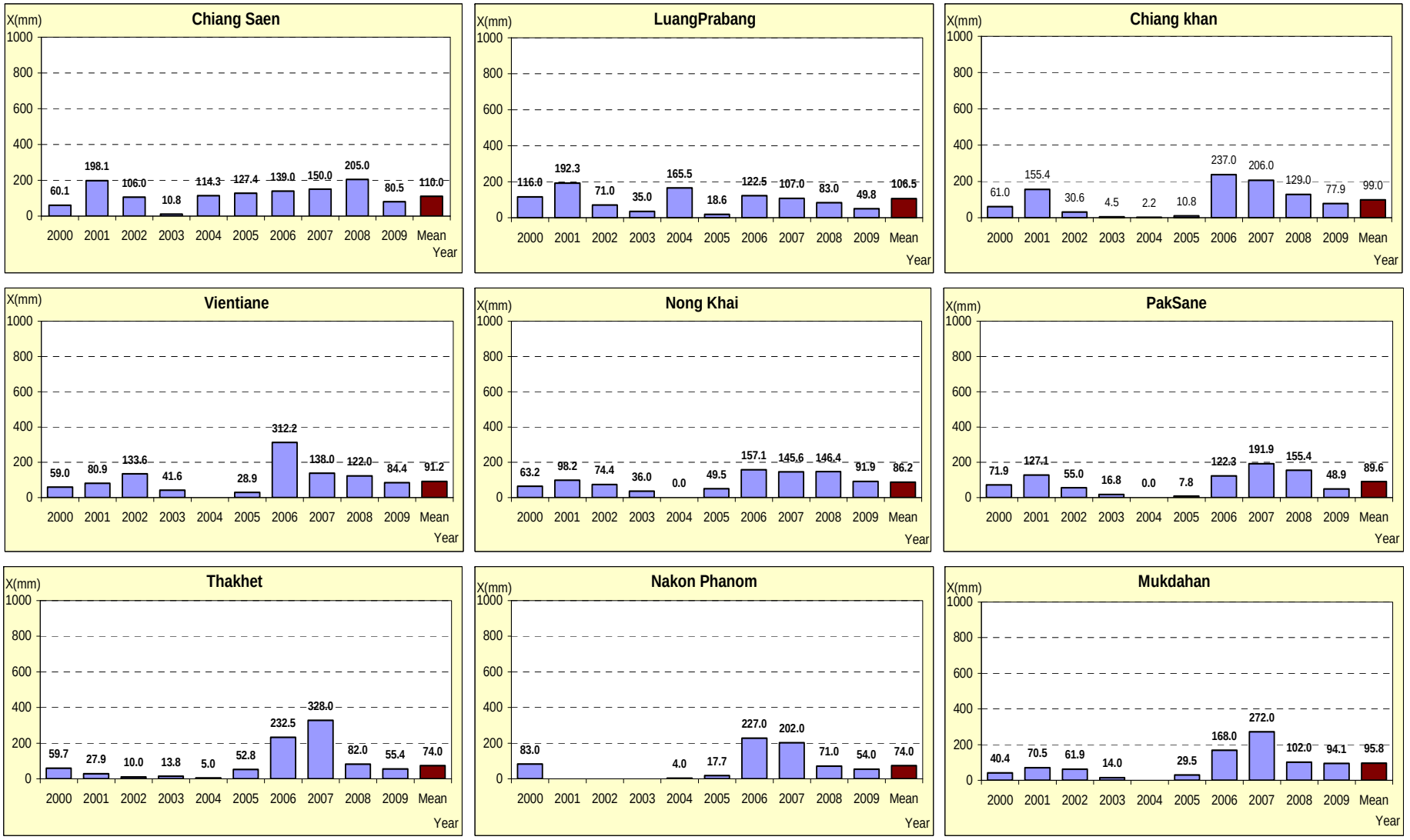


Figure A11 (cont.)

3. Tables of flood event characteristics along the Mekong River in flood season 2009

Table A2: The characteristics of flood events for station from Chiang Saen to Vientiane/Nong Khai

ID	Station	Beginning of flood event		Peak of flood event		Remaining Time	Flood Amplitude	Intensity of Flood Rising			Comment
		Date	H_B (m)	Date	H_P (m)	ΔT (day)	ΔH (m)	Appearence time of I_{max}(day)	I_{max} (m/day)	$I_{Average}$ (m/day)	
010501	**Chiang Saen**	28-Jun-09	3.19	09-Jul-09	5.96	11	2.77	3 Jul - 4 Jul	1.46	0.25	SW moonson + LPT
		04-Aug-09	4.53	08-Aug-09	6.93	4	2.4	06 Aug - 07 Aug	1.06	0.60	
011201	**Luang Prabang**	26-Jun-09	4.7	07-Jul-09	13.84	11	9.14	5 Jul - 6 Jul	3.92	0.83	SW moonson + LPT
		06-Aug-09	9	10-Aug-09	12.4	3.5	3.4	06 Aug - 07 Aug	1.42	0.97	
011903	**Chiang Khan**	29-Jun-09	4.96	08-Jul-09	12.36	9	7.4	6 Jul - 7 Jul	2.33	0.82	SW moonson + LPT
		07-Aug-09	8.73	11-Aug-09	11.22	4	2.49	08 Aug - 09 Aug	1.23	0.62	
011901	**Vientiane**	30-Jun-09	2.2	09-Jul-09	9.23	9	7.03	7 Jul - 8 Jul	2.95	0.78	SW moonson + LPT
		08-Aug-09	5.53	12-Aug-09	8.17	4	2.64	08 Aug - 09 Aug	1.15	0.66	
012001	**Nong Khai**	30-Jun-09	3.06	09-Jul-09	10.1	9	7.04	7 Jul - 8 Jul	2.58	0.78	SW moonson + LPT
		08-Aug-09	6.46	12-Aug-09	9.16	4	2.7	09 Aug - 10 Aug	1.24	0.68	

Table A3: The characteristics of flood events for stations from Paksane to Pakse

ID	Station	Beginning of flood event		Peak of flood event		Remaining Time	Flood Amplitude	Intensity of Flood Rising			Comment
		Date	H_B (m)	Date	H_P (m)	ΔT (day)	ΔH (m)	Appearence time of I_{max}(day)	I_{max} (m/day)	$I_{Average}$ (m/day)	
012703	**Paksane**	03-Jul-09	6	10-Jul-09	11.56	7	5.56	7 Jul - 8 Jul	2.14	0.79	SW moonson + LPT
		08-Aug-09	8.76	13-Aug-09	11.13	5	2.37	10 Aug - 11 Aug	0.75	0.47	
013101	**Nakhon Phanom**	05-Jul-09	4.99	11-Jul-09	9.25	6	4.26	6 Jul - 7 Jul	1.27	0.71	SW moonson + LPT
		08-Aug-09	8.19	14-Aug-09	10.01	6	1.82	09 Aug - 10 Aug	0.62	0.30	
013102	**Thakhek**	04-Jul-09	6.23	12-Jul-09	10.29	7.5	4.06	6 Jul - 7 Jul	1.28	0.54	
		08-Aug-09	9.28	14-Aug-09	11.1	6	1.82	09 Aug - 10 Aug	0.62	0.30	
013402	**Mukdahan**	05-Jul-09	4.96	12-Jul-09	8.85	7	3.89	7 Jul - 8 Jul	1.18	0.56	
		08-Aug-09	7.89	15-Aug-09	10.17	7	2.28	10 Aug - 11 Aug	0.65	0.33	
013401	**Savanakhet**	05-Jul-09	3.92	12-Jul-09	7.95	7	4.03	7 Jul - 8 Jul	1.12	0.58	
		08-Aug-09	6.98	14-Aug-09	8.99	6	2.01	09 Aug - 10 Aug	0.8	0.34	
013801	**Khong Chiam**	06-Jul-09	5.56	13-Jul-09	9.47	7	3.91	8 Jul - 9 Jul	1.29	0.56	
		30-Jul-09	9.14	02-Aug-09	11.46	3	2.32	31 Jul - 1 Aug	1.12	0.77	
		09-Aug-09	9.31	15-Aug-09	11.95	6	2.64	10 Aug - 11 Aug	0.96	0.44	SW moonson + LPT
		25-Sep-09	8.12	02-Oct-09	11.31	7	3.19	31 Aug - 01 Sep	0.85	0.46	Ketsana Storm
013901	**Pakse**	06-Jul-09	4.26	14-Jul-09	7.73	7.5	3.47	8 Jul - 9 Jul	1.21	0.46	
		30-Jul-09	7.12	02-Aug-09	9.82	3	2.7	31 Jul - 1 Aug	1.47	0.90	
		09-Aug-09	7.74	15-Aug-09	9.92	6	2.18	10 Aug - 11 Aug	0.79	0.36	
		25-Sep-09	6.58	02-Oct-09	9.86	7	3.28	29 Sep - 30 Sep	1.26	0.47	Ketsana Storm

Table A4: The characteristics of flood events for stations from Strung Treng to Kangpong Cham

ID	Station	Beginning of flood event		Peak of flood event		Remaining Time	Flood Amplitude	Intensity of Flood Rising			Comment
		Date	H_B (m)	Date	H_P (m)	ΔT (day)	ΔH (m)	Appearence time of I_{max}(day)	I_{max} (m/day)	$I_{Average}$ (m/day)	
014501	Stung Treng	08-Jul-09	4.75	18-Jul-09	8.85	10	4.1	15 Jul - 16 Jul	0.77	0.41	
		28-Jul-09	7.73	04-Aug-09	9.94	7	2.21	1 Aug - 2 Aug	0.5	0.32	
		31-Aug-09	6.5	10-Sep-09	9.17	10.5	2.67	9 Sep - 10 Sep	0.7	0.25	
		26-Sep-09	6.67	05-Oct-09	10.56	9	3.89	29 Sep - 30 Sep	1.12	0.43	Ketsana Storm
014901	Kratie	09-Jul-09	11.93	19-Jul-09	18.86	10	6.93	16 Jul - 17 Jul	1.2	0.69	
		29-Jul-09	17.66	05-Aug-09	20.48	7.5	2.82	29 Jul - 30 Jul	0.55	0.38	
		31-Aug-09	15.83	11-Sep-09	20.29	11.5	4.46	6 Sep - 7 Sep	0.76	0.39	
		26-Sep-09	16.34	06-Oct-09	21.44	9.5	5.1	30 Sep - 1 Oct	1.23	0.54	Ketsana Storm
019803	Kompong Cham	09-Jul-09	7.05	19-Jul-09	12.75	10	5.7	16 Jul - 17 Jul	0.92	0.57	
		29-Jul-09	12.28	06-Aug-09	14.2	8	1.92	3 Aug - 4 Aug	0.36	0.24	
		31-Aug-09	11.08	12-Sep-09	14.05	12	2.97	10 Sep - 11 Sep	0.45	0.25	
		27-Sep-09	11.72	07-Oct-09	15.16	10	3.44	30 Sep - 1 Oct	0.67	0.34	Ketsana Storm

Table A5: The characteristics of flood events for stations from Phnom Penh Bassac/Phnom Penh Port to Kon Khel/Neak Luong

ID	Station	Beginning of flood event		Peak of flood event		Remaining Time	Flood Amplitude	Intensity of Flood Rising			Comment
		Date	H_B (m)	Date	H_P (m)	ΔT (day)	ΔH (m)	Appearence time of I_{max}(day)	I_{max} (m/day)	$I_{Average}$ (m/day)	
020101	Phnom Penh Port	08-Jul-09	3.36	20-Jul-09	6.51	12	3.15	18 Jul - 19 Jul	0.56	0.26	
		30-Jul-09	6.51	07-Aug-09	7.63	8	1.12	3 Aug - 4 Aug	0.21	0.14	
		31-Aug-09	7.03	13-Sep-09	8.23	13	1.2	10 Sep - 11 Sep	0.28	0.09	
		27-Sep-09	7.96	09-Oct-09	9.03	12	1.07	30 Sep - 1 Oct	0.23	0.09	Ketsana Storm
033401	PhnomPenh Bassac	08-Jul-09	4.27	20-Jul-09	7.4	12	3.13	18 Jul - 19 Jul	0.51	0.26	
		30-Jul-09	7.49	07-Aug-09	8.61	8	1.12	3 Aug - 4 Aug	0.21	0.14	
		31-Aug-09	7.96	13-Sep-09	9.02	13	1.06	10 Sep - 11 Sep	0.26	0.08	
		27-Sep-09	8.75	10-Oct-09	9.92	13.5	1.17	30 Sep - 1 Oct	0.22	0.09	Ketsana Storm
033402	Koh Khel	08-Jul-09	3.9	19-Jul-09	6.5	11	2.6	17 Jul - 18 Jul	0.44	0.24	
		30-Jul-09	6.46	07-Aug-09	7.09	8	0.63	3 Aug - 4 Aug	0.14	0.08	
		31-Aug-09	6.57	13-Sep-09	7.16	13	0.59	10 Aug - 11 Aug	0.1	0.05	
		27-Sep-09	6.96	09-Oct-09	7.53	12.5	0.57	2 Oct - 3 Oct	0.07	0.05	Ketsana Storm
019806	Neak Luong	08-Jul-09	2.74	20-Jul-09	5.24	12	2.5	17 Jul - 18 Jul	0.43	0.21	
		30-Jul-09	5.29	07-Aug-09	6.08	8.5	0.79	2 Aug - 3 Aug	0.16	0.09	
		30-Aug-09	5.69	14-Sep-09	6.44	15	0.75	8 Sep - 9 Sep	0.14	0.05	
		27-Sep-09	6.24	10-Oct-09	7.23	13.5	0.99	7 Oct - 8 Oct	0.13	0.07	Ketsana Storm
020102	Prek Dam	08-Jul-09	3.38	20-Jul-09	6.16	12.5	2.78	16 Jul - 17 Jul	0.48	0.22	
		29-Jul-09	6.33	10-Aug-09	7.32	11.5	0.99	3 Aug - 4 Aug	0.16	0.09	
		30-Aug-09	7.11	14-Sep-09	8.08	14.5	0.97	11 Aug - 12 Aug	0.14	0.07	
		26-Sep-09	7.97	10-Oct-09	9.06	14	1.09	30 Sep - 1 Oct	0.18	0.08	Ketsana Storm

Table A6: The characteristics of flood events for stations from Tan Chau and Chau Doc (**)

ID	Station	Beginning of flood event		Peak of flood event		Remaining Time	Flood Amplitude	Intensity of Flood Rising			Comment
		Date	H_B (m)	Date	H_P (m)	ΔT (day)	ΔH (m)	Appearence time of I_{max}(day)	I_{max} (m/day)	$I_{Average}$ (m/day)	
019803	Tan Chau	10-Jul-09	0.83	20-Jul-09	2.41	10	1.58	18 Jul - 19 Jul	0.22	0.16	
		30-Jul-09	2.42	19-Aug-09	3.17	20	0.75	1 Aug - 2 Aug 3 Aug - 4 Aug	0.08	0.04	
		06-Sep-09	2.93	19-Sep-09	3.45	13	0.52	10 Sep - 11 Sep	0.07	0.04	
		29-Sep-09	3.29	12-Oct-09	4.09	13	0.8	30 Sep - 1 Oct 3 Oct - 4 Oct 6 Oct - 7 Oct	0.09	0.06	Ketsana Storm
039801	Chau Doc	10-Jul-09	0.38	21-Jul-09	1.88	11	1.5	17 Jul - 18 Jul	0.26	0.14	
		30-Jul-09	1.83	19-Aug-09	2.59	20	0.76	31 Jul - 1 Aug	0.08	0.04	
		07-Sep-09	2.41	19-Sep-09	2.93	12	0.52	14 Sep - 15 Sep	0.07	0.04	
		29-Sep-09	2.77	16-Oct-09	3.52	17	0.75	6 Oct - 7 Oct	0.09	0.04	Ketsana Storm

(**) Water levels at Tan Chau and Chau Doc are influenced by tidal, the WL in the table A6 were recorded at 7AM during 2009 flood season.

Annex B: Accuracy and performance

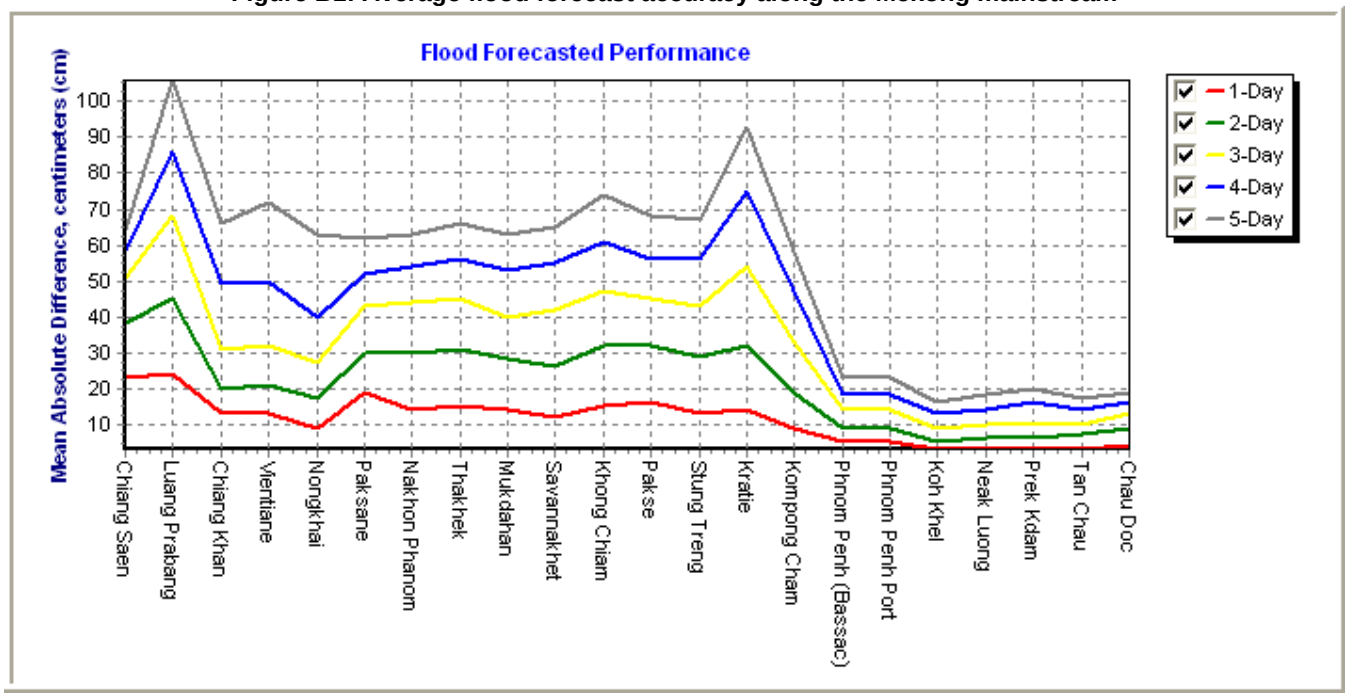
Accuracy

"Accuracy" describes the accuracy of the adjusted and published forecast, based on the results of the MRC Mekong Flood Forecasting System, which are then adjusted by the Flood Forecaster in Charge taking into consideration known biases in input data and his/her knowledge of the response of the model system and the hydrology of the Mekong River Basin.

The information is presented as a graph below, showing the average flood forecasting accuracy along the Mekong mainstream.

The graph of average difference between forecast and actual water levels for the past week shows the normal pattern.
In general the overall accuracy falls inside the average ranges for 1-day to 3-day forecasts lead time. The forecast accuracy at Kratie was less than expected. The detail analysis is presented in paragraph 2.2.

Figure B1: Average flood forecast accuracy along the Mekong mainstream



Forecast Achievement

The forecast achievement indicates the % of days that the forecast at a particular station for a lead-time is successful against a respective benchmark (Table B2).

Table B1: Achievement of daily forecast against benchmarks

unit in %

	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nongkhai	Paksane	Nakhon Phanom	Thakhek	Mukdahan	Savannakhet	Khong Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Phnom Penh (Bassac)	Phnom Penh Port	Koh Khel	Neak Luong	Prek Kdam	Tan Chau	Chau Doc	***Average***
1-day	90.1	90.8	88.2	88.8	96.1	79.6	83.6	83.6	88.8	88.8	83.6	83.6	52.6	52.6	74.3	87.5	88.2	98.0	96.1	96.1	94.7	88.2	***85.2***
2-day	93.4	84.1	73.5	74.8	79.5	61.6	80.1	79.5	83.4	84.8	81.5	80.1	53.0	55.0	74.8	71.5	70.2	90.1	82.1	83.4	82.1	77.5	***77.1***
3-day	80.7	80.7	78.0	83.3	90.7	70.7	68.0	70.0	70.7	70.7	82.7	81.3	60.7	58.7	44.7	47.3	54.0	76.7	64.7	64.0	73.3	68.0	***70.0***
4-day	85.9	77.9	80.5	60.4	71.8	62.4	62.4	61.1	76.5	74.5	73.8	79.2	56.4	39.6	61.1	79.2	80.5	87.9	51.0	80.5	55.0	55.7	***68.8***
5-day	78.4	79.1	63.5	62.8	72.3	73.0	68.2	66.9	68.9	66.9	64.9	72.3	52.7	33.1	51.4	67.6	66.9	78.4	37.2	75.0	48.0	39.2	***63.0***

Table B2: Benchmarks of success (Indicator of accuracy in mean absolute error)

Unit in cm

	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nongkhai	Paksane	Nakhon Phanom	Thakhek	Mukdahan	Savannakhet	Khong Chiam	Pakse	Stung Treng	Kratie	Kompong Cham	Phnom Penh (Bassac)	Phnom Penh Port	Koh Khel	Neak Luong	Prek Kdam	Tan Chau	Chau Doc
1-day	50	50	25	25	25	25	25	25	25	25	25	25	10	10	10	10	10	10	10	10	10	10
2-day	75	75	25	25	25	25	50	50	50	50	50	50	25	25	25	10	10	10	10	10	10	10
3-day	75	100	50	50	50	50	50	50	50	50	75	75	50	50	25	10	10	10	10	10	10	10
4-day	100	*125*	75	50	50	50	50	50	75	75	75	75	50	50	50	25	25	25	10	25	10	10
5-day	100	*150*	75	75	75	75	75	75	75	75	75	75	50	50	50	25	25	25	10	25	10	10

Note: *An indication of the accuracy given in the Table B2 is based on the performance of the forecast made in 2008 from the new flood forecasting system and the configuration for the 2009 flood season and is published on the website of MRC (http://ffw.mrcmekong.org/accuracy.htm).*

In the future these indicators will be adjusted against a set of performance indicators that is established by combining international standards and the specific circumstances in the Mekong River Basin. An expert mission to establish these performance indicators and future benchmarks was conducted in the fourth quarter of 2009 and the result of the mission will be presented to the MRC member countries during a regional consultation meeting in the first quarter of 2010.

Performance

Performance is assessed by evaluating a number of performance indicators, see table and graphs below:

Table B3: Overview of performance indicators for flood season 2009 from June to October

	Flood Forecast: time sent				Arrival time of input data (average)							Missing data (number)						
2009	FF completed and sent (time)	stations without forecast	FF2 completed and sent (time)	Weather information available (number)	NOAA data	China	Cambodia - DHRW	Cambodia - DOM	Lao PDR - DMH	Thailand - DWR	Viet Nam - NCHMF	NOAA data	China	Cambodia - DHRW	Cambodia - DOM	Lao PDR - DMH	Thailand - DWR	Viet Nam - NCHMF
June	10:50	13	0	09:20	08:20	08:22	08:10	08:16	09:04	08:18	07:24	30	16	30	30	7	0	2
July	10:45	12	2	08:31	08:28	08:28	08:13	08:19	08:36	08:38	08:10	31	31	31	31	31	31	31
August	10:14	1	1	09:09	08:18	08:20	07:53	08:24	08:34	08:15	08:02	31	31	31	31	31	31	30
September	10:08	7	2	09:00	08:16	08:21	07:49	08:39	08:29	08:23	08:07	30	30	30	30	30	30	30
October	10:20	0	0	08:13	08:15	08:20	08:06	08:00	08:47	08:08	07:52	31	15	31	30	31	31	31
Season	**10:27**	**33**	**5**	**08:47**	**08:19**	**08:23**	**08:02**	**08:19**	**08:42**	**08:20**	**07:55**	**153**	**123**	**153**	**152**	**130**	**123**	**124**

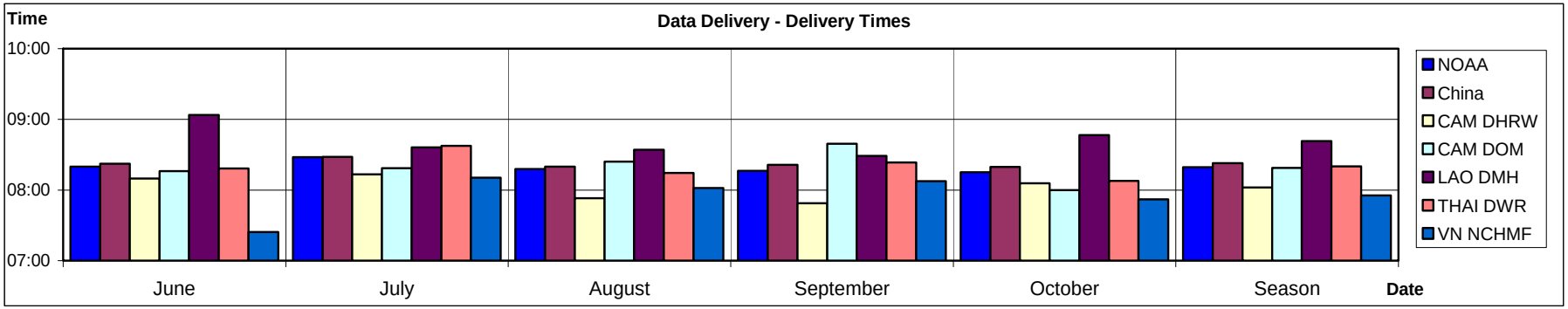


Figure B2: Data delivery times for flood season 2009 from June to October

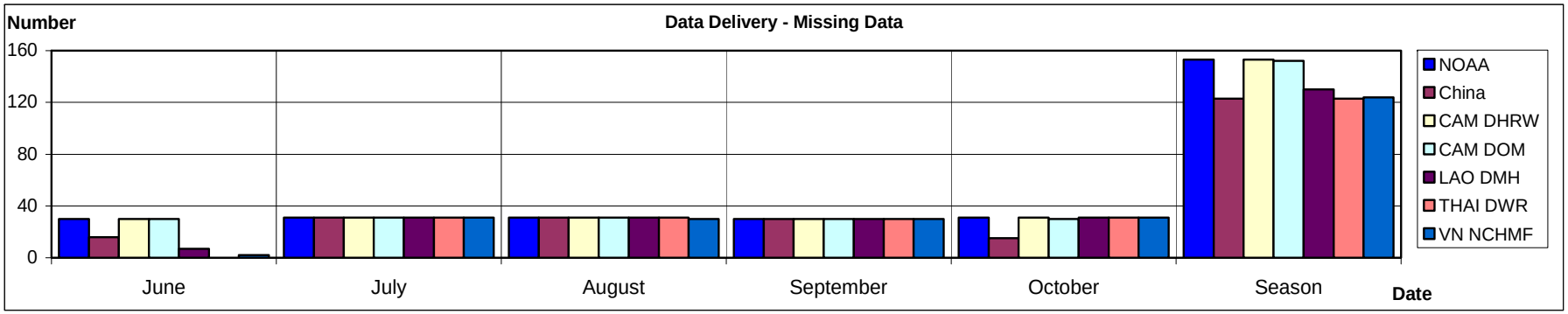


Figure B3: Missing data for flood season 2009 from June to October

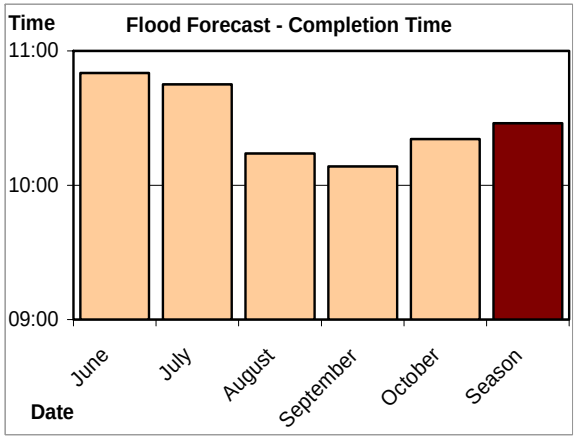


Figure B4: Flood forecast completion time

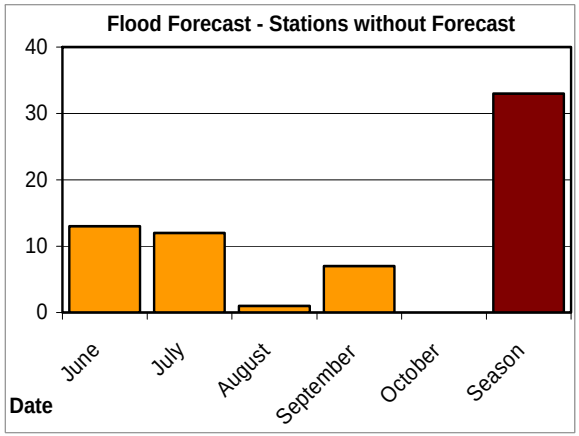


Figure B5: Flood forecast stations without forecast

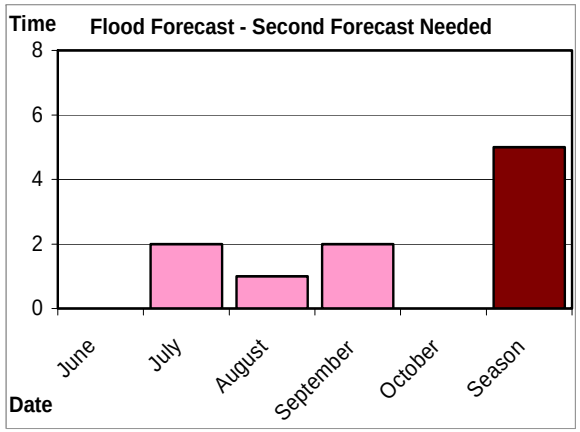


Figure B6: Second forecast needed

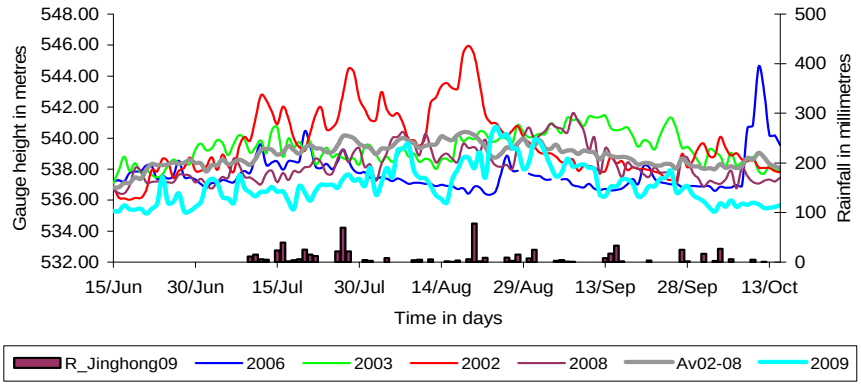
Annex C: Season Water Level Graphs

This Annex has the water level and rainfall graphs of the report date. These graphs are distributed daily by email together with the Flood Bulletins.

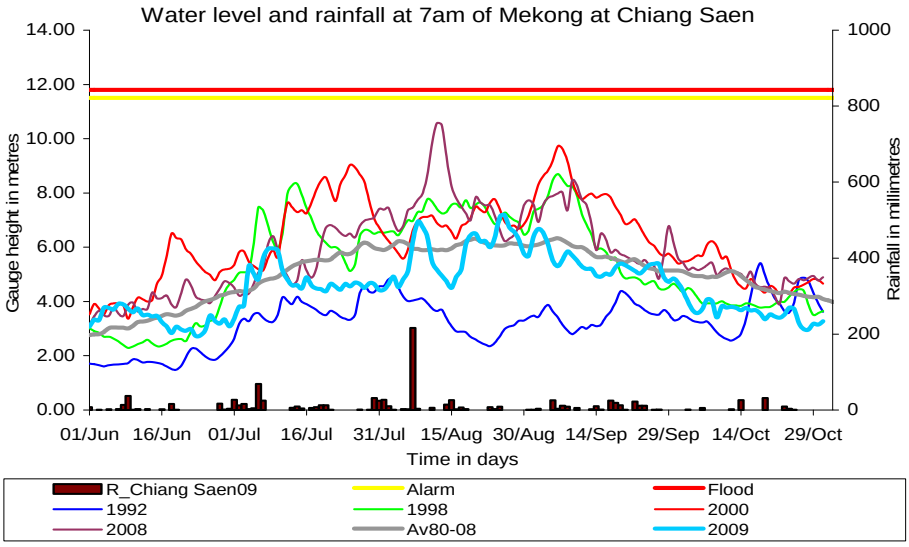
HYDROGRAPHS OF THE MEKONG AT MAINSTREAM STATIONS

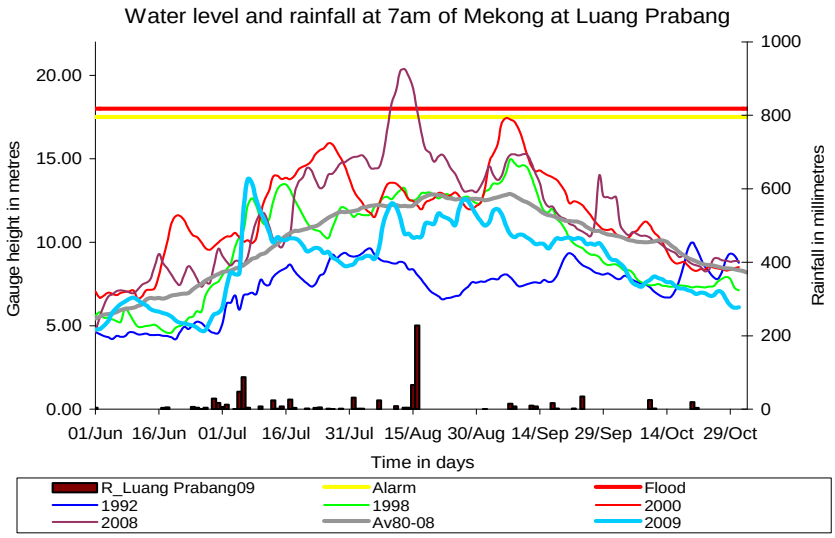
IN FLOOD SEASON FROM 1 JUNE TO 31 OCTOBER

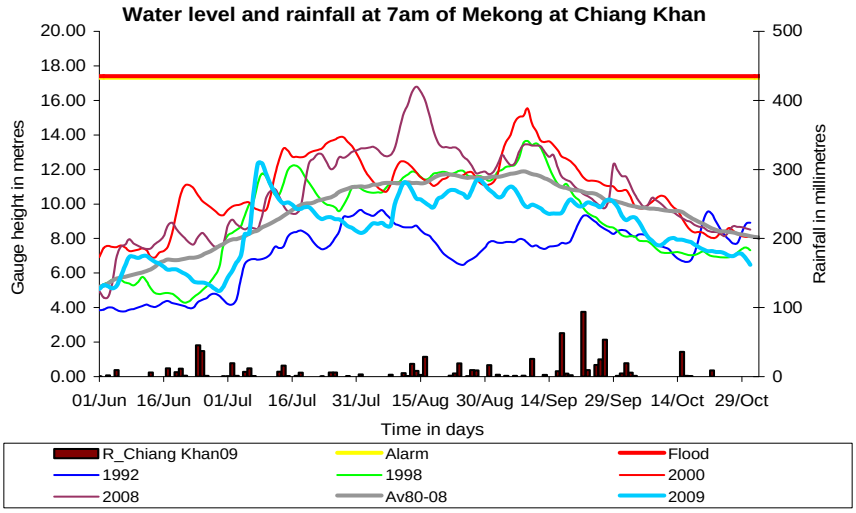
Water level and rainfall at 7am of Mekong at Jinghong

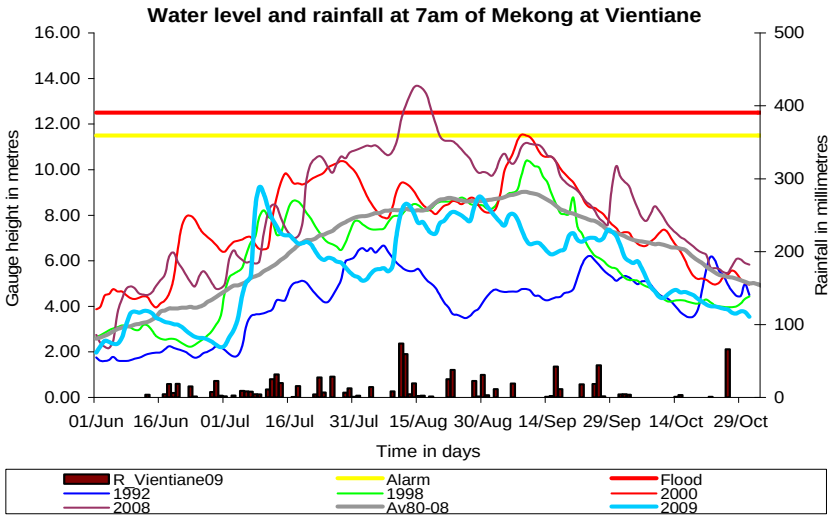


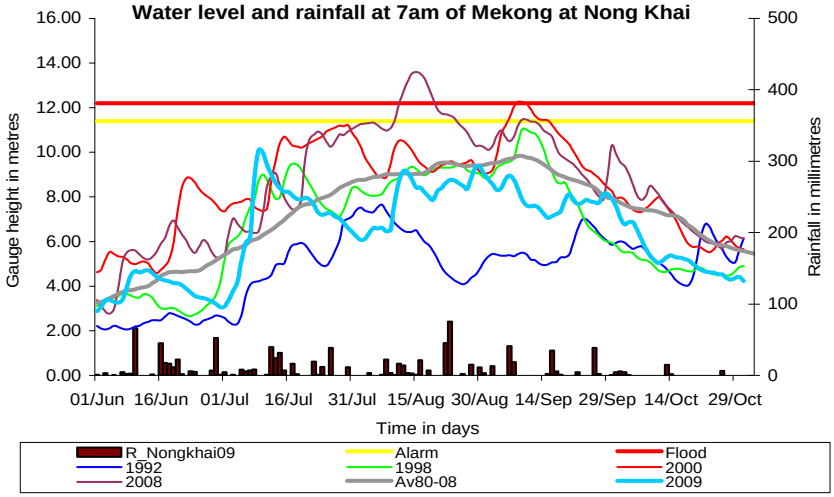
Water level and rainfall at 7am of Mekong at Chiang Saen

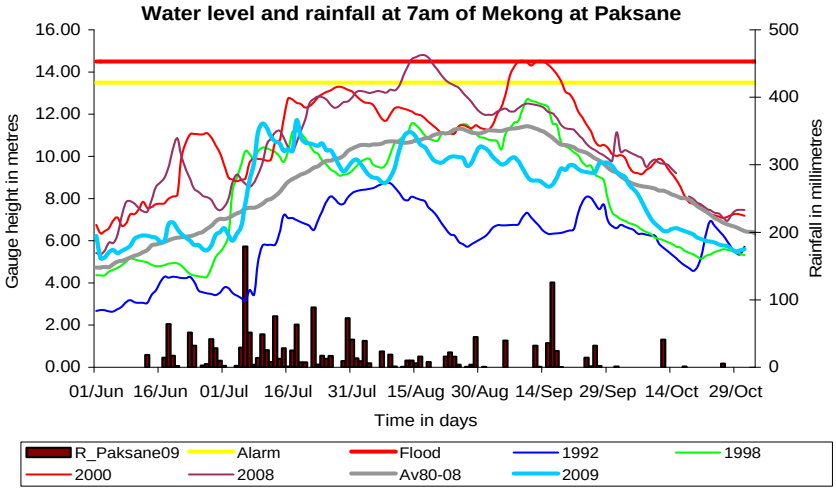


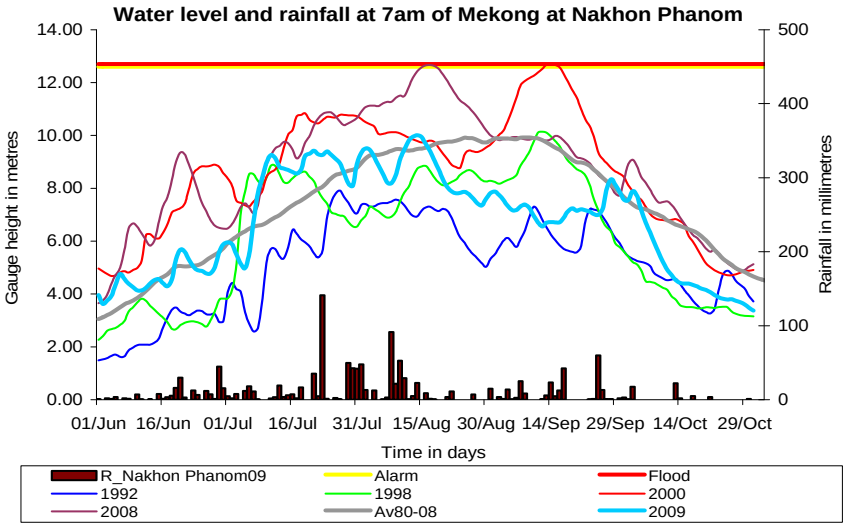

Water level and rainfall at 7am of Mekong at Luang Prabang
Gauge height in metres
Rainfall in millimetres
20.00
15.00
10.00
5.00
0.00
1000
800
600
400
200
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Luang Prabang09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

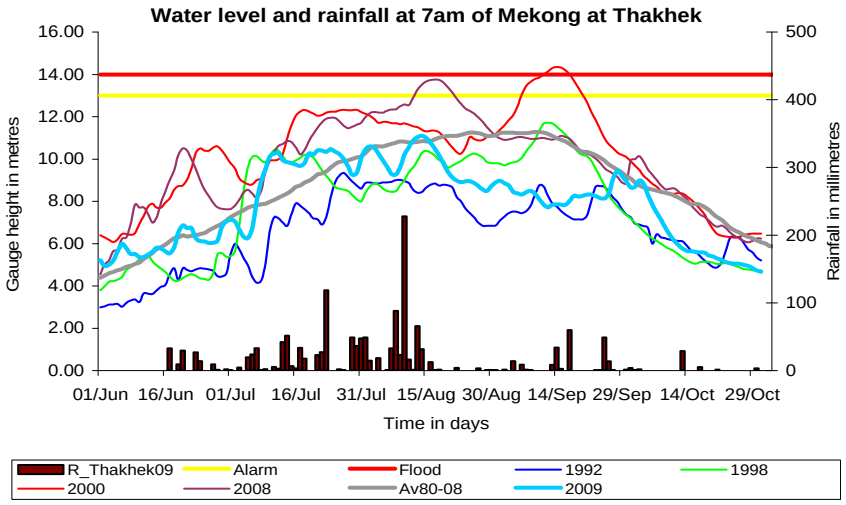

Water level and rainfall at 7am of Mekong at Chiang Khan
Gauge height in metres
Rainfall in millimetres
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Chiang Khan09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

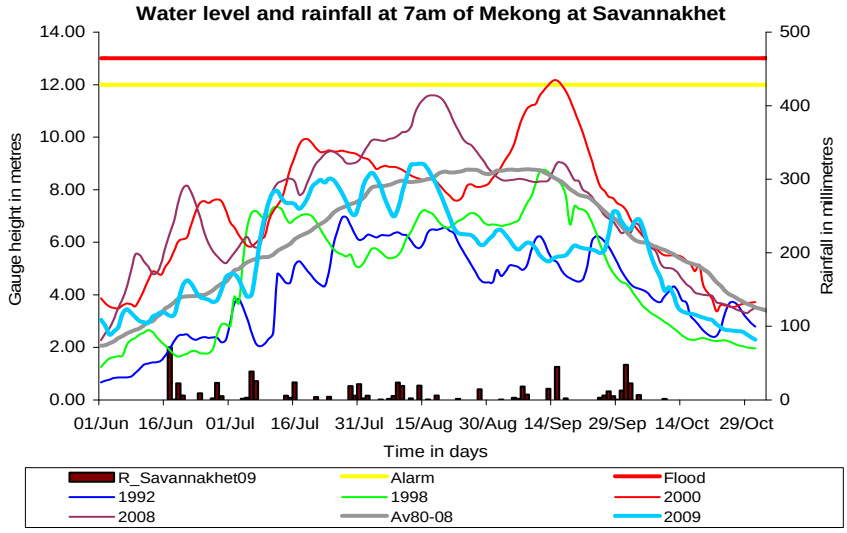

Water level and rainfall at 7am of Mekong at Vientiane
Gauge height in metres
Rainfall in millimetres
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Vientiane09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

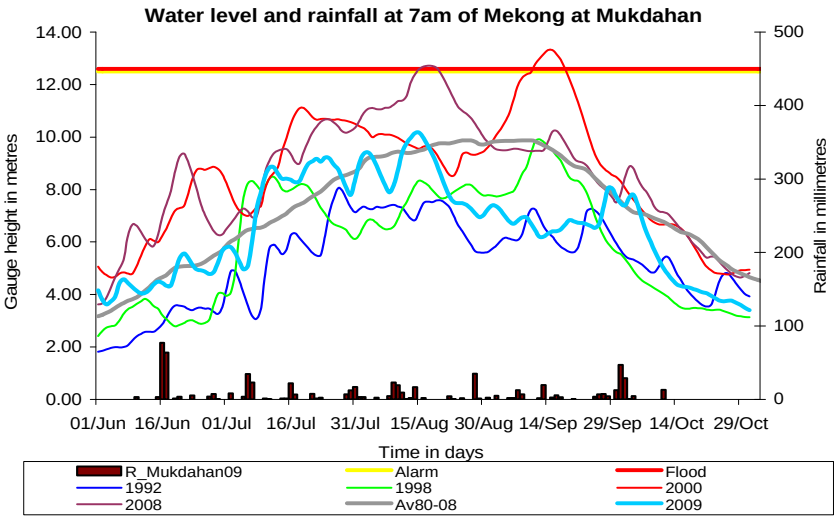

Water level and rainfall at 7am of Mekong at Nong Khai
Gauge height in metres
Rainfall in millimetres
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Nongkhai09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

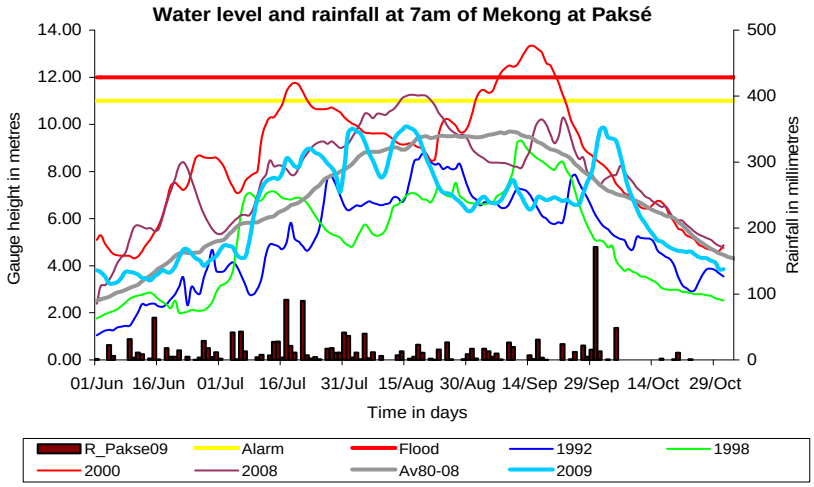

Water level and rainfall at 7am of Mekong at Paksane
Gauge height in metres
Rainfall in millimetres
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Paksane09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

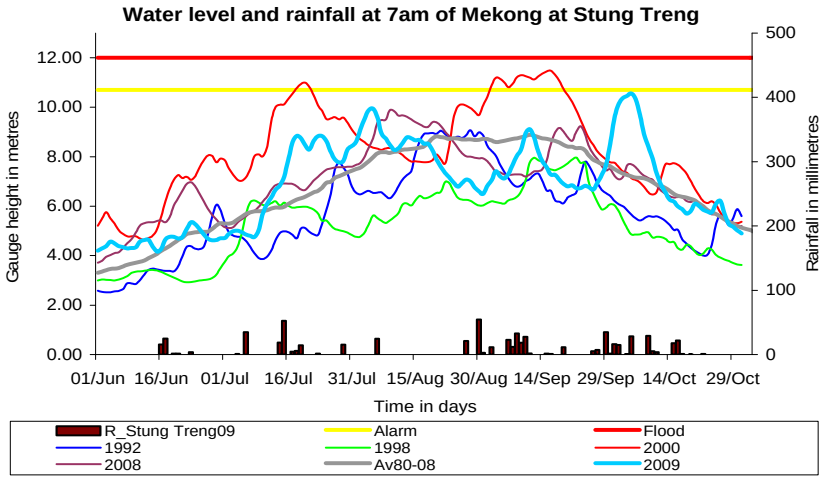

Water level and rainfall at 7am of Mekong at Nakhon Phanom
Gauge height in metres
Rainfall in millimetres
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Nakhon Phanom09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

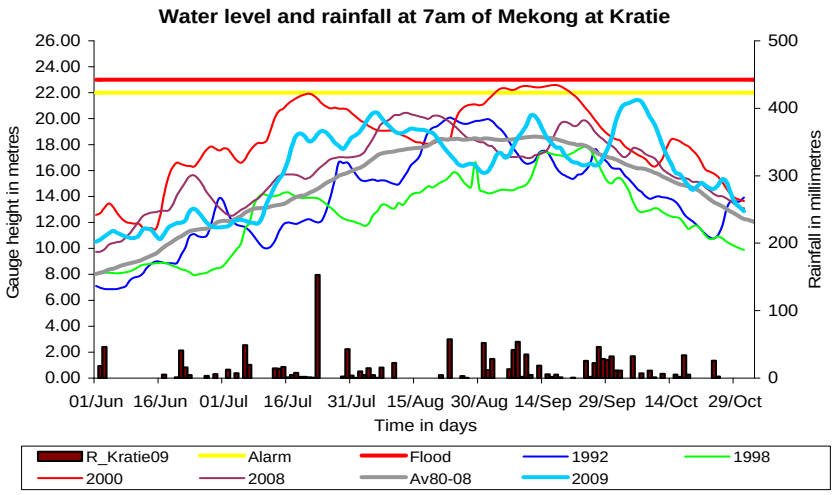

Water level and rainfall at 7am of Mekong at Thakhek
Gauge height in metres
Rainfall in millimetres
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Thakhek09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

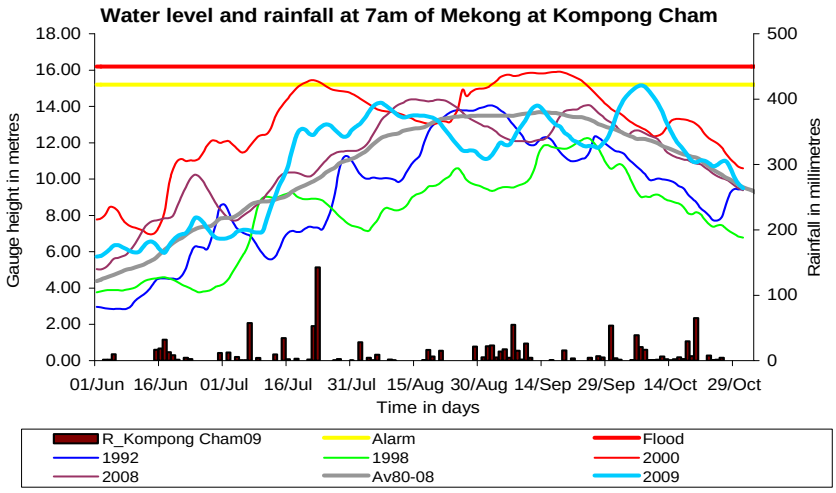

Water level and rainfall at 7am of Mekong at Savannakhet
Gauge height in metres
Rainfall in millimetres
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Savannakhet09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

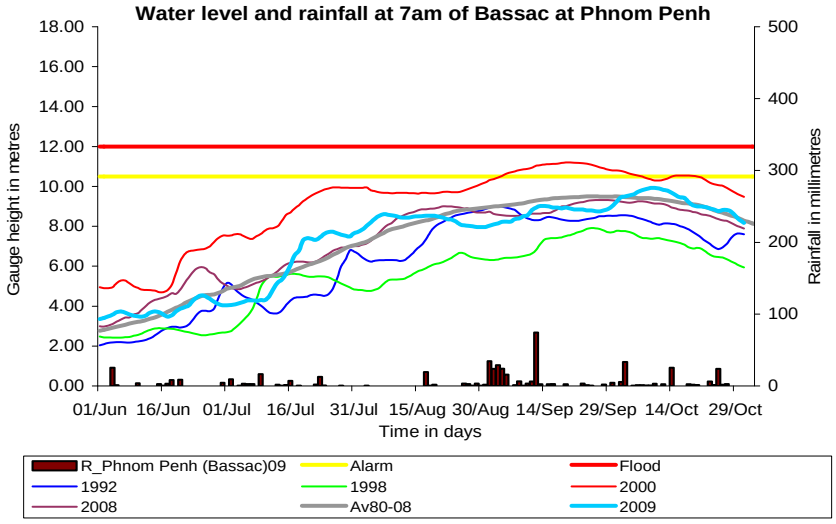

Water level and rainfall at 7am of Mekong at Mukdahan
Gauge height in metres
Rainfall in millimetres
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Mukdahan09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

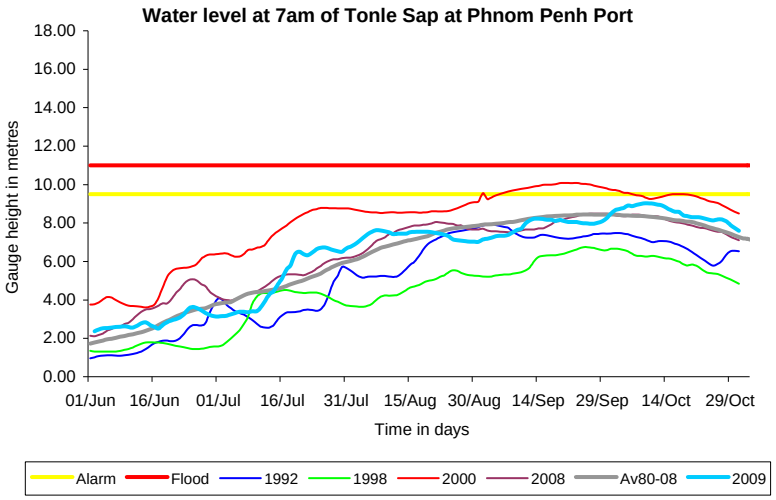

Water level and rainfall at 7am of Mekong at Paksé
Gauge height in metres
Rainfall in millimetres
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Pakse09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

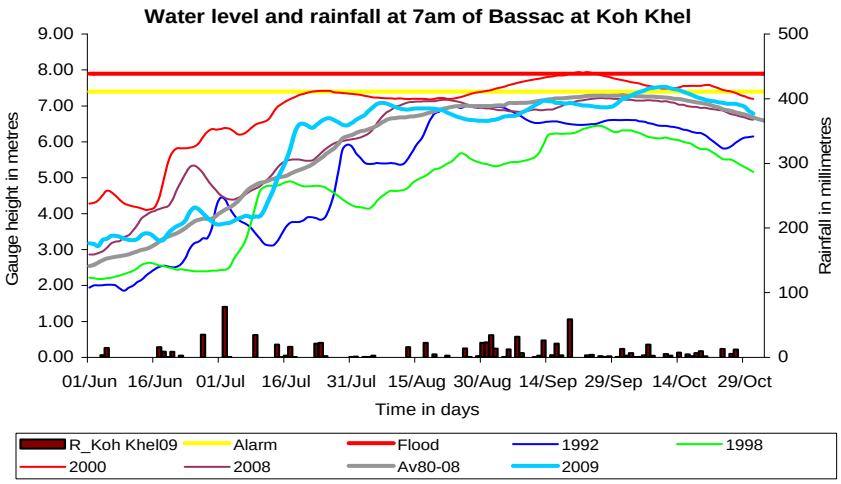

Water level and rainfall at 7am of Mekong at Stung Treng
Gauge height in metres
Rainfall in millimetres
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Stung Treng09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

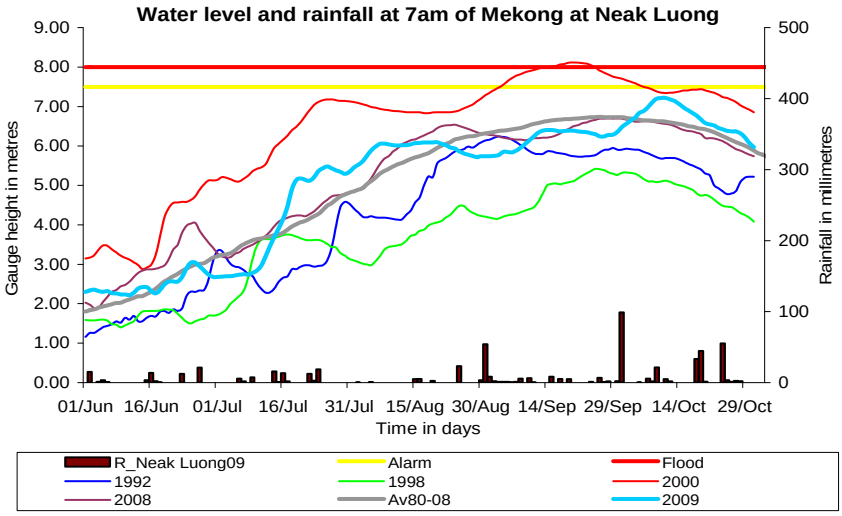

Water level and rainfall at 7am of Mekong at Kratie
Gauge height in metres
Rainfall in millimetres
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Kratie09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

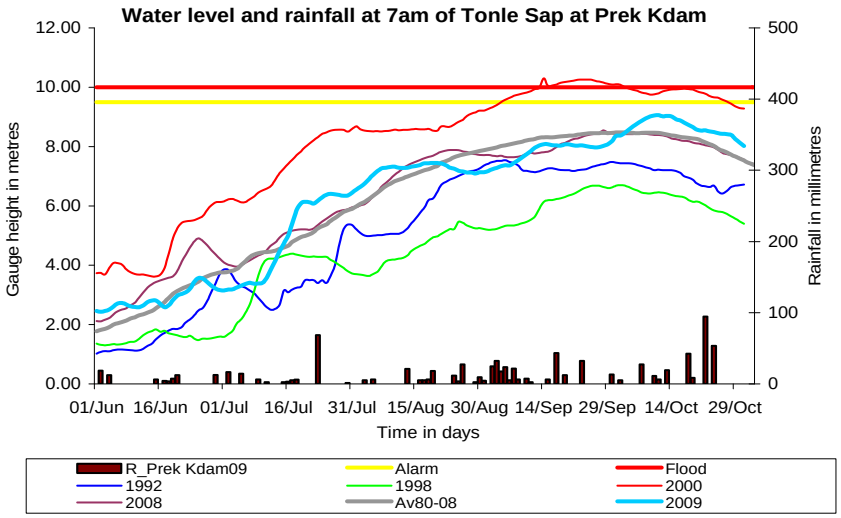

Water level and rainfall at 7am of Mekong at Kompong Cham
Gauge height in metres
Rainfall in millimetres
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Kompong Cham09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

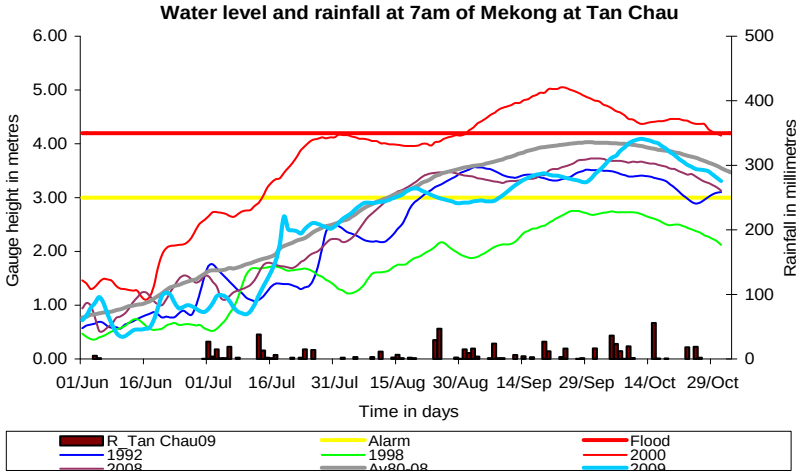

Water level and rainfall at 7am of Bassac at Phnom Penh
Gauge height in metres
Rainfall in millimetres
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Phnom Penh (Bassac)09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009

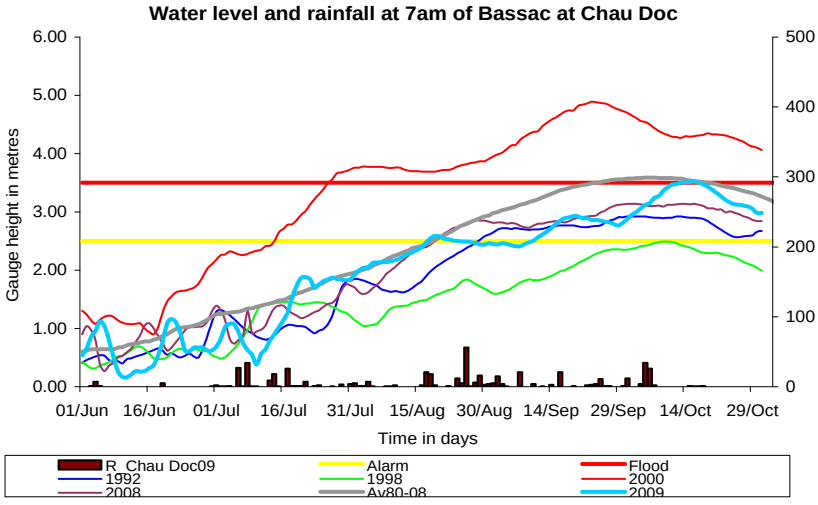

Water level at 7am of Tonle Sap at Phnom Penh Port
Gauge height in metres
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
Alarm Flood 1992 1998 2000 2008 Av80-08 2009


Water level and rainfall at 7am of Bassac at Koh Khel
Gauge height in metres
Rainfall in millimetres
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Koh Khel09 Alarm Flood 1992 1998
2000 2008 Av80-08 2009


Water level and rainfall at 7am of Mekong at Neak Luong
Gauge height in metres
Rainfall in millimetres
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Neak Luong09 Alarm Flood
1992 1998 2000
2008 Av80-08 2009


Water level and rainfall at 7am of Tonle Sap at Prek Kdam
Gauge height in metres
Rainfall in millimetres
12.00
10.00
8.00
6.00
4.00
2.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Prek Kdam09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009


Water level and rainfall at 7am of Mekong at Tan Chau
Gauge height in metres
Rainfall in millimetres
6.00
5.00
4.00
3.00
2.00
1.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Tan Chau09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009


Water level and rainfall at 7am of Bassac at Chau Doc
Gauge height in metres
Rainfall in millimetres
6.00
5.00
4.00
3.00
2.00
1.00
0.00
500
400
300
200
100
0
01/Jun 16/Jun 01/Jul 16/Jul 31/Jul 15/Aug 30/Aug 14/Sep 29/Sep 14/Oct 29/Oct
Time in days
R_Chau Doc09
Alarm
Flood
1992
1998
2000
2008
Av80-08
2009