Mekong River Commission

Flood Management and Mitigation Programme

Seasonal Flood Situation Report for the Lower Mekong River Basin

Covering the period from 1st June to 31rd October 2015

(Final)

Prepared by:

Regional Flood Management and Mitigation Centre

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Seasonal Flood Situation Report for the Lower Mekong River Basin
Cover the period from 1st June to 31st October 2015

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1. INTRODUCTION

While annual floods have the potential to wreak havoc on unprepared communities, spoil crops and endanger food security, whereas they play a vital role in agriculture, while the annual flood pulses also contribute to the world-renowned productivity of the Mekong freshwater fisheries.

As part of the implementation of the Strategic Plan 2011-2015, the MRC Flood Management and Mitigation Programme (FMMP), like in previous years, supported the Regional Flood Management and Mitigating Centre (RFMMC)'s Mission by minimising the negative flood-related impacts while preserving the environmental and other benefits. The Phnom Penh-based RFMMC has helped the four MRC Member Countries to reduce negative impacts of flooding through the dissemination of daily flood forecasting and (when applicable) early warning information.

During the 2015 flood season, from June to October, the RFMMC issued daily flood forecasts and early warning information during critical situations. Rainfall and/or water level data were collected from 169 hydro-meteorological stations (these include manual and automatic stations, like the HYCOS and AHNIP stations) and were used to forecast water levels at 22 mainstream stations (forecast points) on the Mekong River system. The FMMP communicates these daily bulletins by fax, e-mail, and on the flood pages of the MRC website to the National Mekong Committees, Non-Governmental Organisations, the media and, most importantly, the general public. The RFMMC's daily information provides government agencies and communities in Lao PDR, Cambodia, Thailand and Viet Nam with advanced notice of rising and falling water levels. Through online postings, radio communication, dissemination of guidebooks as well as workshops, FMMP strives to reach a wide audience throughout the entire Mekong Basin.

This report is produced by the RFMMC's flood forecasting team in analysing and verifying the summaries of rainfall and water levels, the general behaviour of the flood situation, the accuracy and limitation of flood forecast operation for the Lower Mekong Basin (LMB) in the 2015 flood season.

Note: The following definition is used in the different parts of the Lower Mekong Basin:

- *Upper part : from Chiang Saen to Paksane*
- *Middle part : from Nakhon Phanom to Pakse*
- *Downstream part : from Stung Treng to Tan Chau / Chau Doc*

The downstream part is further subdivided into three sections:

Section a: from Stung Treng to Kampong Cham

Section b: from Phnom Penh Bassac Chaktomuk / Phnom Penh Port to Neak Luong

Section c: At Tan Chau and at Chau Doc

The data used for the analyses in this report is including:

- *Manually observed rainfall and water level data refer to mainstream stations only.*
- *Manually observed daily data that is transferred by Line Agencies via the Hydmet tool during the flood season, and;*
- *The Long Term Average (LTA), which is calculated based on the observed water levels during the period 2000 - 2015.*

2. FLOOD SEASON 2015

2.1 Rainfall situation

During the five months of the flood season 2015, the critical rainfall situation in the Lower Mekong Basin was concentrated in the months of August and September, and was caused by the combined influences of the Southwest Monsoons (SWs), Low Pressure Troughs (LPTs), Inter Tropical Convergence Zone (ITCZs), Storm and Typhoon's appearances in the East Sea.

In terms of total seasonal rainfall, the general picture in 2015 in the mainstream stations along LMB was lower than average; in particular the total rainfall recorded was less than in the flood season 2014; it was in the upper part 130mm less, in the middle part 630mm less, and in the downstream part 320mm less. (See Table 2-1).

The spatial and temporal variations of rainfall were 'high', indicating that the intensity of heavy rainfall situations along the LMB from upstream to downstream took place as a function of time. Table 2-1 shows the distribution of 'monthly rainfall means' in the three parts of LMB for flood seasons 2000 - 2015; compared to the long term average (LTA) the percentage of 'monthly rainfall mean' in the 2015 flood season in all of part of LMB was 7.7%, 25.6% and 9.7% lower in the upper, middle and downstream part respectively. Table 2-2 illustrates the total rainfall in the three parts of the LMB.

By the spatial, in the 2015 flood season was smaller than the LTA flood season. However, compared to 2014 flood season, the total rainfall at Upper and Middle part was smaller while at downstream was higher.

Table 2-1 The average monthly rainfall in the flood seasons 2000-2015.

Unit: mm

Year	Upper part					Middle part					Downstream part				
	Jun	Jul	Aug	Sep	Oct	Jun	Jul	Aug	Sep	Oct	Jun	Jul	Aug	Sep	Oct
2000	417.90	210.70	312.87	286.23	71.87	318.33	434.60	399.63	311.76	86.20	210.67	164.80	259.62	158.62	236.30
2001	234.17	287.62	474.25	268.45	142.00	451.00	380.30	566.35	319.15	98.92	155.39	102.24	254.49	176.93	362.34
2002	290.69	273.90	463.43	332.45	78.43	518.13	599.87	426.60	339.72	71.04	182.09	118.47	184.13	195.01	142.48
2003	363.05	219.04	302.72	359.05	24.12	226.93	222.35	413.80	276.50	20.30	107.78	255.25	174.47	177.22	187.35
2004	240.20	250.80	331.13	282.17	56.40	266.58	408.97	541.58	405.32	2.45	181.60	125.32	188.16	224.13	198.13
2005	424.98	228.16	368.18	339.28	40.50	303.47	520.68	491.53	294.98	26.00	127.59	259.91	158.27	272.33	270.00
2006	163.92	285.46	381.55	175.13	181.68	174.98	625.56	472.60	342.77	208.50	108.37	181.92	218.35	220.63	255.27
2007	291.38	123.72	337.72	316.57	156.42	264.86	279.74	371.61	111.32	285.40	124.04	147.57	197.05	180.68	210.82
2008	408.28	241.66	284.63	240.37	140.13	393.85	333.05	406.18	183.20	107.33	115.03	80.31	205.79	302.38	234.34
2009	176.93	226.34	295.72	223.88	72.23	213.58	394.58	310.75	339.23	65.35	81.82	189.59	138.83	249.13	204.29
2010	255.47	258.20	561.97	330.88	98.35	188.73	246.90	504.20	257.60	191.65	166.51	149.93	208.71	177.19	337.54
2011	285.32	349.12	438.93	402.33	78.90	352.95	504.92	568.68	209.75	123.73	167.60	184.31	254.62	253.08	119.80
2012	216.23	236.30	253.95	164.10	68.72	215.45	352.98	295.50	424.55	28.18	86.17	253.38	128.33	274.51	138.74
2013	214.37	296.44	388.67	315.02	89.18	232.78	489.83	242.43	245.72	105.55	192.09	226.90	196.93	261.82	206.82
2014	299.05	366.30	352.75	337.93	33.67	506.53	626.28	394.47	445.58	40.10	175.12	245.08	130.63	204.88	212.53
2015	**129.87**	**288.90**	**371.52**	**258.77**	**100.98**	**89.90**	**408.52**	**322.22**	**216.87**	**79.38**	**118.80**	**120.67**	**179.40**	**245.17**	**195.87**
P%	-52.877	11.58	1.0384	-10.628	12.22	-69.843	-4.0778	-22.781	-14.18	-17.298	-15.263	-29.658	-3.1558	8.5753	-9.2118
Mean defected P (%)	**-7.73%**					**-25.64%**					**-9.74%**				

Table 2-2 Average total rainfall in Upper, Middle and Downstream part in flood season 2015.

Year	Upper part	Middle Part	Downstream
2000	1370.02	1557.92	184.08
2001	1478.25	1819.80	472.90
2002	1523.29	1880.30	737.22
2003	1350.77	1285.32	607.81
2004	1222.48	1513.75	559.74
2005	1486.05	1684.45	506.74
2006	1323.90	1298.30	816.30
2007	1320.47	1154.01	656.36
2008	1460.18	1579.65	860.17
2009	1128.45	1241.87	925.07
2010	1565.03	1341.23	863.67
2011	1628.40	1974.83	1039.89
2012	983.38	1137.83	979.41
2013	1403.62	1516.18	881.13
2014	1446.87	1784.25	1084.57
2015	**1313.90**	**1152.72**	**968.24**
Average	**1375.32**	**1495.15**	**758.96**

Note: The value of the accumulated rainfall is given for the mainstream stations only.

Figure 2-1 shows the manually observed accumulated rainfall distribution in the LMB of the 2015 flood season (includes mainstream and tributary stations).

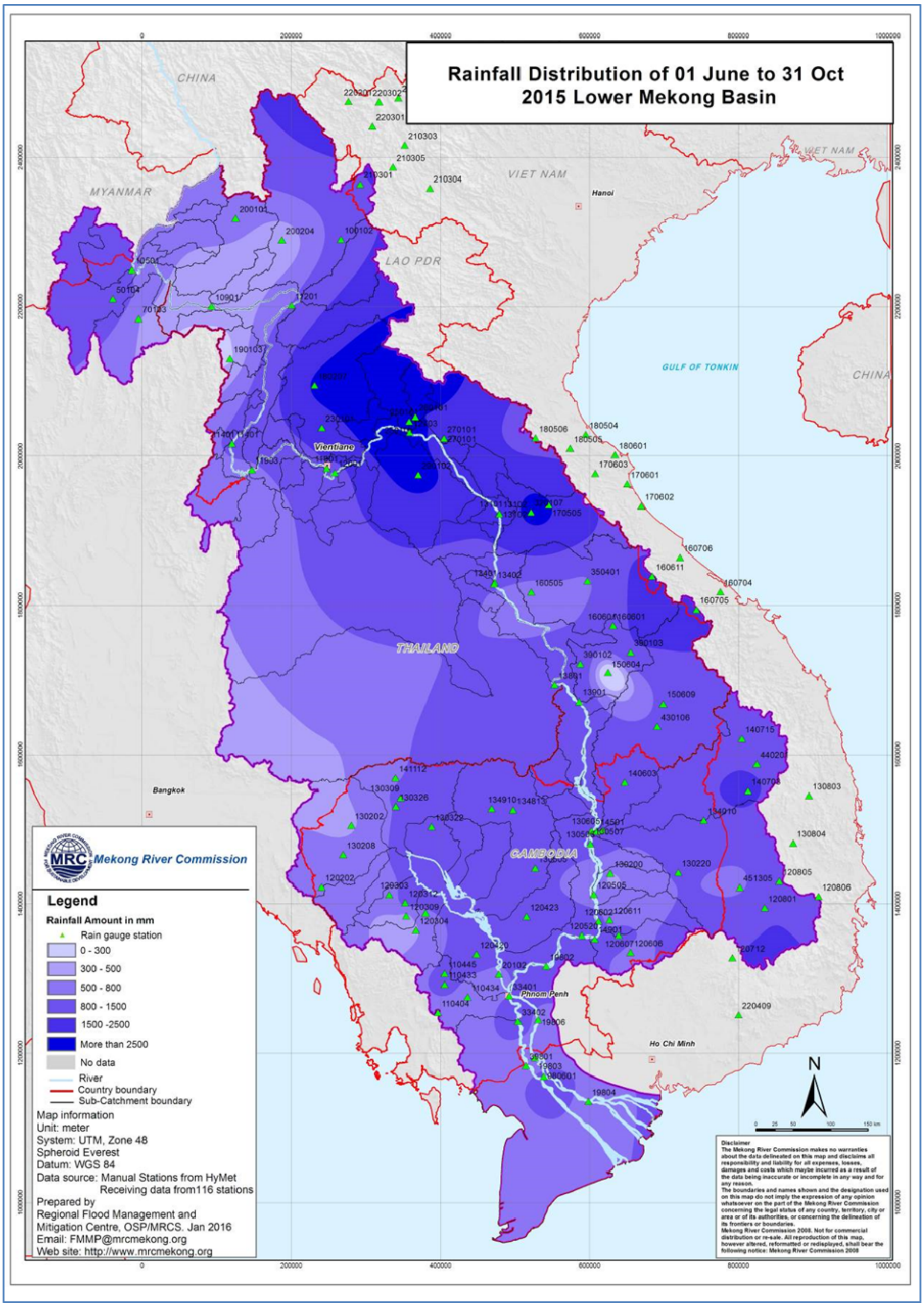


Figure 2-1 Rainfall Distribution from 01 June to 31 October 2015 in the Lower Mekong Basin.

Tropical Low Pressure (TLP) and Inter Tropical Convergence Zone (ITCZ):

The TLP and ITCZ periodically appeared from early July to the mid of October with on average 3 to 7 days duration. In the flood season 2015, the frequent appearances of these phenomena during almost the entire flood season were the main cause of continuous heavy rainfall and rising waters along the Mekong River. In July and August, TLP and ITCZ were observed and had significant influence on the upper and middle parts of the LMB, while the influence on the downstream part took place mostly in September and October. Figure 2-2 shows an illustration of the appearances and influences of TLP and ITCZ to the LMB on 31 July 2015.

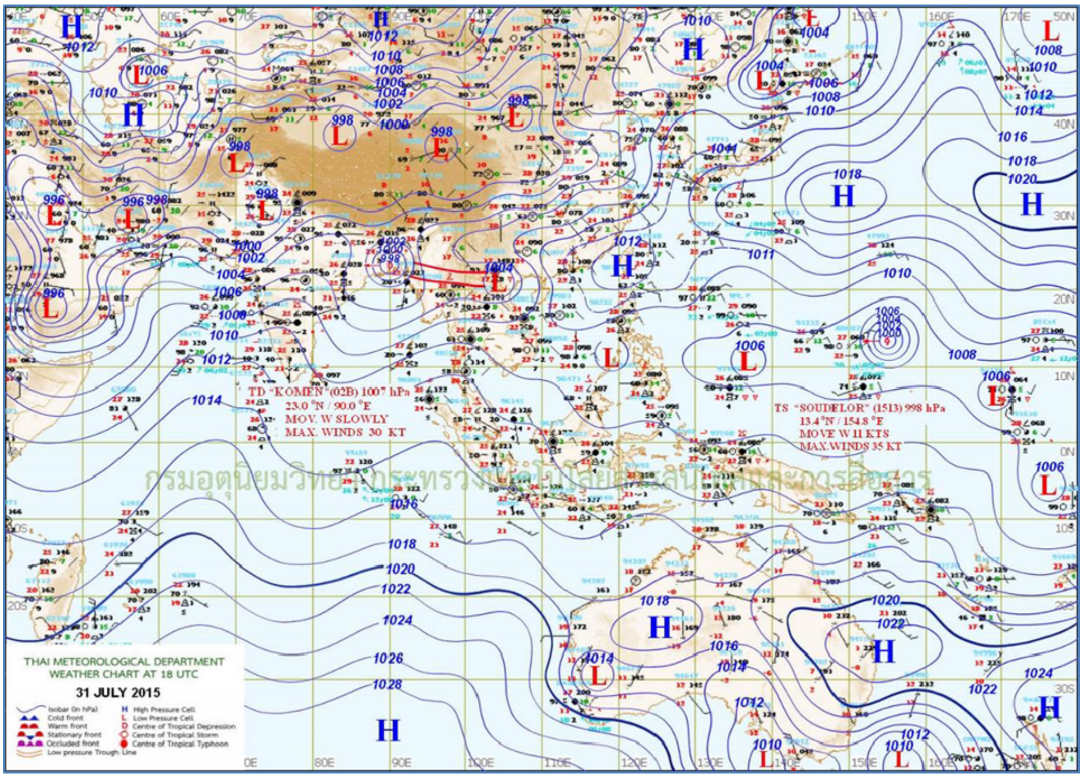


Figure 2-2 Weather map for TLP and ITCZ on 31 July 2015

Source: Thai Meteorological Department

Tropical depressions (TD), tropical storms (TS) and typhoons (TY):

During the 2015 flood season there were more than 30 tropical depressions, storms and typhoons, which were observed in the Pacific Ocean area (see Table 2-3 and Figure 2-3). However only 04 typhoons came from the East Sea, 01 tropical cyclone from North Indian Ocean and 01 tropical storm from the North of the Indian Ocean directly influenced the Lower Mekong Basin: KUJICA, LINFA, VAM CO, MUJIGAE and KOMEN. However, not one did significantly affect the rainfall in the LMB during the 2015 flood season. See details below.

Table 2-3 List of tropical depressions, storms and typhoons in 2015

No	Name	Time (date)	Wind (mph)
1	Typhoon-1 MEKKHALA	13-18 JAN	70
2	Typhoon-3 HIGOS	07-11 FEB	105
3	Tropical Storm BAVI	11-18 MAR	50
4	Super Typhoon-5 MAYSAK	27 MAR-05 APR	140
5	Tropical Storm HAISHEN	03-06 APR	45
6	Super Typhoon-5 NOUL	03-12 MAY	140
7	Super Typhoon-5 DOLPHIN	07-19 MAY	140
8	Tropical Storm KUJIRA	20-24 JUN	45
9	Typhoon-4 CHAN_HOM	30 JUN-12 JUL	120
10	Typhoon-1 LINFA	02-09 JUL	65
11	Super Typhoon-4 NANGKA	03-18 JUL	135
12	Typhoon-2 HALOLA	13-26 JUL	90
13	Tropical Storm TWELVE	23-25 JUL	40
14	Super Typhoon-5 SOUDELOR	30 JUL-08 AUG	155
15	Tropical Depression FOURTE	02-04 AUG	30
16	Tropical Storm MOLAVE	07-13 AUG	50
17	Typhoon-4 GONI	14-25 AUG	115
18	Super Typhoon-5 ATSANI	14-25 AUG	140
19	Typhoon-3 KILO	01-11 SEP	105
20	Tropical Storm ETAU	06-09 SEP	55
21	Tropical Storm VAMCO	13-14 SEP	35
22	Typhoon-3 KROVANH	14-20 SEP	105
23	Super Typhoon-4 DUJUAN	21-29 SEP	125
24	Typhoon-4 MUJIGAE	01-04 OCT	115
25	Typhoon-1 CHOI_WAN	02-07 OCT	70
26	Tropical Depression EIGHT	03-04 OCT	30
27	Super Typhoon-4 KOPPU	13-21 OCT	130
28	Super Typhoon-4 CHAMPI	13-24 OCT	130
29	Tropical Depression 26W	22-22 OCT	25
30	Typhoon-4 IN_FA	17-26 NOV	115
31	Super Typhoon-4 MELOR	12-17 DEC	125
32	Tropical Depression 29W	16-18 DEC	25

Source:http://weather.unisys.com/hurricane/w_pacific/2015/index.php

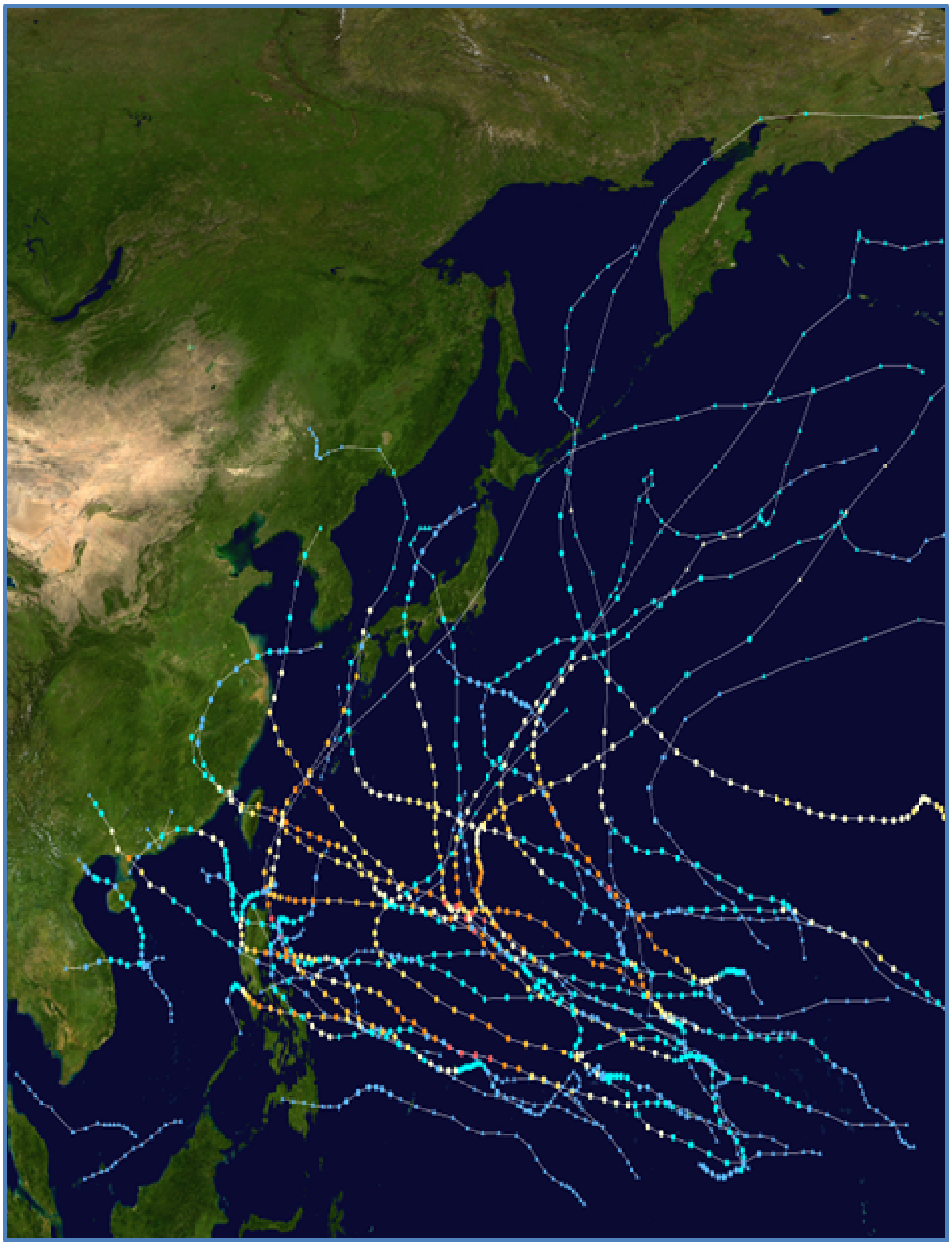


Figure 2-3 Typhoons, Tropical Storms and Tropical Depressions entering the Pacific Ocean area in 2015

Source:https://en.wikipedia.org/wiki/Timeline_of_the_2015_Pacific_typhoon_season

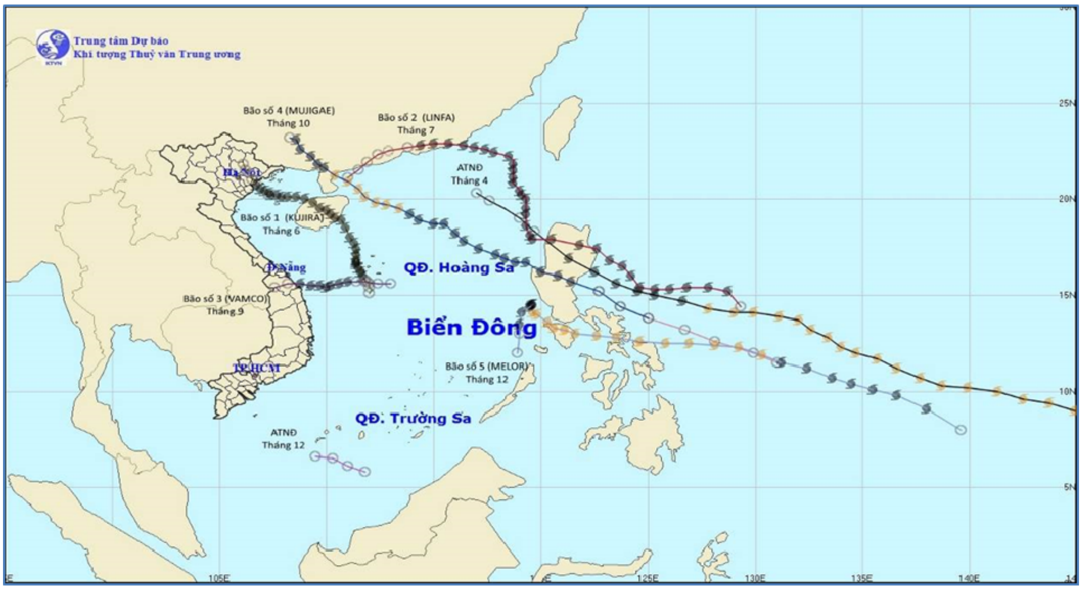


Figure 2-4 Tropical Depressions, Storms and Typhoons that directly affected the LMB in 2015 from East Sea

Source: NCHMF

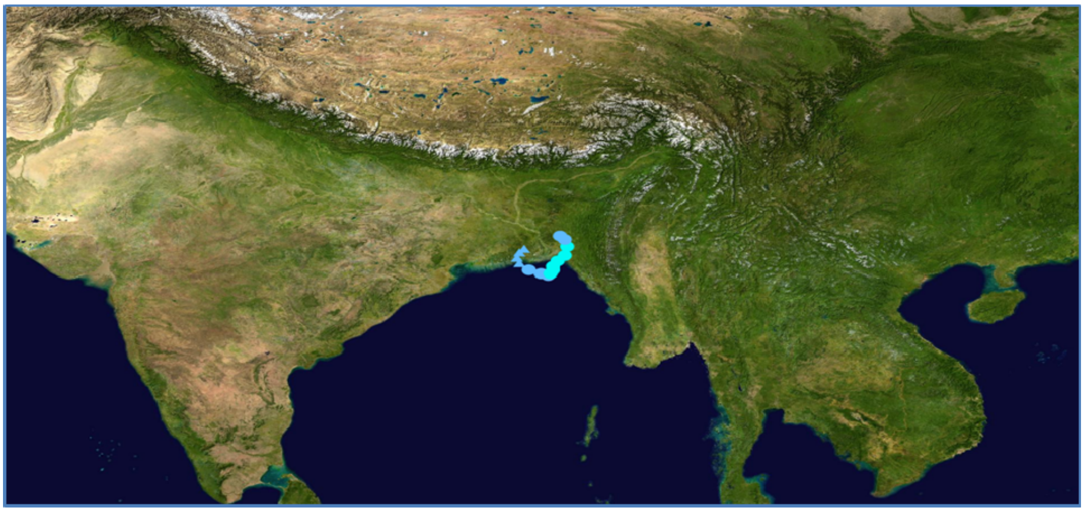


Figure 2-5 Tropical Cyclone KOMEN from North India Ocean affected the LMB.

Source:https://en.wikipedia.org/wiki/2015_North_Indian_Ocean_cyclone_season#Cyclonic_Storm_Komen)

KUJIRA: On 19 June 2015 the Japan Meteorological Agency (JMA) started monitoring a tropical depression that had developed within the East Sea about 940 km (585 miles) to the southeast of Hanoi, Vietnam. Over the next day the system gradually developed further before the Joint Typhoon Warning Center (JTWC) initiated advisories on the system and designated it as Tropical Depression 08W. Deep convection obscured its low-level circulation center; however, upper level analysis indicated that 08W was in an area of moderate vertical wind shear. On 21 June 2015, the JMA had reported that 08W had intensified into a tropical storm, naming it "*KUJIRA*". KUJIRA slightly intensified and the JTWC finally upgraded the system to a tropical storm on 22 June 2015. At the same time, KUJIRA's circulation became exposed but convection remained stable. Therefore, according to both agencies, KUJIRA reached its peak intensity with a minimum pressure of 985mbar later in the same data. KUJIRA would've been a severe tropical storm but because of displaced convection and moderate to high wind shear, the storm began a weakening trend. The JTWC downgraded KUJIRA to a tropical storm as it was located in an area of very unfavorable environments early on 23 June however, by their next advisory it was reported that KUJIRA entered an area of warm waters and was upgraded back to tropical storm status. During 24 June KUJIRA made landfall in the east of Hanoi, Vietnam and weakened into a tropical depression. The system was subsequently last noted during the next day, as it dissipated to the north of Hanoi.

Although outside of the Philippine Area of Responsibility, KIJURA's circulation enhanced the southwest monsoon and marked the beginning of the nation's rainy season on 23 June 2015. Striking Hainan on 20 June, KUJIRA produced torrential rain across the island with an average of 102mm falling across the Chinese province of Guangdong on 20 June; accumulations peaked at 732mm.

Table 2-4 KUJIRA Track History.

Advisory	Date (EST)	Name	Position		Moving	Speed mph (kts)	Pressure in (mb)	Winds mph (kts)
			Lat	Lon				
15	3:00 AM WED JUN 24	Tropical Depression Kujira	20.4N	106.4E	WNW	6 (5)	N/A	35 (30)
14	9:00 PM TUE JUN 23	Tropical Storm Kujira	20.2N	106.9E	W	10 (9)	N/A	40 (35)
13	3:00 PM TUE JUN 23	Tropical Storm Kujira	20.1N	107.8E	W	9 (8)	N/A	40 (35)
12	9:00 AM TUE JUN 23	Tropical Storm Kujira	20.3N	108.3E	NW	13 (11)	N/A	40 (35)
11	3:00 AM TUE JUN 23	Tropical Depression Kujira	19.7N	109.3E	NW	9 (8)	N/A	35 (30)
10	9:00 PM MON JUN 22	Tropical Storm Kujira	19.1N	109.8E	NW	7 (6)	N/A	40 (35)
9	3:00 PM MON JUN 22	Tropical Storm Kujira	19.2N	110.6E	NW	9 (8)	N/A	40 (35)
8	9:00 AM MON JUN 22	Tropical Storm Kujira	18.5N	111.1E	N	7 (6)	N/A	52 (45)
7	3:00 AM MON JUN 22	Tropical Storm Kujira	17.8N	111.1E	NNW	7 (6)	N/A	40 (35)
6	9:00 PM SUN JUN 21	Tropical Depression Kujira	17.2N	111.4E	NW	6 (5)	N/A	35 (30)
5	3:00 PM SUN JUN 21	Tropical Depression Kujira	16.8N	111.6E	NNE	5 (4)	N/A	35 (30)
4	9:00 AM SUN JUN 21	Tropical Depression Kujira	15.4N	111.4E	NNW	2 (2)	N/A	35 (30)
3	3:00 AM SUN JUN 21	Tropical Depression Kujira	15.4N	111.4E	NNW	2 (2)	N/A	35 (30)
2	9:00 PM SAT JUN 20	Tropical Depression Eight	15.2N	111.1E	W	3 (3)	N/A	29 (25)
1	3:00 PM SAT JUN 20	Tropical Depression Eight	15.3N	111.3E	W	3 (3)	N/A	29 (25)

Source: http://tropics.earlyalert.biz/2015/westpacific/KUJIRA.html

Figure 2-6 KUJIRA tropical storm track.

Source: http://tropics.earlyalert.biz/2015/westpacific

LINFA was a tropical cyclone that affected the northern Philippines, Taiwan and southern China in early July 2015. The tenth named storm of the annual typhoon season, LINFA developed on 1 July over in the Philippine Sea. It moved erratically westward toward the Philippines, eventually striking the island of Luzon on 4 July. LINFA weakened across the island, but reorganized over the East Sea. It turned northward and strengthened to near typhoon intensity, or winds of 120km/h, but weakened as it turned to the northwest toward southern China. On 9 July the storm made landfall along the Chinese province of Guangdong, dissipating the next day west of Hong Kong.

Interacting with the monsoon, LINFA brought heavy rainfall across much of the Philippines for several days, causing flooding and landslides that resulted in traffic accidents and power outages.

Table 2-5 LINFA track history.

Advisory	Date (EST)	Name	Position		Moving	Speed mph (kts)	Pressure in (mb)	Windsmph (kts)
			Lat	Lon				
32	9:00 PM THU JUL 09	Tropical Storm Linfa	23.3N	113.3E	WNW	13 (11)	N/A	46 (40)
31	3:00 PM THU JUL 09	Tropical Storm Linfa	23N	114.5E	W	12 (10)	N/A	63 (55)
30	9:00 AM THU JUL 09	Tropical Storm Linfa	22.9N	115.6E	W	12 (10)	N/A	69 (60)
29	3:00 AM THU JUL 09	Typhoon Linfa	22.6N	116.8E	W	9 (8)	N/A	75 (65)
28	9:00 PM WED JUL 08	Typhoon Linfa	22.5N	117.7E	WNW	8 (7)	N/A	75 (65)
27	3:00 PM WED JUL 08	Tropical Storm Linfa	22.2N	118.4E	NW	6 (5)	N/A	69 (60)
26	9:00 AM WED JUL 08	Tropical Storm Linfa	21.8N	118.7E	N	3 (3)	N/A	63 (55)
25	3:00 AM WED JUL 08	Tropical Storm Linfa	21.6N	118.8E	N	5 (4)	N/A	63 (55)
24	9:00 PM TUE JUL 07	Tropical Storm Linfa	21.2N	118.8E	NNW	5 (4)	N/A	58 (50)
23	3:00 PM TUE JUL 07	Tropical Storm Linfa	20.8N	118.9E	N	3 (3)	N/A	58 (50)
22	9:00 AM TUE JUL 07	Tropical Storm Linfa	20.6N	118.9E	N	5 (4)	N/A	52 (45)
21	3:00 AM TUE JUL 07	Tropical Storm Linfa	20.6N	119E	NNW	8 (7)	N/A	46 (40)
20	9:00 PM MON JUL 06	Tropical Storm Linfa	20N	119.3E	N	3 (3)	N/A	40 (35)
19	3:00 PM MON JUL 06	Tropical Storm Linfa	19.7N	119.3E	N	6 (5)	N/A	46 (40)
18	9:00 AM MON JUL 06	Tropical Storm Linfa	19.2N	119.2E	N	6 (5)	N/A	52 (45)
17	3:00 AM MON JUL 06	Tropical Storm Linfa	18.8N	119.4E	NNW	7 (6)	N/A	46 (40)
16	9:00 PM SUN JUL 05	Tropical Storm Linfa	18.1N	119.3E	WNW	10 (9)	N/A	58 (50)
15	3:00 PM SUN JUL 05	Tropical Storm Linfa	18N	119.6E	WNW	14 (12)	N/A	58 (50)
14	9:00 AM SUN JUL 05	Tropical Storm Linfa	17.9N	121.2E	WNW	9 (8)	N/A	52 (45)
13	3:00 AM SUN JUL 05	Tropical Storm Linfa	17.7N	122E	WNW	8 (7)	N/A	52 (45)
12	9:00 PM SAT JUL 04	Tropical Storm Linfa	17.9N	123E	NW	7 (6)	N/A	58 (50)
11	3:00 PM SAT JUL 04	Tropical Storm Linfa	17.4N	123.4E	NNW	9 (8)	N/A	52 (45)
10	9:00 AM SAT JUL 04	Tropical Storm Linfa	16.7N	123.8E	NW	8 (7)	N/A	58 (50)
9	3:00 AM SAT JUL 04	Tropical Storm Linfa	15.9N	124.2E	NW	8 (7)	N/A	52 (45)
8	9:00 PM FRI JUL 03	Tropical Storm Linfa	15.2N	124.6E	W	7 (6)	N/A	52 (45)
7	3:00 PM FRI JUL 03	Tropical Storm Linfa	15.1N	125.2E	W	7 (6)	N/A	52 (45)
6	9:00 AM FRI JUL 03	Tropical Storm Linfa	15.2N	126E	SW	8 (7)	N/A	52 (45)
5	3:00 AM FRI JUL 03	Tropical Storm Linfa	16.3N	126.6E	W	15 (13)	N/A	40 (35)
4	9:00 PM THU JUL 02	Tropical Storm Linfa	16.1N	127.9E	NW	7 (6)	N/A	40 (35)
3	3:00 PM THU JUL 02	Tropical Depression Ten	15.7N	128.4E	NNW	14 (12)	N/A	35 (30)
2	9:00 AM THU JUL 02	Tropical Depression Ten	14.2N	128.5E	WNW	12 (10)	N/A	35 (30)
1	3:00 AM THU JUL 02	Tropical Depression Ten	13.9N	129.7E	NNW	7 (6)	N/A	29 (25)

Source: http://tropics.earlyalert.biz/2015/westpacific/linfa.html

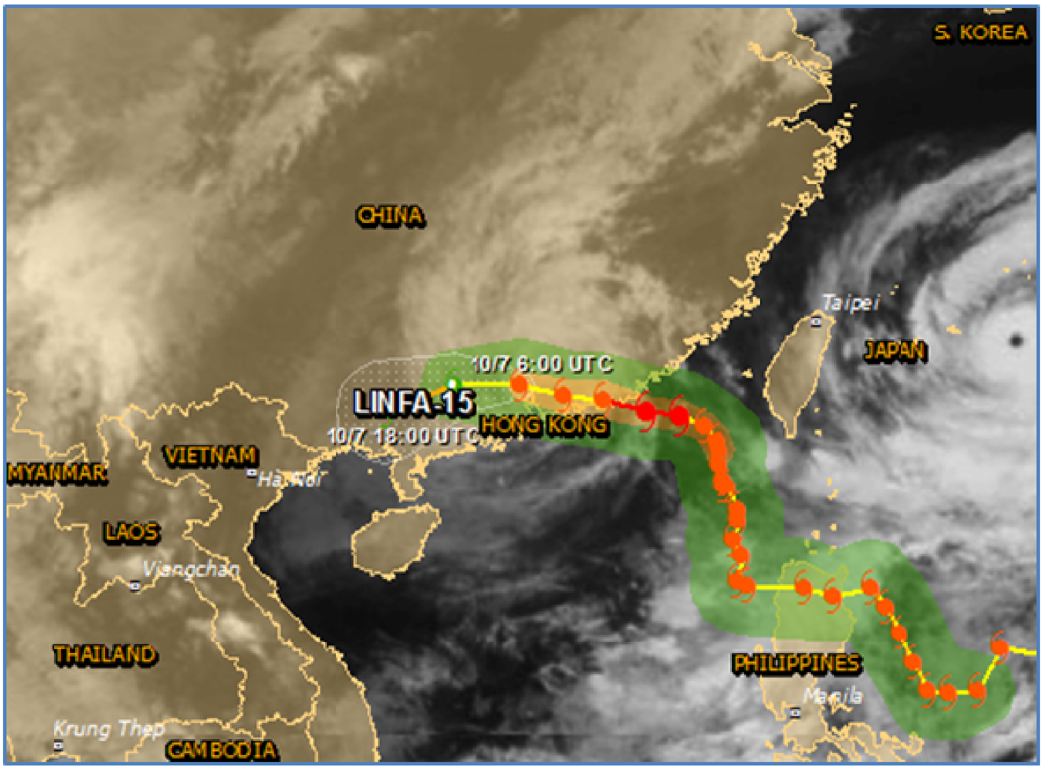


Figure 2-7 LINFA tropical storm track

Source: http://www.gdacs.org/report.aspx?eventtype=TC&eventid=1000175

VAMCO: On 10 September a tropical disturbance formed within the monsoon 560 km west of Manila, Philippines over the East Sea and was classified as a low by the JTWC on the next day. The disturbance meandered for a few days and was later classified as a tropical depression by the JMA on 13 September. The JTWC started issuing bulletins and was assigned the designation 19W. Thereafter, both the JMA and the JTWC upgraded 19W to a tropical storm, naming it VAMCO. On 14 September deep convection slightly weakened and became displaced near its center, however the environment was still favorable at this moment. A few hours later, the JTWC reported that according to animations, the center of VAMCO became partially exposed and wind shear inhibited further development, which favorable conditions started to fade. Therefore, the JTWC issued its final warning. VAMCO made landfall south of Da Nang, Vietnam, and the JMA later downgraded VAMCO to a tropical depression and issued their final advisory early on 14 September. The remnants of VAMCO continued to move in a westward direction inland and crossed the 100th meridian east on 15 and 16 September.

Table 2-6 VAMCO track history.

Advisory	Date (EST)	Name	Position		Moving	Speed mph (kts)	Pressure in (mb)	Winds mph (kts)
			Lat	Lon				
5	3:00 PM MON SEP 14	Tropical Storm Vamco	15.6N	108.9E	W	9 (8)	N/A	40 (35)
4	9:00 AM MON SEP 14	Tropical Storm Vamco	15.5N	109.7E	WNW	7 (6)	N/A	40 (35)
3	3:00 AM MON SEP 14	Tropical Storm Vamco	14.8N	110.4E	W	9 (8)	N/A	40 (35)
2	9:00 PM SUN SEP 13	Tropical Storm Vamco	14.9N	111.2E	WSW	5 (4)	N/A	40 (35)
1	3:00 PM SUN SEP 13	Tropical Depression Nineteen	15.8N	111.3E	W	8 (7)	N/A	29 (25)

Source: http://tropics.earlyalert.biz/2015/westpacific/Vamco.html

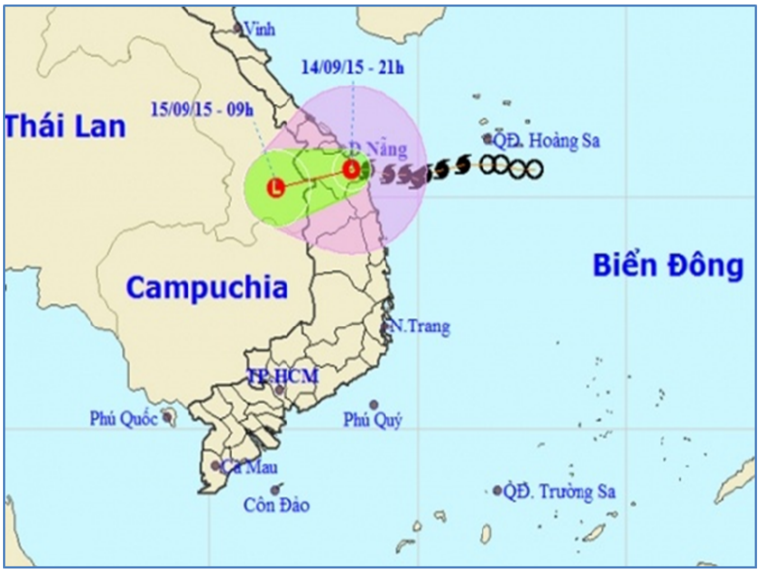


Figure 2-8 VAMCO tropical storm track

Source: NCHMF

MUJIGAE: On 28 September a cluster of thunderstorms developed into a tropical disturbance near Palau. The JMA classified the system to a tropical depression early on 30 September. On the next day, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) upgraded it to a tropical depression, assigning it the name "*KABAYAN*". The JTWC designated it as 22W later that day and started issuing warnings. All three agencies, JMA, JTWC and PAGASA, later classified KABAYAN as a tropical storm, with the JMA having named it "*MUJIGAE*". The system was located in a region of light vertical wind shear. By 2 October MUJIGAE made landfall over Aurora Province of the Philippines and the JTWC later downgraded the system to a tropical depression. Soon the storm left the Philippine Area of Responsibility. Later on the same day, MUJIGAE reemerged into the East Sea, where weak vertical wind shear and warm sea surface temperature favored development and reorganization of the system. The JTWC upgraded it back to a tropical storm whilst the JMA upgraded its intensity to severe tropical storm strength. The next day, due to radial outflow, MUJIGAE began a phase of rapid deepening, with convection wrapping around a developing eye, as it moved towards western Guangdong, China, prompting the JMA and the JTWC to classify MUJIGAE as a typhoon. The JTWC upgraded MUJIGAE to a Category 4-equivalent typhoon. At that time the storm was about 350 km south-south of Hong Kong. Later on the same day, MUJIGAE made landfall for the second time near Zhanjiang, China.

Table 2-7 MUJIGAE track history.

Advisory	Date (EST)	Name	Position		Moving	Speed mph (kts)	Pressure in (mb)	Winds mph (kts)
			Lat	Lon				
15	3:00 PM SUN OCT 04	Typhoon Mujigae	21.9N	109.5E	NW	12 (10)	N/A	92 (80)
14	9:00 AM SUN OCT 04	Typhoon Mujigae	21.3N	110.4E	NW	15 (13)	N/A	132 (115)
13	3:00 AM SUN OCT 04	Typhoon Mujigae	20.5N	111.5E	NW	12 (10)	N/A	109 (95)
12	9:00 PM SAT OCT 03	Typhoon Mujigae	19.8N	112.2E	WNW	13 (11)	N/A	92 (80)
11	3:00 PM SAT OCT 03	Typhoon Mujigae	19.5N	113.3E	NW	12 (10)	N/A	75 (65)
10	9:00 AM SAT OCT 03	Tropical Storm Mujigae	18.9N	114.2E	WNW	14 (12)	N/A	69 (60)
9	3:00 AM SAT OCT 03	Tropical Storm Mujigae	18.4N	115.4E	NW	15 (13)	N/A	63 (55)
8	9:00 PM FRI OCT 02	Tropical Storm Mujigae	17.8N	116.3E	WNW	18 (16)	N/A	63 (55)
7	3:00 PM FRI OCT 02	Tropical Storm Mujigae	17.1N	117.8E	WNW	16 (14)	N/A	52 (45)
6	9:00 AM FRI OCT 02	Tropical Storm Mujigae	16.5N	119.1E	WNW	10 (9)	N/A	40 (35)
5	3:00 AM FRI OCT 02	Tropical Depression Mujigae	16.1N	119.9E	WNW	18 (16)	N/A	35 (30)
4	9:00 PM THU OCT 01	Tropical Depression Twentytwo	15.5N	121.4E	WNW	15 (13)	N/A	35 (30)
3	3:00 PM THU OCT 01	Tropical Storm Twentytwo	15.2N	122.7E	NW	17 (15)	N/A	40 (35)
2	9:00 AM THU OCT 01	Tropical Depression Twentytwo	14.4N	124E	WNW	18 (16)	N/A	35 (30)
1	3:00 AM TUE SEP 01	Tropical Depression Twentytwo	13.7N	125.5E	NW	21 (18)	N/A	29 (25)

Source: http://tropics.earlyalert.biz/2015/westpacific/Vamco.html

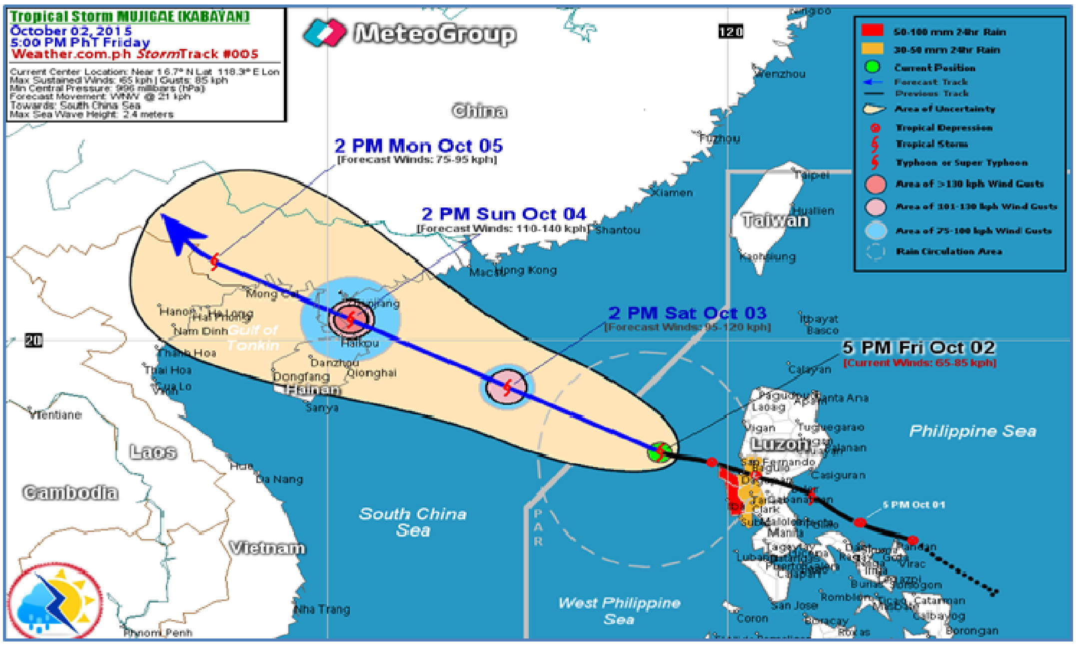


Figure 2-9 MUJIGAE tropical storm track

Source: Weather Philippines & Meteogroup

2.2 General Behaviour of the Mekong River and Seasonal Flood Situation

The terms "flood" and "flooding" may world-wide 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.*

As mentioned, the following factors affected the rainfall situation of LMB above: During the 2015 flood season, the onset of the Southwest Monsoons (SWs) started later than in previous flood years; as it is affected by the location and influence of meteorology (ICTZs, SWs, Typhoons…). Therefore the first flood event occurred in 2015 at a different time; in the downstream part it occurred in June, while it occurred in the upper and middle parts by the end of July.

In general terms, the water levels at all mainstream stations along LMB were under the Long-Term Average (LTA) from the beginning of flood season (01 June) until the end of July, from August until the end of flood season (31 October), the WLs fluctuated strongly following the distribution of the precipitation by space and time, except for some stations in the upper and middle part which were above the LTA from the end of July until the middle of August. See Annex C. During the entire 2015 flood season the Alarm level was only reached in Nong Khai (Thailand) during one day on 8 August only, while water levels in other mainstream stations remained in 2015 below the Alarm level. See Table 2-8 for more detail.

Thus, it can be concluded that based on the water levels records of the flood season 2015, the year 2015 can be characterized as a "dry year".

Table 2-8 The flood peaks of the Mekong mainstream stations during the 2015 flood season.

Stations	Alarm level (m)	Flood level (m)	Day/Month of max	Hmax (m)	Day/Month of min	Hmin (m)	Comnment
Chiang Saen	11.50	11.80	04/08/2015	7.35	13/07/2015	2.31	Bellow Alarm level
Luang Prabang	17.50	18.00	06/08/2015	14.84	01/06/2015	3.80	Bellow Alarm level
Chiang Khan	17.32	17.40	07/08/2015	13.38	03/06/2015	4.31	Bellow Alarm level
Vientiane	11.50	12.50	07/08/2015	10.20	05/06/2015	1.30	Bellow Alarm level
Nong Khai	11.40	12.20	**08/08/2015**	**11.40**	**05/06/2015**	**1.94**	**Above Alarm level**
Paksane	13.50	14.50	08/08/2015	12.88	07/06/2015	3.90	Bellow Alarm level
Nakhon Phanom	12.60	12.70	05/08/2015	11.04	08/06/2015	1.72	Bellow Alarm level
Thakhek	13.00	14.00	05/08/2015	12.14	08/06/2015	3.05	Bellow Alarm level
Mukdahan	12.50	12.60	05/08/2015	10.96	09/06/2015	2.09	Bellow Alarm level
Savannakhet	12.00	13.00	06/08/2015	9.85	01/06/2015	1.20	Bellow Alarm level
Khong Chiam	16.00	16.20	06/08/2015	11.89	10/06/2015	2.43	Bellow Alarm level
Pakse	11.00	12.00	12/08/2015	9.88	10/06/2015	1.46	Bellow Alarm level
Stung Treng	10.70	12.00	13/08/2015	8.41	12/06/2015	2.70	Bellow Alarm level
Kratie	22.00	23.00	14/08/2015	18.21	12/06/2015	7.54	Bellow Alarm level
Kampong Cham	15.20	16.20	14/08/2015	12.16	14/06/2015	3.03	Bellow Alarm level
Phnom Penh Chakto	10.50	12.00	14/08/2015	7.09	01/06/2015	1.73	Bellow Alarm level
Phnom Penh Port	9.50	11.00	19/09/2015	6.13	01/06/2015	0.75	Bellow Alarm level
Koh Khel (Bassac)	7.40	7.90	15/08/2015	6.21	01/06/2015	1.71	Bellow Alarm level
Neak Luong	7.50	8.00	15/08/2015	5.06	03/06/2015	1.00	Bellow Alarm level
Prek Kdam (Tonle Sa	9.50	10.00	19/09/2015	6.02	14/06/2015	0.93	Bellow Alarm level
Tan Chau	3.50	4.50	26/10/2015	2.43	22/06/2015	-0.27	Bellow Alarm level
Chau Doc	3.00	4.00	26/10/2015	2.31	22/06/2015	-0.34	Bellow Alarm level

Note: Alarm levels and flood levels are defined by the National Line Agency.

The main 2015 hydrological situations along the Mekong River are presented in more detail hereafter.

For stations from Chiang Saen to Paksane (Upper part)

In general, the water levels of the stations in the upper part from Chiang Saen to Paksane during the 2015 flood season remained below the LTA, with exception of the period from the end of July until the middle of August when the WLs increased to above the LTA.

In that particular period three (3) flood events have been identified:

i) 25 July – 12 August,

ii) 30 August – 17 September, and

iii) 09 – 22 October.

See Table 2-9, Figure 2-10, Figure 2-11, and Figure 2-12 for more details.

Table 2-9 Flood event characteristics from Chiang Saen to Paksane.

Stations	Flood Event	Peak of Flood Event									Flood Amplitude (m)	Intensity of Flood Rising			Comment
		Flood beginning		Peak			Flood end								
		Time beginning (date)	Water level (m)	Time of peak (date)	Water level (m)	Rising time (days)	Time end (date)	Water level (m)	Downing Time	flood duration time (days)		Interval of I_{max} (Date)	I_{max} (m/day)	Iaverage (m/day)	
Chiang Saen	**Flood event 1**	25-Jul					12-Aug			**18**					SWs,ITCZs,TLPs,
	i) Sub flood event 01	25-Jul	4.26	28-Jul	5.85	3	02-Aug	5.17	5	8	1.59	26 - 27/Aug	0.83	0.53	SWs,ITCZs,TLPs
	ii) Sub flood event 02	02-Aug	5.17	04-Aug	7.35	2	12-Aug	4.77	8	10	2.18	03 - 04/Aug	1.25	1.09	SWs,ITCZs,TLPs
	Flood event 2	31-Aug	4.2	02-Sep	5.22	2	15-Sep		13	15	1.02	31/Aug - 01/Sep	0.53	0.51	SWs,ITCZs,TLPs
	Flood event 3	09-Oct	2.95	12-Oct	3.95	3	19-Oct	3.09	7	10	1.00	10 - 11/Oct	0.4	0.33	SWs,ITCZs,TLPs
Luang Prabang	**Flood event 1**	25-Jul					14-Aug			**20**					SWs,ITCZs,TLPs
	i) Sub flood event 01	25-Jul	8.5	29-Jul	11.62	4	02-Aug	10.1	4	8	3.12	26-27/Jul	1.19	0.78	SWs,ITCZs,TLPs
	ii) Sub flood event 02	02-Aug	10.1	06-Aug	14.84	4	14-Aug	4.77	8	12	**4.74**	3-4/Aug	2.04	1.19	SWs,ITCZs,TLPs
	Flood event 2	30-Aug	9.06	06-Sep	12.31	7	17-Sep	9.06	11	18	3.25	31/Aug - 01/Sep	1.07	0.46	SWs,ITCZs,TLPs
	Flood event 3	10-Oct	6.15	14-Oct	8.74	4	22-Oct	6.15	8	12	2.59	10-11/Oct	1.33	0.65	SWs,ITCZs,TLPs
Chiang Khan	**Flood event 1**	26-Jul					16-Aug			**21**					SWs,ITCZs,TLPs
	i) Sub flood event 01	26-Jul	8.38	30-Jul	10.14	4	03-Aug	9.91	4	8	1.76	27-28/Jul	1.12	0.44	SWs,ITCZs,TLPs
	ii) Sub flood event 02	03-Aug	9.91	07-Aug	13.38	4	16-Aug	9.96	9	13	3.47	4-5/Aug	1.85	0.87	SWs,ITCZs,TLPs
	Flood event 2	31-Aug	8.8	07-Sep	11.73	7	18-Sep	9.2	11	18	2.93	1-2/Sep	1.62	0.42	SWs,ITCZs,TLPs
	Flood event 3	11-Oct	7.31	16-Oct	8.93	5	21-Oct	7.25	5	10	1.62	18 - 19/Sep	1.60	0.32	SWs,ITCZs,TLPs
Vientiane	**Flood event 1**	04-Aug	6.9	07-Aug	10.2	3	20-Aug	6.25	13	16	3.30	5 -6/Aug	1.57	1.10	SWs,ITCZs,TLPs
	Flood event 2	01-Sep	5.28	07-Sep	8.5	6	20-Sep	5.3	13	19	3.22	2 - 3/Sep	1.54	0.54	SWs,ITCZs,TLPs
	Flood event 3	11-Oct	3.9	17-Oct	5.55	6	23-Oct	3.37	6	12	1.65	11 - 12/Oct	0.50	0.28	SWs,ITCZs,TLPs
Nong Khai	**Flood event 1**	04-Aug	8.2	08-Aug	11.38	4	17-Aug	7.85	9	13	3.18	5 -6/Aug	1.60	0.80	SWs,ITCZs,TLPs
	Flood event 2	01-Sep	6.22	08-Sep	9.75	7	22-Sep	6.3	14	21	3.53	1-2/Sep	1.81	0.50	SWs,ITCZs,TLPs
	Flood event 3	11-Oct	4.74	17-Oct	6.56	6	22-Oct	4.56	5	11	1.82	13-14/Oct	0.64	0.30	SWs,ITCZs,TLPs
Paksane	**Flood event 1**	28-Jul	8.07	08-Aug	12.88	11	22-Aug	8.19	14	25	**4.81**	30-31/Jul	1.52	0.44	SWs,ITCZs,TLPs
	Flood event 2	02-Sep	8.35	05-Sep	11.55	3	16-Sep	8.43	11	14	3.20	4-5/Sep	2.25	1.07	SWs,ITCZs,TLPs
	Flood event 3	09-Oct	6.20	12-Oct	8.02	3	22-Oct	4.77	10	13	1.82	11 - 12/Oct	0.77	0.61	SWs,ITCZs,TLPs

Flood event 1 (25 July – 12 August) may be called "the biggest flood event of the 2015 flood season", because all amplitudes recorded in the stations in the upper part exceeded 3m. The flood wave amplitude at Luang Prabang was 4.72m, calculated for a 04 days' duration rising time. And the flood wave amplitude at Paksane was 4.81, calculated for 11 days' duration rising time. See Figure 2-11 and Figure 2-12.

In the period from the first to mid of July, heavy rain was recorded in upstream areas of the LMB, caused by typhoon LINFA, the SWs, and ITCZs.

Table 2-10 illustrates the distribution of observed precipitation at mainstream stations along LMB during the first flood event from 25 July – 15 August. Heavy rainfall was concentrated in the period from 27 July until 04 August. In particular the daily rainfall recorded on 05 August at Vientiane was 82.6mm, while the total accumulated rainfall over the flood event period was even 397.5mm. The daily rainfall in Paksane of 183.2mm on 29 July was recorded and the total accumulated rainfall during the flood event (from 25 July to 16 August) was calculated in 1060.1mm. See Table 2-10 and Figure 2-10 for more details.

Table 2-10 Precipitation observed in the mainstream stations during the flood event 25 July – 16 August 2015 in the LMB

Time (dd/mm/yyyy)	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Paksane
25/07/2015	3.60	13.00	11.80	56.20	49.30	24.20
26/07/2015	54.40	21.20	0.00	12.50	0.00	18.00
27/07/2015	11.60	14.60	4.10	6.00	5.10	124.10
28/07/2015	9.50	2.60	0.00	0.80	2.80	49.80
29/07/2015	4.30	2.40	0.80	2.50	4.20	183.20
30/07/2015	35.80	nr	3.20	51.80	nr	77.50
31/07/2015	8.00	18.40	19.70	48.70	30.90	153.70
01/08/2015	0.20	2.40	6.20	72.60	64.10	79.90
02/08/2015	5.20	21.90	4.00	14.50	13.40	93.50
03/08/2015	66.50	17.60	10.20	8.20	6.80	97.30
04/08/2015	53.80	8.60	16.60	11.80	6.20	26.40
05/08/2015	5.50	1.10	0.00	82.60	69.40	23.00
06/08/2015	33.50	14.40	0.00	nr	42.50	2.30
07/08/2015	2.10	1.60	0.50	nr	6.50	1.30
08/08/2015	3.70	nr	16.80	nr	0.00	3.00
09/08/2015	0.30	6.30	0.00	nr	1.60	nr
10/08/2015	0.00	nr	0.00	nr	0.00	nr
11/08/2015	0.10	8.20	0.00	nr	0.00	42.90
12/08/2015	0.00	48.80	10.00	12.80	3.00	35.80
13/08/2015	2.30	1.20	0.00	nr	0.00	1.70
14/08/2015	0.90	nr	0.00	nr	6.50	21.50
15/08/2015	43.00	nr	4.90	16.50	6.00	1.00
16/08/2015	3.20	nr	0.00	nr	0.00	nr
Total rainfall	**347.50**	**204.30**	**108.80**	**397.50**	**318.30**	**1060.10**

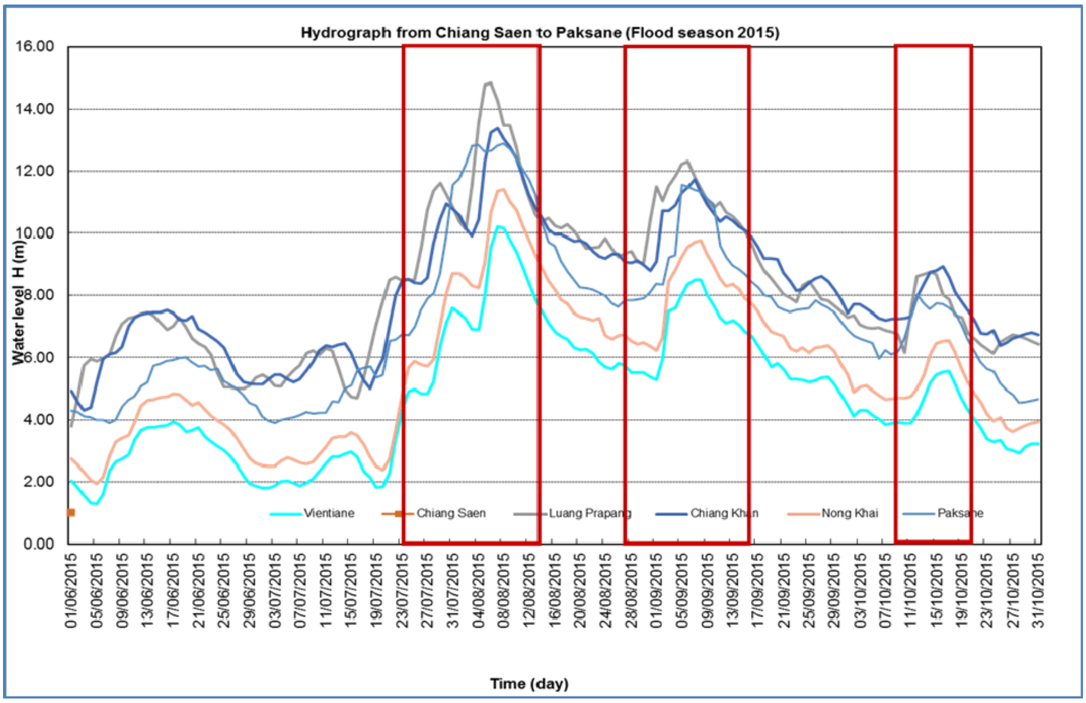


Figure 2-10 Rapidly rising of water levels at stations: Chiang Saen, Luang Prabang, Chiang Khan, Vientiane, Nong Khai and Paksane.

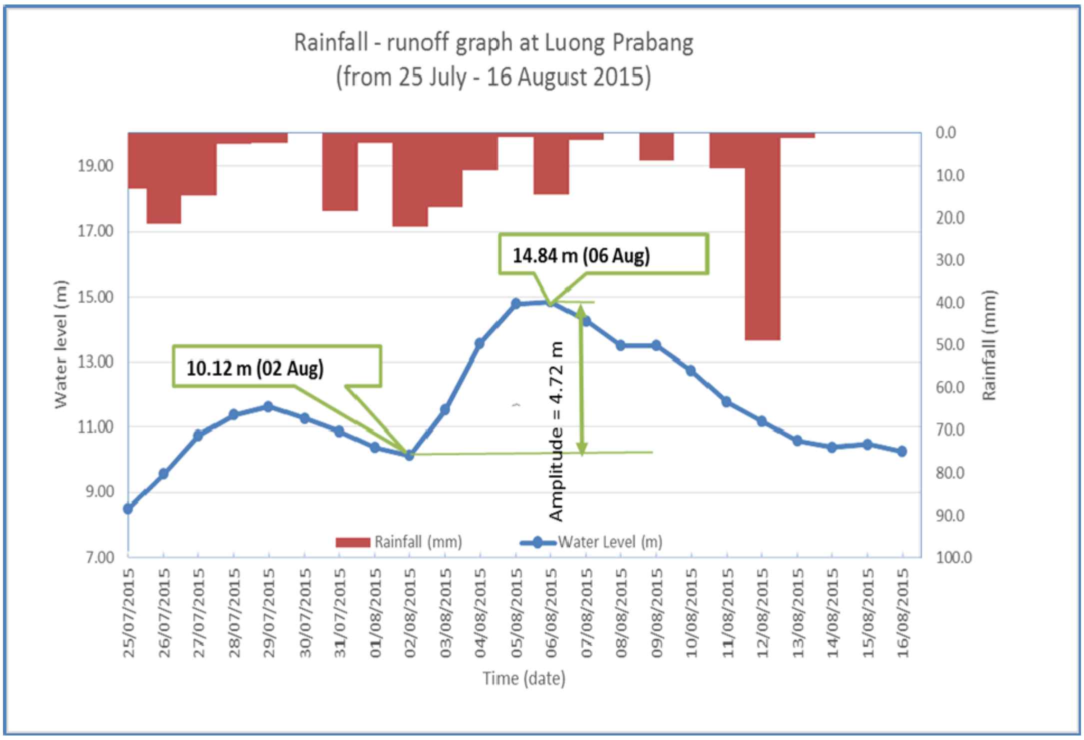


Figure 2-11 Hydrograph of Flood event 1 at Luang Prabang.

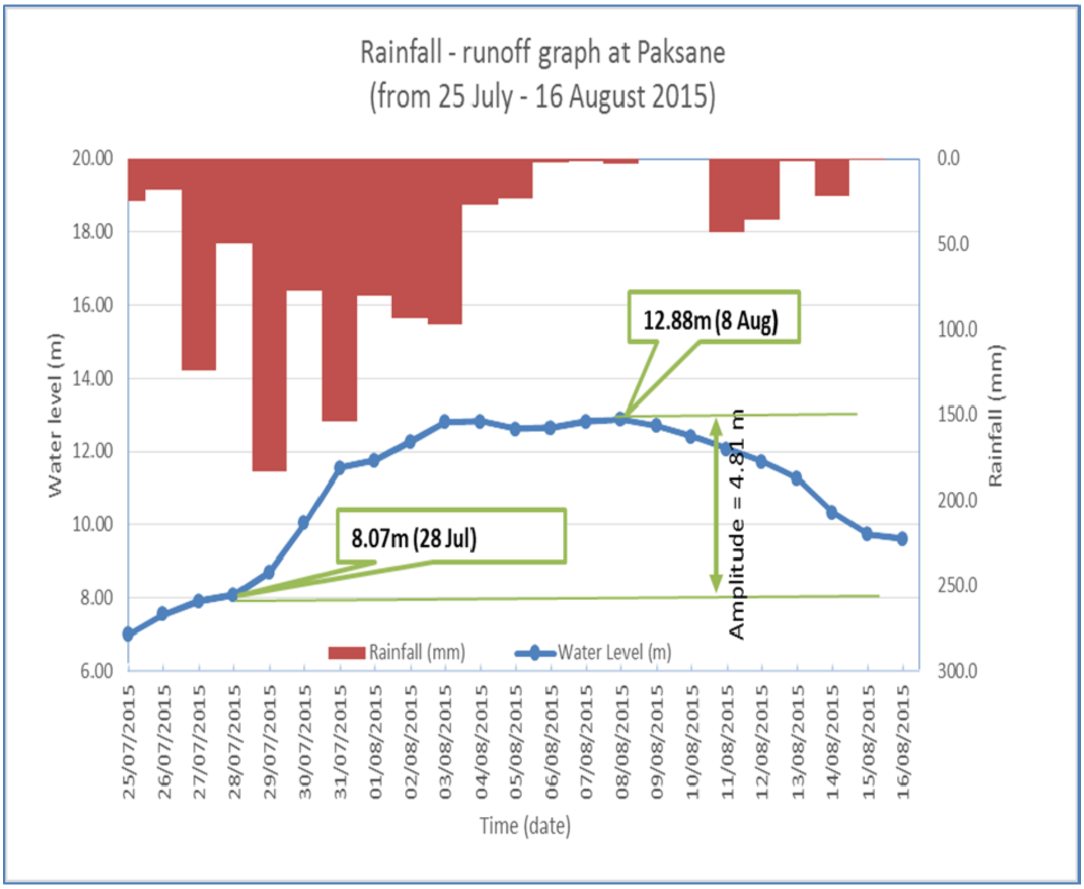


Figure 2-12 Rainfall – runoff graph at Paksane (25 July – 16 August 2015).

For stations from Nakhon Phanom to Pakse (Middle part)

The WLs of all stations started under LTA during the 2015 flood season and maintained below the TLA for almost all season time, except short duration time from the end of July to mid of August when the WLs were above the LTA (see Annex C)

There were three flood events which have been identified at that time as follows:

i) 26 July – 22 August,

ii) 02 – 16 September, and

iii) 08 – 22 October.

See Figure 2-13 and Figure 2-14, Table 2-11 and Table 2-12 for more details.

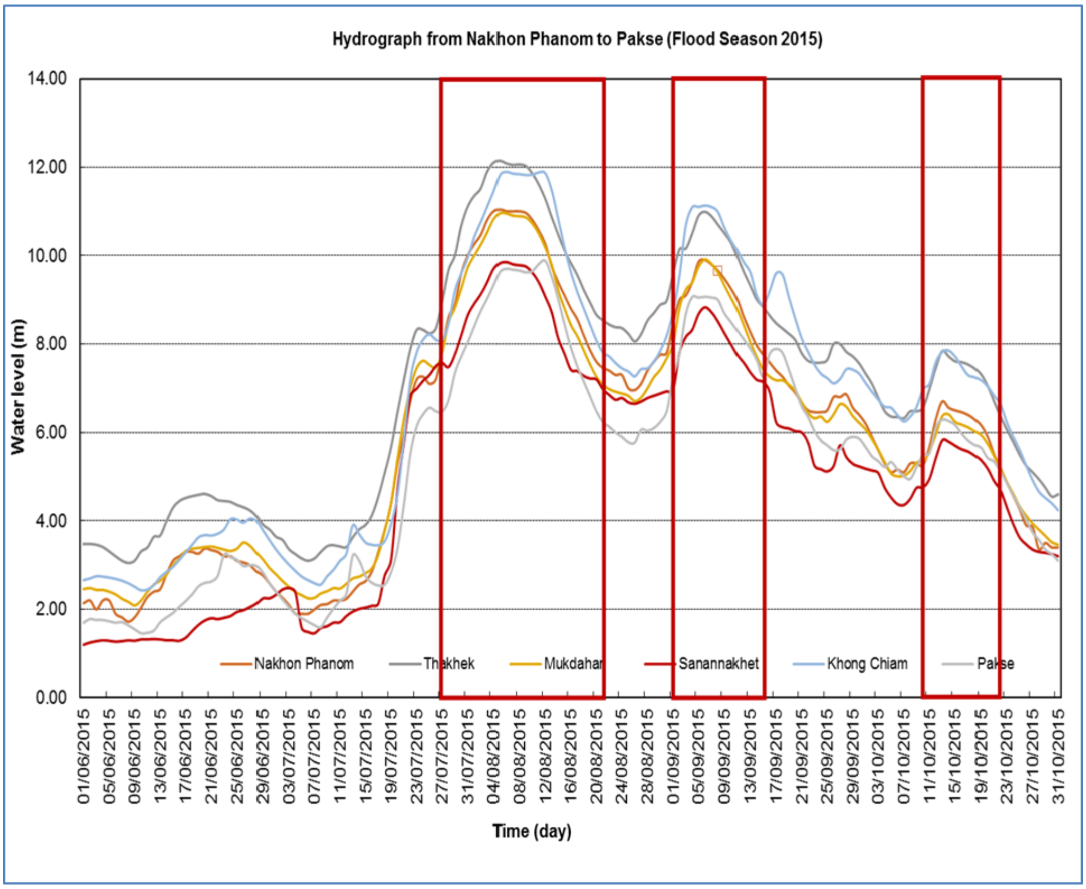


Figure 2-13 Rapidly rising of water levels at stations: Nakhon Phanom, Thakhek, Mukdahan, Savannakhet, Khong Chiam and Pakse.

Table 2-11 Flood event characteristics from Nakhon Phanom to Pakse.

Stations	Flood Event	Peak of Flood Event									Flood Amplitude (m)	Intensity of Flood Rising			Comment
		Flood beginning		Peak			Flood end								
		Time beginning (date)	Water level (m)	Time of peak (date)	Water level (m)	Rising time (days)	Time end (date)	Water level (m)	Downing Time	flood duration time (days)		Interval of I_{max} (Date)	I_{max} (m/day)	Iaverage (m/day)	
Nakhon Phanom	**Flood event 1**	26-Jul	7.20	05-Aug	11.04	10	23-Aug	7.3	18	28	3.84	27-28/Jul	0.74	0.38	SWs,ITCZs,TLPs
	Flood event 2	26-Aug	6.96	06-Sep	9.9	11	20-Sep	6.15	14	25	2.94	31/Aug-1/Sep	0.66	0.27	SWs,ITCZs,TLPs
	Flood event 3	10-Oct	5.26	13-Oct	6.7	3	22-Oct	5.2	9	12	1.44	11 - 12/Oct	0.62	0.48	SWs,ITCZs,TLPs
Thakhek	**Flood event 1**	26-Jul	8.3	05-Aug	12.14	10	24-Aug	8.36	19	29	3.84	27-28/Jul	0.71	0.38	SWs,ITCZs,TLPs
	Flood event 2	26-Aug	8.06	06-Sep	10.99	11	20-Sep	9.96	14	25	2.93	31/Aug-1/Sep	0.6	0.27	SWs,ITCZs,TLPs
	Flood event 3	10-Oct	5.56	13-Oct	7.84	3	22-Oct	6.36	9	12	2.28	11 - 12/Oct	0.48	0.76	SWs,ITCZs,TLPs
Mukdahan	**Flood event 1**	26-Jul	7.47	05-Aug	10.96	10	20-Aug	7.25	15	25	3.49	27-28/Jul	0.69	0.35	SWs,ITCZs,TLPs
	Flood event 2	26-Aug	6.71	06-Sep	9.91	11	22-Sep	6.44	16	27	3.20	1-2/Sep	0.81	0.29	SWs,ITCZs,TLPs
	Flood event 3	09-Oct	5.32	14-Oct	6.4	5	21-Oct	5.3	7	12	1.08	12 - 13/Oct	0.41	0.22	SWs,ITCZs,TLPs
Savannakhet	**Flood event 1**	28-Jul	7.47	06-Aug	9.85	9	16-Aug	7.42	10	19	2.38	30 - 31/Jul	0.45	0.26	SWs,ITCZs,TLPs
	Flood event 2	01-Sep	6.95	06-Sep	8.83	5	16-Sep	6.93	10	15	1.88	1-2/Sep	0.85	0.38	SWs,ITCZs,TLPs
	Flood event 3	10-Oct	4.76	13-Oct	5.82	3	22-Oct	4.7	9	12	1.06	11-12/Oct	0.47	0.35	SWs,ITCZs,TLPs
Khong Chiam	**Flood event 1**	26-Jul	8.1	06-Aug	11.89	11	24-Aug	8.8	18	29	3.79	19 - 20/Jul	1.12	0.34	SWs,ITCZs,TLPs
	Flood event 2	31-Aug	8.19	06-Sep	11.13	6	15-Sep	8.89	9	15	2.94	2 - 3/Sep	1.15	0.49	SWs,ITCZs,TLPs
	Flood event 3	07-Oct	6.36	14-Oct	7.85	7	23-Oct	6.22	9	16	1.49	13 - 14/Oct	1.34	0.21	SWs,ITCZs,TLPs
Pakse	**Flood event 1**	27-Jul	6.47	12-Aug	9.88	16	20-Aug	6.48	8	24	3.41	28 - 29/Jul	0.62	0.21	SWs,ITCZs,TLPs
	Flood event 2	27-Aug	6.06	06-Sep	9.07	10	23-Sep	6.03	17	27	3.01	2 - 3/Sep	0.9	0.30	SWs,ITCZs,TLPs
	Flood event 3	08-Oct	4.95	13-Oct	6.29	5	22-Oct	5.11	9	14	1.34	11 - 12/Jul	0.59	0.27	SWs,ITCZs,TLPs

Based on the flow propagation at the upper station Paksane and meteorological factors that affected the 'broader' middle part, the Flood event 1, from 28 July until 22 August, was analysed.

The flood wave amplitudes at the stations in the middle part were more than 3.5m. The flood wave amplitude at Nakhon Phanom was 3.84m, calculated over a 25 days' flood duration time and 10 days' rising time. Heavy rains in the upper part of the LMB were caused by the combined influences of typhoon LINFA, the SWs and the ITCZs.

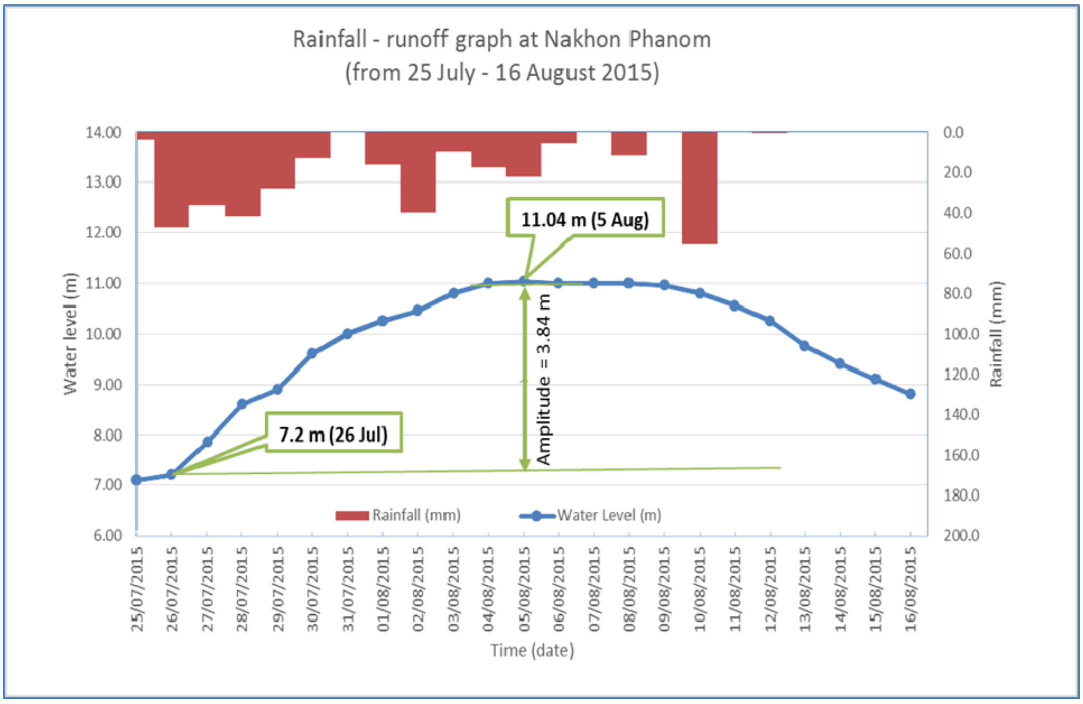


Figure 2-14 Rainfall – runoff graph at Nakhon Phanom (25 July – 16 August 2015).

Table 2-12 illustrates the distribution of the daily rainfall at mainstream stations along LMB from 25 July to 16 August, covering a large part of the duration of Flood event 1. Heavy rain was concentrated in the period from 26 July until 05 August. The total accumulated rainfall during the flood event (from 25 July to 16 August) was calculated in 349.4 mm in Nakhon Phanom. See Table 2-12 and Figure 2-13 for more details.

Table 2-12 Precipitation observed in the mainstream stations during the 2015 flood season.

Time (dd/mm/yyyy)	Nakhon Phanom	Thakhek	Mukdahan	Savnannakhet	Khong Chiam	Pakse
25/07/2015	3.80	3.80	2.30	nr	0.50	24.20
26/07/2015	47.20	36.70	12.50	17.80	27.00	7.40
27/07/2015	36.30	37.30	28.50	6.00	6.70	nr
28/07/2015	42.00	35.80	5.00	8.20	8.70	nr
29/07/2015	27.80	33.70	22.00	10.20	3.20	nr
30/07/2015	13.20	11.10	3.70	nr	6.80	nr
31/07/2015	0.00	16.10	4.20	3.20	2.20	4.40
01/08/2015	16.10	21.40	8.70	9.60	7.70	nr
02/08/2015	39.80	40.70	6.00	5.60	2.70	nr
03/08/2015	9.80	9.40	3.60	1.50	22.70	nr
04/08/2015	17.80	10.20	22.10	62.00	32.70	nr
05/08/2015	22.20	13.60	21.50	nr	23.90	nr
06/08/2015	5.60	1.20	3.80	17.50	0.00	nr
07/08/2015	0.00	nr	18.70	9.80	2.10	nr
08/08/2015	11.70	6.90	2.80	nr	0.00	11.00
09/08/2015	0.00	nr	4.80	nr	0.00	nr
10/08/2015	55.80	45.70	0.90	nr	23.10	36.10
11/08/2015	0.00	nr	4.30	21.20	11.80	1.80
12/08/2015	0.30	nr	0.00	nr	4.20	nr
13/08/2015	0.00	6.40	0.00	nr	11.10	nr
14/08/2015	0.00	nr	0.00	nr	0.00	nr
15/08/2015	0.00	nr	0.00	nr	0.00	nr
16/08/2015	0.00	nr	0.00	nr	0.00	nr
Total rainfall	**349.40**	**330.00**	**175.40**	**172.60**	**197.10**	**84.90**

For stations from Stung Treng to Chau Doc (Downstream part)

During the 2015 flood season, the WLs of all stations in the downstream part, section a, fluctuated below the LTA. From the middle of June until the beginning of July a slight flood appeared due to the combined impacts of WSs and LTPs.

There were three minor flood events which have been identified as follows:

- i) 14 June – 10 July,
- ii) 28 July - 24 August, and
- iii) 01 – 25 September.

The minor flood events will be analysed for each of the 3 sections.

For stations from Stung Treng to Kampong Cham (Downstream part, Section a)

The minor Flood event 1, from 14 June until the middle of July, was caused by the upstream station inflow (flood wave propagation) in combination with the meteorological effects of the WSs and ICTZs. Heavy rain in the upper part of the LMB led to increasing WLs, although all WLs remained below the LTA until the beginning of the minor Flood event 2. The minor Flood event 2 is related to the period from 28 July until 24 August. The WLs in this period remained below the LTA, until a slight increase of the WLs was recorded in the first half of September. Subsequently a slight Flood event 3 was recorded in the period 01 September until 25 September.

See Figure 2-14 and Table 2-13 for more details.

Table 2-13 Flood event characteristics from Stung Treng to Kampong Cham.

Stations	Flood Event	Peak of Flood Event									Flood Amplitude (m)	Intensity of Flood Rising			Comment
		Flood beginning		Peak			Flood end								
		Time beginning (date)	Water level (m)	Time of peak (date)	Water level (m)	Rising time (days)	Time end (date)	Water level (m)	Downing Time	flood duration time (days)		Interval of I_{max} (Date)	I_{max} (m/day)	Iaverage (m/day)	
Stung Treng	**Flood event 1**	18-Jun	3.02	25-Jun	4.47	7	07-Jul	3.03	12	19	1.45	24 - 25/Jun	0.44	0.21	SWs,ITCZs,TLPs
	Flood event 2	28-Jul	5.96	13-Aug	8.41	16	22-Aug	5.81	9	25	2.45	29 - 30/Jul	0.41	0.15	SWs,ITCZs,TLPs
	Flood event 3	31-Aug	6.23	05-Sep	7.81	5	22-Sep	6.22	17	22	1.58	1 -2/Sep	0.62	0.32	SWs,ITCZs,TLPs
Kratie	**Flood event 1**	14-Jun	7.54	27-Jun	11.2	13	08-Jul	8.42	11	24	3.66	24- 25/Jun	0.8	0.28	SWs,ITCZs,TLPs
	Flood event 2	29-Jul	13.9	14-Aug	18.21	16	23-Aug	13.92	9	25	4.31	31/Jul - 1/Aug	0.57	0.27	SWs,ITCZs,TLPs
	Flood event 3	01-Sep	14.85	06-Sep	17.34	5	24-Sep	14.58	18	23	2.49	2-3/Sep	0.78	0.50	SWs,ITCZs,TLPs
Kampong Cham	**Flood event 1**	15-Jun	3.05	27-Jun	5.95	12	09-Jul	3.69	12	24	2.90	25 - 26/Jun	0.64	0.24	SWs,ITCZs,TLPs
	Flood event 2	29-Jul	7.43	14-Aug	12.16	16	26-Aug	8.69	12	28	4.73	31/Jul - 1/Aug	0.42	0.30	SWs,ITCZs,TLPs
	Flood event 3	01-Sep	9.48	06-Sep	11.43	5	25-Sep	9.46	19	24	1.95	2-3/Sep	0.62	0.39	SWs,ITCZs,TLPs

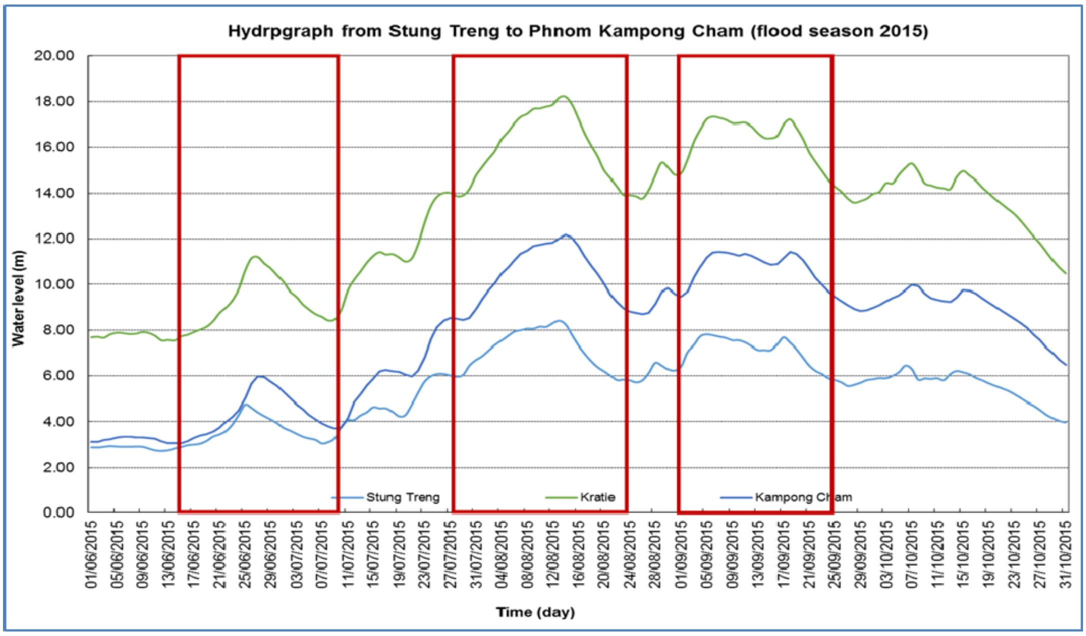


Figure 2-15 Rapidly rising of water levels from Stung Treng to Kampong Cham.

For stations from Phnom Penh Bassac Chaktomuk / Phnom Penh Port to Koh Khel / Neak Luong / Prek Kdam (Downstream part, Section b)

Like before, three distinct Flood waves can be distinguished. Two critical factors defined the behavior in this section: less precipitation in the upper and middle parts of the LMB and therefore less upstream station inflow at Phnom Penh Bassac (Chaktomuk), especially during the September, the main month of the flood season. WLs fluctuated below the LTA.

From the middle of June until the middle of July a small early flood event, Flood event 1, was identified recorded due to the effects of WSs and LTPs. From the end of July to the end of August a bigger flood event, Flood event 2, was observed. This period was impacted by WSs and, ICTZs in combination with flood wave propagation from the upper part of the LMB, which brought heavy rain which raised the water levels. A minor third flood event has been identified in September. This wave has not been analysed in detail.

See Table 2-14 and Figure 2-15 for more details.

Table 2-14 Flood event characteristics from Phnom Penh Bassac Chaktomuk / Phnom Penh Port to Koh Khel / Neak Luong / Prek Kdam.

Stations	Flood Event	Peak of Flood Event									Flood Amplitude (m)	Intensity of Flood Rising			Comment
		Flood beginning		Peak			Flood end								
		Time beginning (date)	Water level (m)	Time of peak (date)	Water level (m)	Rising time (days)	Time end (date)	Water level (m)	Downing Time	flood duration time (days)		Interval of I_{max} (Date)	I_{max} (m/day)	Iaverage (m/day)	
Phnom Penh Bassac Chaktomouk	Flood event 1	19-Jun	2.09	28-Jun	3.14	9	10-Jul	2.16	12	21	1.05	25 - 26/Jun	0.3	0.12	SWs,ITCZs,TLPs
	Flood event 2	20-Jul	4.7	14-Aug	7.09	25	26-Aug	5.4	12	37	2.39	24 - 25/Jul	0.35	0.10	SWs,ITCZs,TLPs
Phnom Penh Port	Flood event 1	21-Jun	1.18	28-Jun	2.16	7	11-Jul	1.24	13	20	0.98	24 - 25/Jun	0.65	0.14	SWs,ITCZs,TLPs
	Flood event 2	30-Jul	3.7	15-Aug	6.12	16	26-Aug	4.44	11	27	2.42	22 - 23/Jul	0.46	0.15	SWs,ITCZs,TLPs
Koh Khel	Flood event 1	19-Jun	1.98	28-Jun	2.9	9	10-Jul	2.2	12	21	0.92	25-26/Jun	0.28	0.10	SWs,ITCZs,TLPs
	Flood event 2	30-Jul	4.24	15-Aug	6.21	16	24-Aug	4.94	9	25	1.97	3 - 4/Aug	0.23	0.12	SWs,ITCZs,TLPs
Neak Luong	Flood event 1	24-Jun	1.48	28-Jun	2.2	4	08-Jul	1.48	10	14	0.72	25 - 26/Jun	0.3	0.18	SWs,ITCZs,TLPs
	Flood event 2	02-Aug	3.77	15-Aug	5.06	13	25-Aug	3.86	10	23	1.29	3-4/Aug	0.27	0.10	SWs,ITCZs,TLPs
Prek Kdam	Flood event 1	23-Jun	1.28	28-Jun	2.24	5	09-Jul	1.28	11	16	0.96	25 - 26/Jun	0.31	0.19	SWs,ITCZs,TLPs
	Flood event 2	03-Aug	4.53	15-Aug	5.86	12	26-Aug	4.58	11	23	1.33	4-5/Aug	0.22	0.11	SWs,ITCZs,TLPs

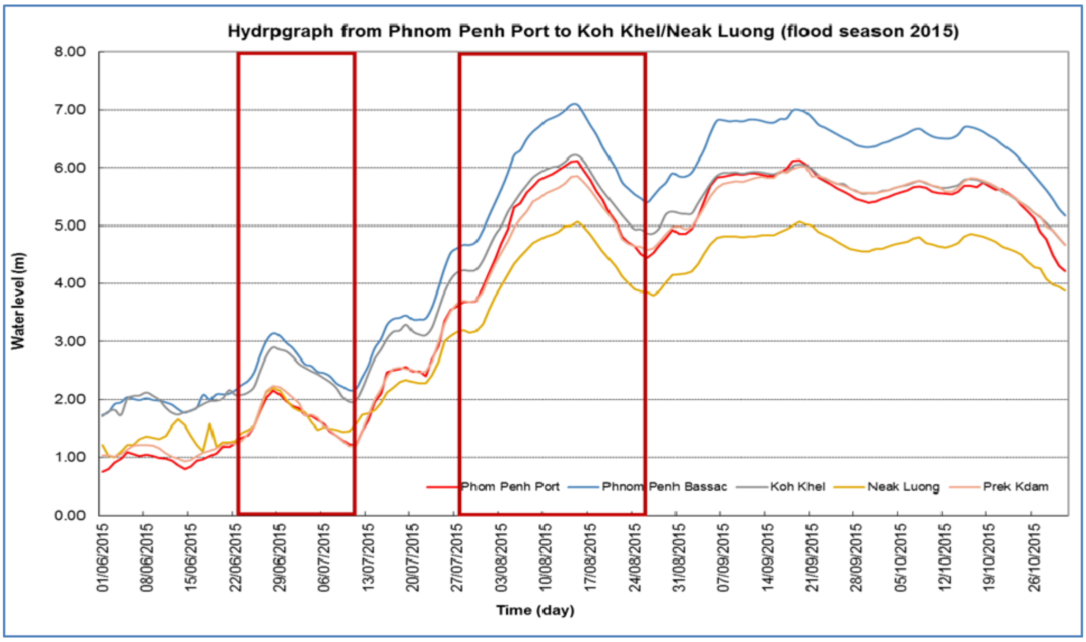


Figure 2-16 Hydrographic at stations Phnom Penh Bassac Chactomuk / Phnom Penh Port to Koh Khel / Neak Luong / Prek Kdam.

For stations Tan Chau and Chau Doc (Downstream part, Section c)

From the middle/end of June to the end of July there is only minor flood wave propagation from the upper and middle parts of LMB. Therefore water levels in the two stations in the Mekong Delta of Vietnam fluctuated by tide only.

However, in early August, due to the combination of high tides and low flow from the upper and middle parts of the LMB, water levels at Tan Chau and Chau Doc dropped quickly to below the LTA. According to the observed data recorded; monthly maximum water levels during the 2015 flood season at Tan Chau were

2.45m on 15 August and Tan Chau was 2.09m on 16 August; 0.3m and 0.65m respectively less than the LTA.

In September and October the stations Tan Chau and Chau Doc were impacted by three high tides; the highest took place by the end of October (26 – 28 Oct). According to the daily WL data from the Hydmet's database, the maximum water levels at Tan Chau and Chau Doc during the 2015 flood season were 2.43m on 26 October; 1.07m below the Tan Chau alarm level, and 2.31m on 26 October; 0.69m below the Chau Doc alarm level.

In summary, it should be noted that the 2015 peak flood level at Tan Chau and Chau were at their lowest level since 1926. This was caused by the effects of the 2015-2016 El Niño weather phenomenons. The 2015 flood season ended early.

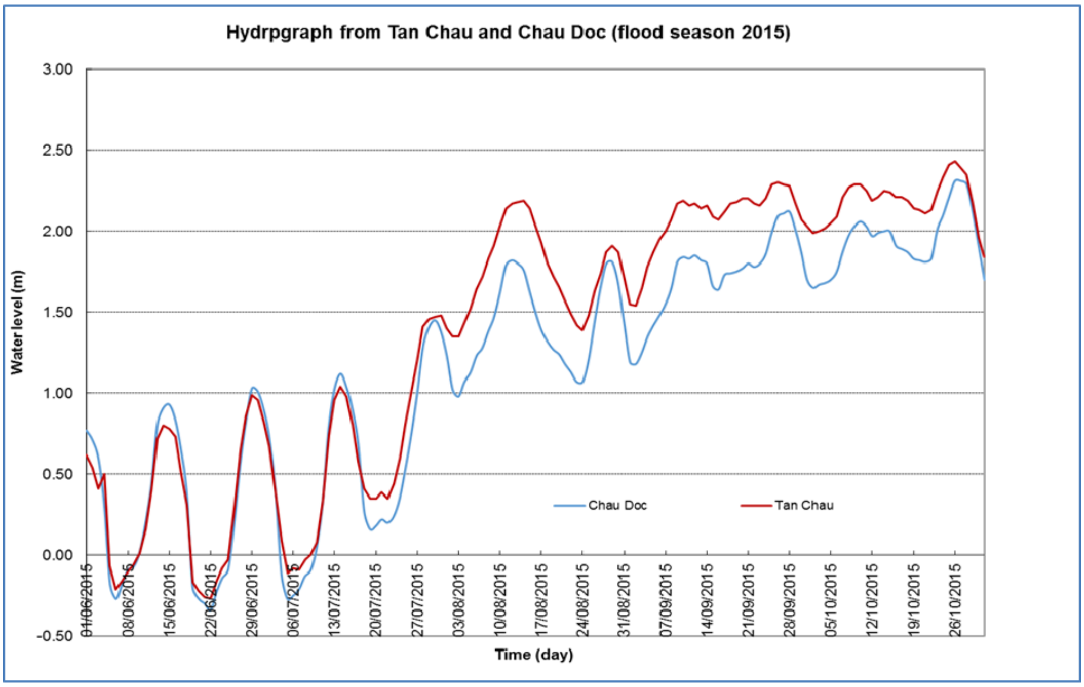


Figure 2-17   Hydrographic at stations at Tan Chau and at Chau Doc.

3. FLOOD FORECAST IN 2015

3.1 Data collection for models and flood forecast bulletin dissemination

Daily data collection consisted of hydrological and meteorological data (observed water levels and rainfall) by HydMet from Line Agencies, Satellite Rainfall Estimate (SRE) and Numerical Weather Prediction (NWP) obtained from NOAA which served as inputs for the Mekong Flood Forecasting System (FFS). The performance indicators are shown in the Tables and Graphs of the forecast achievement. Please see Annex B, Table B3, Figure B2 to Figure B4.

The results of the evaluation show that the data from most of LAs normally arrived before 09:00am. Please see Annex B, Table B3 and Figure B2. The manual data collected by HydMet was checked by LAs; hence, the quality of data is in general terms fairly good. However, there are a number of unavoidable problems in data transmission such as the late transfer of data, errors and especially missing data during five months of this flood season. See for more details Annex B, Table B3 and the performance graphs.

Satellite Rainfall Estimation and Numerical Weather Prediction inputs for the URBS / FEWS, were the most important factors to determine forecast results. Following the investigations and comments of the forecaster-in-charge in the weekly reports throughout the 2015 flood season, it is found that the high variability in both SRE and NWP was one of the main reasons which lead to large errors of forecast results, especially when the weather patterns caused heavy rain as tropical storms, southwest monsoon and ITCZ.

Performance indicators of bulletin delivery) shows that the flood bulletins containing flood situation information were disseminated timely to the registered national Line Agencies, MRC website, and other interested users around 10:30am, which is a prescribed time in the Operational Manual. Please see Annex B, Table B3 and Figure B4. It can be seen that the time of flood forecasting bulletin delivery in July to October of the flood season was a bit later than 10:30am. This was due to two main factors:

- The late transfer and incomplete of data from LA’s usually occurred during flood season.

- The low water level together with significant tidal effect in the downstream of the LMB, which resulted in difficulties for forecaster-in-charge in analysing and adjusting forecast results and which consequently lead to the late bulletin dissemination.

3.2 Accuracy and limitations in forecasting

A detailed report is compiled by the RFMMC titled: "*Flood Forecasting Performance in the 2015 Flood Season*" and is available on the MRC website. Therefore in this paragraph the accuracy and limitations of the flood forecasting will be summarised.

During flood season 2015, like in any flood season, the degree of accuracy varies from station to station. The shorter the lead time, the more accurate will be the forecast. See Annex B, Table B1.

The evaluation of the forecast achievement is presented in Table B1 by indicating the % of days "successful" against a respective benchmark presented in Table B2. Please note that the present benchmark is narrower than those used before the year 2012, with the purpose of 'continuously enhancing the forecast accuracy'. In general, the forecast errors for all lead times at all stations along the Mekong River did not show large differences, except for Paksane, Pakse and Kratie, which were strongly affected by tropical storms. In these stations accuracies for 3-5 day forecast lead times were less than expected, if following "the benchmarks of success". See Annex A, Table A1.

Forecast errors for 3-5 day lead times were less than 0.90m for all stations in LMB, although the worse was at Luang Prabang times. See Figure B1: Average flood forecast accuracy along the Mekong mainstream, Annex B. For the lower reach of the Mekong River, it can be seen that the use of a regression model is quite promising. Stations downstream from Phnom Penh Bassac, show average errors for 1-day and 2-day forecasts smaller than 0.05m and 0.10m respectively, while average errors for 4-day to 5-day forecasts were smaller than 0.25m.

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

- *Internal model functionality in forecasting at tidal affected stations in downstream:* 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 was another reason leading to poor results for forecast at stations in the upstream of LMB. The forecast results at Luang Prabang were a specific illustration of this. The forecast performances by mean absolute error in using original forecast results from both regression and ISIS models were presented in Figure 2-15 and Figure 2-16 respectively. It was easily realized that the average error for 3-day to 5-day forecasts at Koh Khel, Neak Luong, Prek Kdam and Tan Chau were under 0.1m for Regression model as compared to ISIS model.

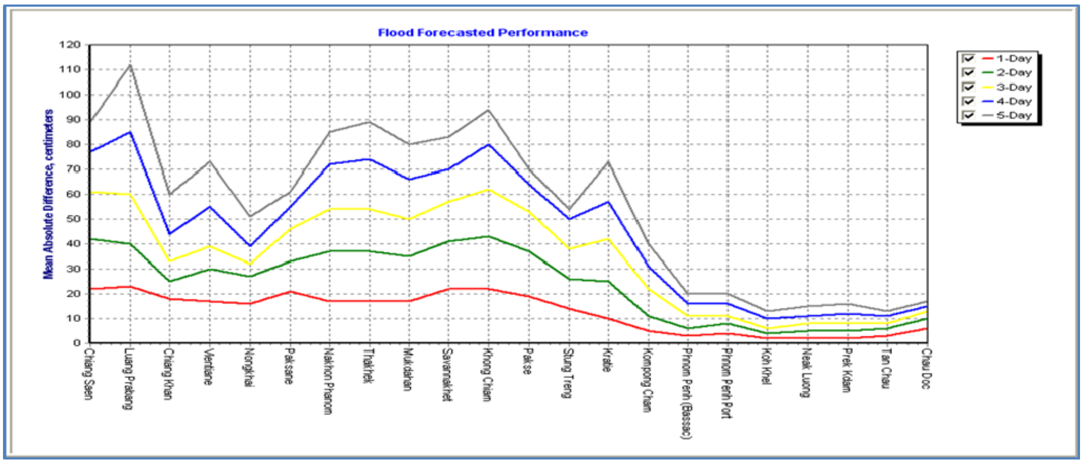


Figure 3-1 Forecast performance based on original results by URBS and Regression.

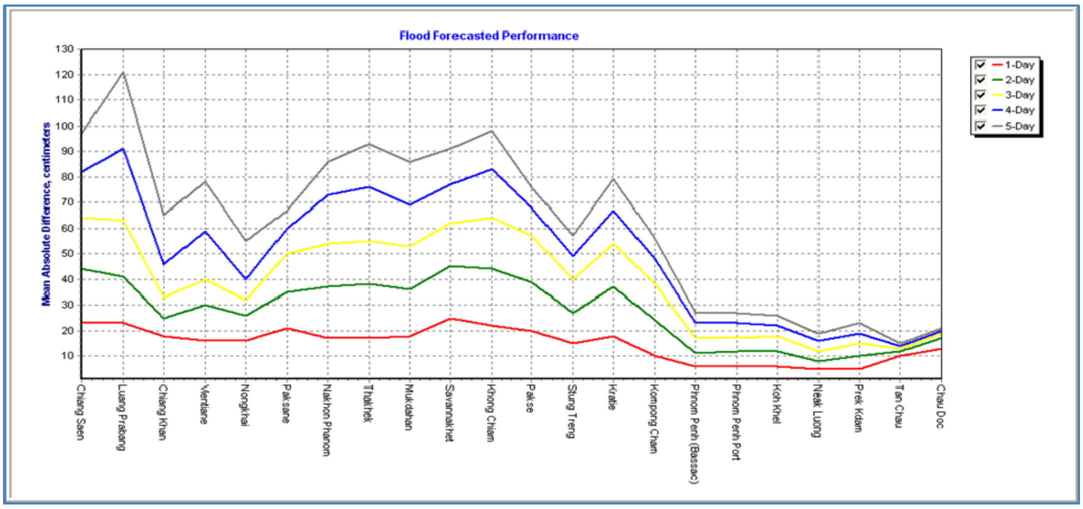


Figure 3-2 Forecast performance based on original results by URBS and ISIS

- *The high variability of satellite rainfall estimate (SRE) and Numerical Weather Prediction (NWP):* SRE rainfall was used instead of observed rainfall, and the NWP model provided a 7-day GFS rainfall forecast. NWP and SRE can provide a 'highly variable rainfall forecast' leading to high variation of forecast results, especially at stations in the upper and middle reaches when critical weather patterns such as tropical storms occur. Based on weekly investigation of the forecasting team, the original forecast results calculated from the model caused relatively large errors as compared to observations. This was a practical difficulty for forecaster-in-charge in forecast adjustment.
- *The quality and accuracy of forecast is also determined by the quality of forecast adjustment, which was usually performed by forecaster-in-charge so their knowledge, expertise and experiences were also the prominent determinant of the final forecast result*.

3.3 Lesson learned and actions to be taken

The following lessons have been drawn from the 2015 flood season, which can serve 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 the deciding factors for forecast results and accuracy. A Senior International Satellite Precipitation Expert was engaged by the RFMMC in 2010 to develop a tool of bias correction of SRE to produce 'corrected SRE' rainfall inputs. The product depends very much on observed rainfalls provided from Line Agencies, which may contain lot of missing data. See Annex B, Table B3 and Figure B3. 'Corrected SRE' can provide better results if there are less missing data.
- The data from stations in the upstream of the Mekong River system in China is very important for analysing and forecasting in the LMB, not only during the flood season but also during the dry season. Hydrological and meteorological data from stations belonging to China need as much and as often as possible to be shared during dry season of 2015-2016.
- Strengthening the relationship 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.

- Improving model calibration by updating the rating curves and other parameters at stations in the MRC's member countries to be supported by Line Agencies. During the middle of the 2015 flood season a) an updated ISIS model was inserted (also the boundary condition was moved from Stung Treng to Kratie), b) the Regression model was extended (max/min parameters and new database from 2000 to 2014 was applied), and c) the URBS model was partly recalibrated. The correctness and consistency of the results will have to be tested and verified over the upcoming flood seasons.
- The forecaster-in-charge needs to have more understanding of sub-basin characteristics, flow regime of left bank tributaries in the middle part of the LMB where frequently intensive rainfall and flooding occurs as well as more understanding of influences of tidal regime to the downstream of the LMB.

Apart from the above-mentioned lessons in order to improve the accuracy of flood forecasting for next flood season 2016, a number of additional actions need to be undertaken as follows:

- Continue to efficiently use water levels and rainfall of the existing two stations: Jinghong and Manan of China. Analyse the impact of water release from dams to the water levels at Jinghong and to water level changes at stations in the upper part, such as at Chiang Saen and Luang Prabang, especially during transitional period between dry and wet season.
- Watch and follow closely situations of the sudden increases in water levels of the left bank tributaries in the middle part of the LMB, such as Ban Mixay and Muong Ngoy, Moung Mai, Moung Kao, Ban Phone Si, Se Kong River at Vuen Khen, Se Bang Fai River at Mahaxai to better understand the impacts of weather patterns causing intensive rainfall by Typhoon or Tropical Depression occurrences in the East Sea, and/or by the formation of low-pressure trough-line and Inter Tropical Convergence Zone (ITCZ) and sometimes the critical activity of the Southwest monsoon.
- Through forecast results of water levels during the 2015 flood season at downstream stations using the Regression Model were evaluated as 'fairly good', it should be explained why the errors for 3-day and 4-day forecasts at Tan Chau and Chau Doc, where water levels are affected by the tide, were "high", although the flood forecaster referred to the tidal regime forecast

documentation in 2015, provided by National Centre for Hydro-meteorology of Viet Nam.

- Learn more about the weather products of rainfall forecast published on the websites of the World Meteorological Organization and their practical applications.
- 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.
- Promote the installation of 7 additional automatic stations in mainstream stations of the LMB (Paksane, Thakhek, Savannakhet, Kampong Cham, Phnom Penh Port, Koh Khel and Neak Luong) that hitherto are equipped with staff gauges and where manual readings are carried out, as this would provide the MRC the opportunity of producing a second daily flood forecast during critical flood situations.

For more details see the following Annex:

Annex A;

- Graphs and Tables for monthly observed rainfall distribution during flood season 2015
- Graphs for monthly rainfall in flood season from 2000 to 2015 and long-term average along the Mekong River
- Tables of flood event characteristics along the Mekong River during flood season 2015

Annex B:

- Graph for flood forecast accuracy along the Mekong mainstream
- Table of forecast achievement
- Tables and graphs for performance

Annex C:

- Seasonal Water Level Graphs

Annex A Graphs and Tables

1. Graphs and Tables for monthly observed rainfall distribution during flood season 2015

Table A1 Monthly observed rainfall in flood season 2015.

Unit in mm

2015	Jinghong	Chiang Saen	Luang Prabang	Chiang Khan	Vientiane	Nong Khai	Paksane	Nakhon Phanom	Thakhek	Mukdahan	Savannakhet	Khong Chiam	Pakse	Stung Treng	Kratie	Kampong Cham	Phnom Penh (Bassac)	Koh Khel	Neak Luong	Prek Kdam	Tan Chau	Chau Doc
June	97.50	100.20	90.40	141.90	184.60	73.30	188.80	2.10	146.00	60.50	48.40	103.80	178.60	245.50	111.90	175.10	49.50	190.50	148.30	42.80	29.20	76.40
July	205.10	228.90	176.70	198.60	488.80	351.50	1272.10	711.20	798.30	275.60	268.40	289.00	108.60	251.10	121.50	156.30	81.70	177.40	40.80	70.50	96.90	89.80
August	157.70	262.00	257.50	84.40	272.80	335.40	1017.00	470.70	550.70	168.10	221.20	318.90	203.70	340.50	138.90	242.00	237.70	134.50	118.50	208.30	64.00	130.20
September	164.50	145.00	172.20	201.20	318.60	309.80	405.80	269.60	349.90	259.00	201.10	253.40	183.20	227.00	247.00	230.60	330.90	221.10	189.20	218.10	315.90	226.70
October	139.00	122.20	121.40	65.10	103.60	136.80	63.60	105.00	100.70	90.90	116.10	0.00	216.50	266.60	201.80	104.70	245.10	249.60	180.40	127.10	171.00	250.50

(*) due to cooperation agreement between MRC and China, the observed data for Jinghong are available from 01 June to 31 October only

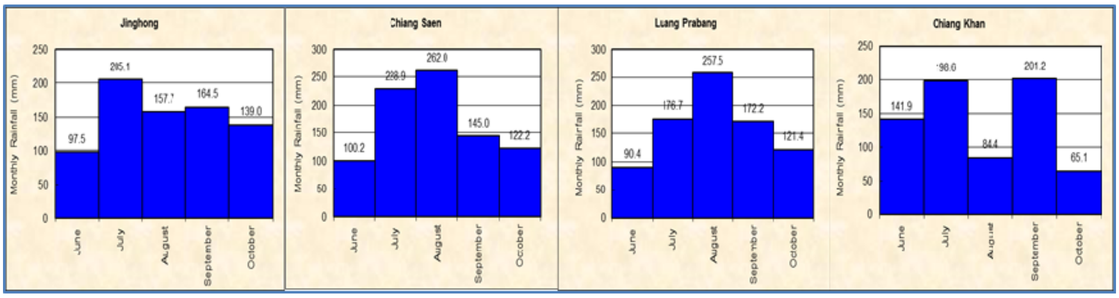


Figure A1 **Monthly rainfall distribution for Jinghong, Chiang Saen, Luang Prabang and Chiang Khan.**

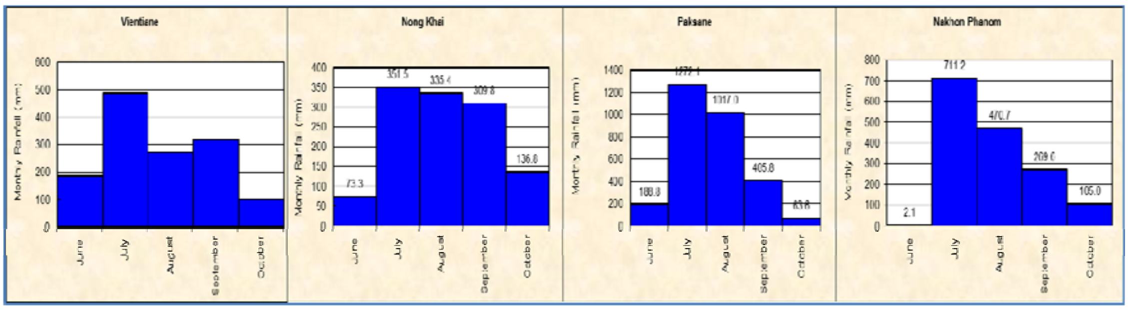


Figure A2 Monthly rainfall distribution for Chiang Khan, Vientiane, Nong Khai, Paksane and Nakon Phanom.

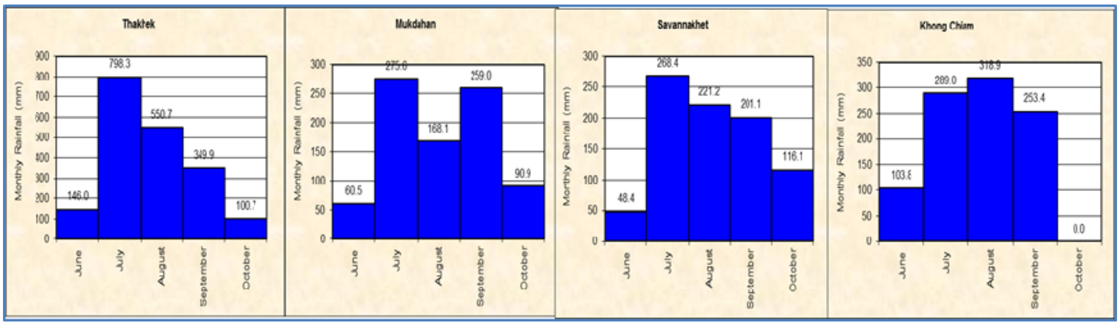


Figure A3 Monthly rainfall distribution for Thakhek, Mukdahan, Savannakhet and Khong Chiam.

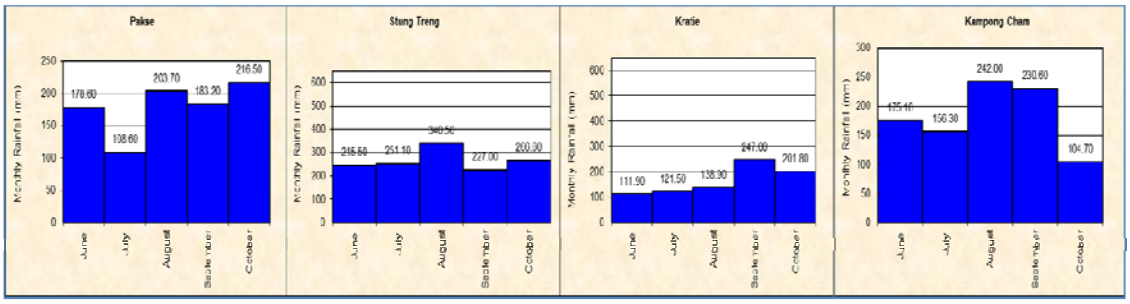


Figure A4 Monthly rainfall distribution for Pakse, Stung Treng, Kratie and Kampong Cham.

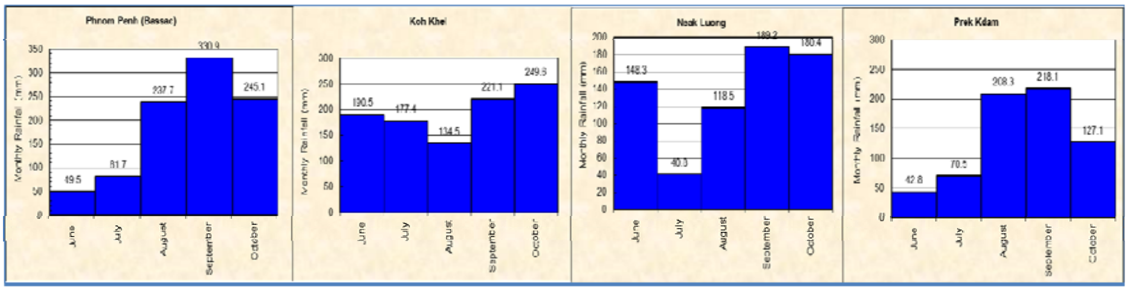


Figure A5 Monthly rainfall distribution for Phnom Penh (Bassac and Port), Koh Khel and Neak Luong.

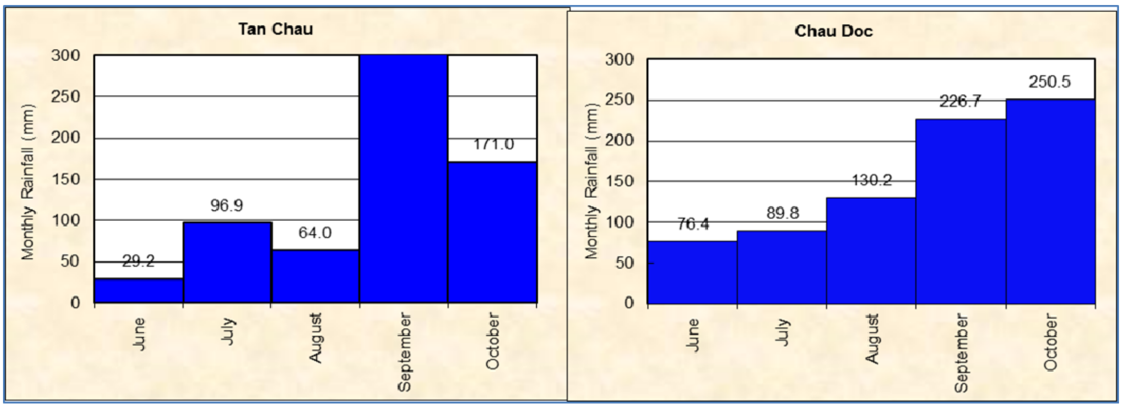


Figure A6 Monthly rainfall distribution for Prek Kdam, Tan Chau and Chau Doc.

2. Graphs for monthly rainfall in flood season from 2000 to 2015 and long-term average along the Mekong River

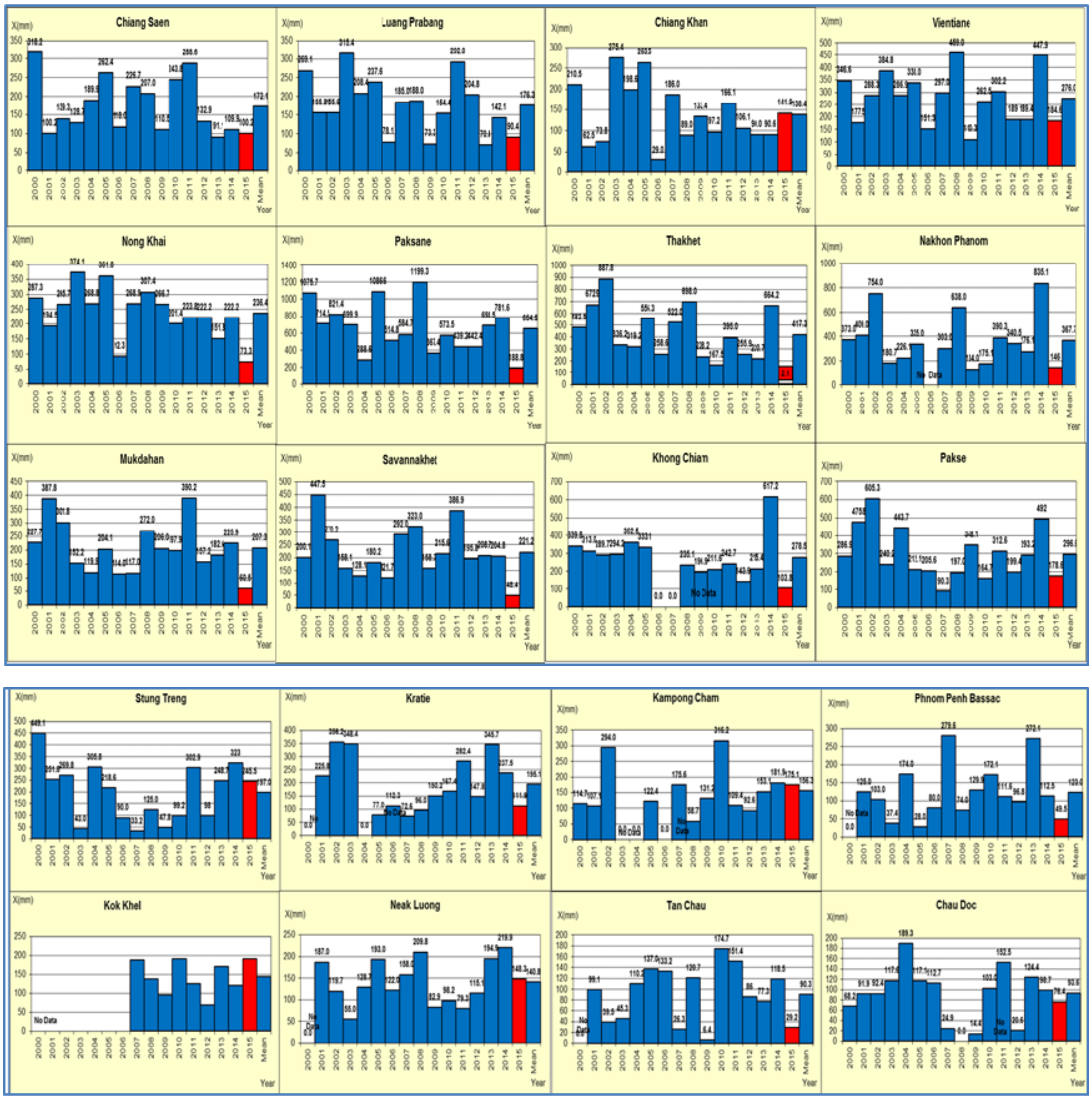


Figure A7 Monthly rainfall in June for main stations along the Mekong River.

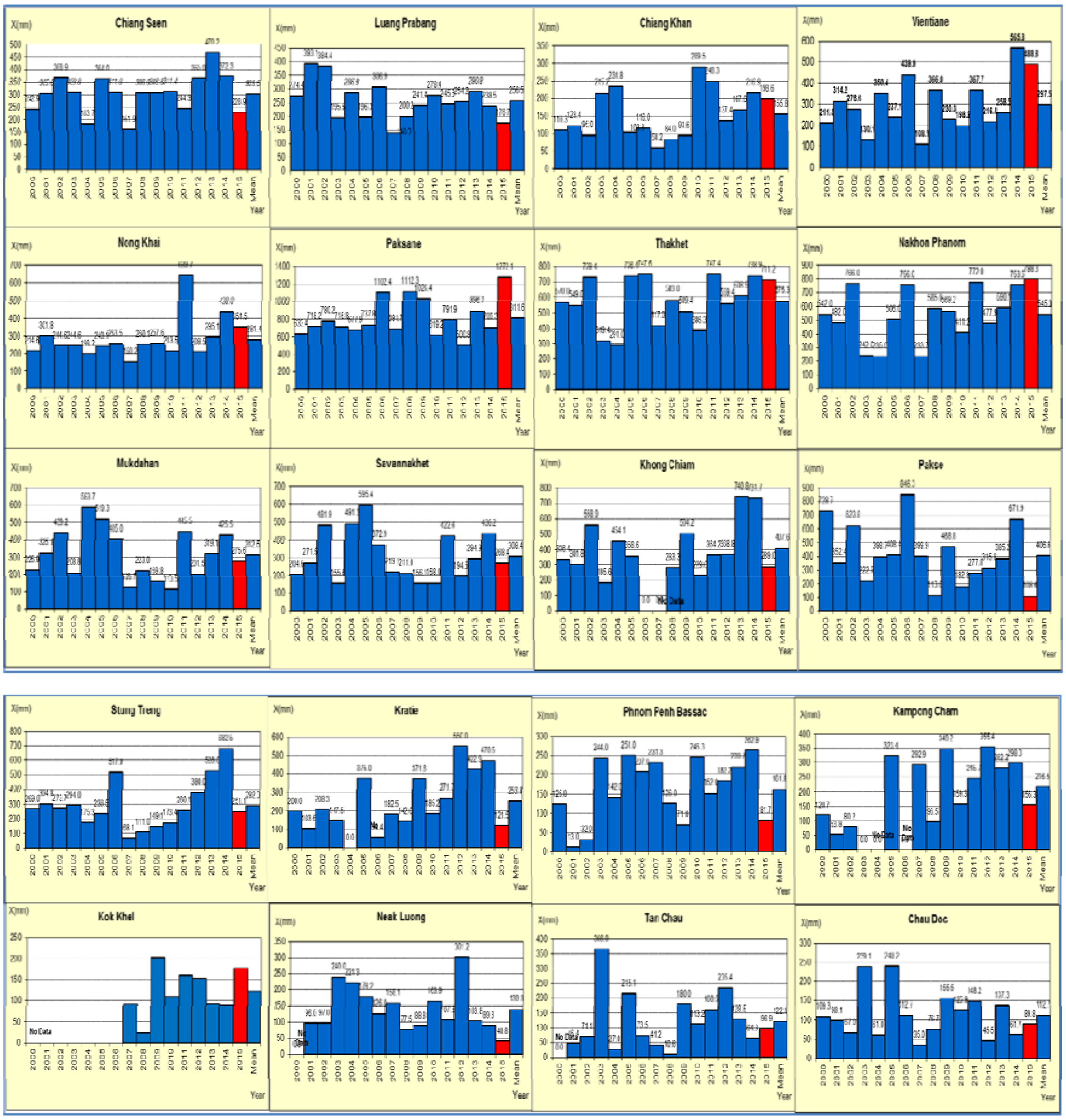


Figure A8 Monthly rainfall in July for main stations along the Mekong River.

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

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

Figure A 11 Monthly rainfall in October for main stations along the Mekong River.

Annex B Accuracy and performance

Accuracy

Accuracy is one of the factors to establish the quality of the forecast results, and is describes here as the difference in centimeters between the approved results of the Mekong-Flood Forecasting System of the RFMMC ('adjusted' or 'not adjusted' by the Flood Forecaster in charge) and the 1-, 2-, 3-, 4- and 5-day measured and reported water levels by the Line Agencies. The 'adjustment' by the Flood Forecaster in charge takes into consideration known biases in input data and his/her knowledge of the response of the model system and the hydrology of the Mekong Basin River Basin.

The graphical information presented below, is showing the average flood forecasting accuracy of the stations along the Mekong River. In general, the accuracy was 'good' during the 2015 flood season for all forecasts lead times. However, the accuracy for 03 days forecast lead time at all stations was 'not good'. Please see Figure B1 and Table B1 for more details.

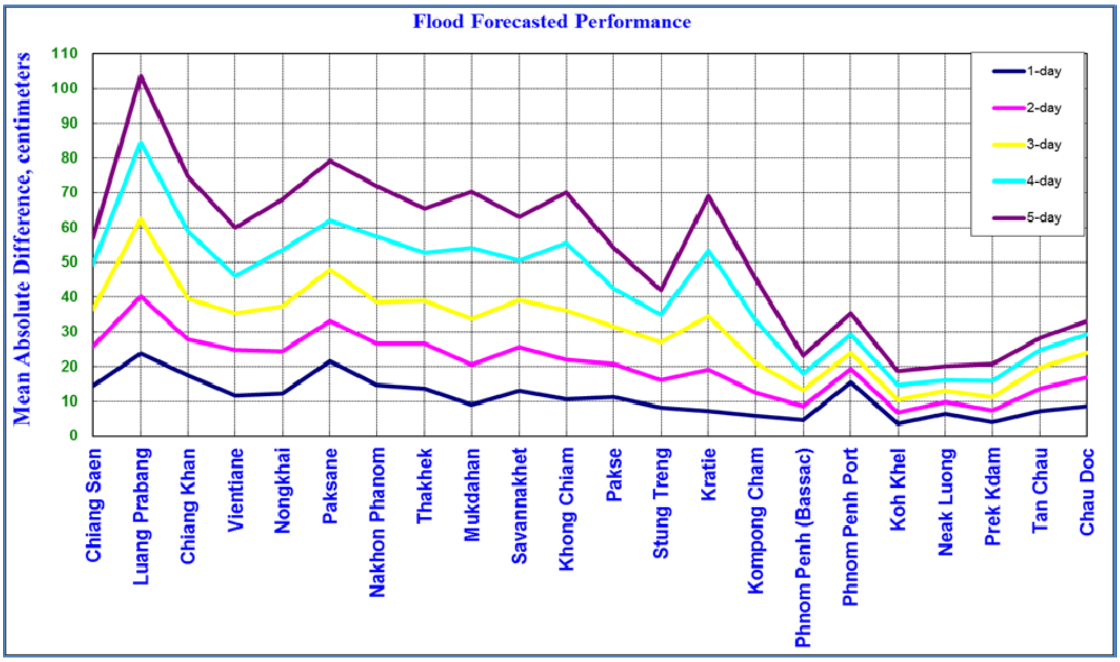


Figure B1 Average flood forecast accuracy along the Mekong mainstream.

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 %

2015	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	85.5	66.4	78.9	61.2	61.8	44.7	49.3	61.8	72.4	61.2	67.8	65.1	69.7	80.9	84.9	89.5	77.6	94.7	85.5	92.8	80.9	75.0	***73.1***
2-day	84.8	75.5	84.8	61.6	64.9	54.3	64.9	64.2	77.5	60.9	72.8	72.2	78.8	73.5	86.8	68.2	58.9	80.1	66.2	72.8	56.3	44.4	***69.3***
3-day	75.2	55.0	72.5	47.0	45.0	40.3	47.0	46.3	55.0	41.6	49.7	57.0	63.1	47.7	87.9	47.7	42.3	59.7	52.3	55.7	39.6	34.2	***52.8***
4-day	81.8	58.8	75.7	65.5	62.8	55.4	61.5	62.2	65.5	62.2	62.8	73.6	74.3	57.4	75.0	37.8	63.5	47.3	78.4	78.4	30.4	27.7	***61.7***
5-day	76.9	49.7	52.4	59.2	53.7	45.6	49.7	51.0	55.8	54.4	51.0	67.3	70.1	46.9	63.3	63.9	53.1	74.1	68.7	71.4	57.1	49.7	***58.4***

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

Unit in cm

2015	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	25	25	25	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2-day	50	50	50	25	25	25	25	25	25	25	25	25	25	25	25	10	10	10	10	10	10	10
3-day	50	50	50	25	25	25	25	25	25	25	25	25	25	25	25	10	10	10	10	10	10	10
4-day	75	75	50	50	50	50	50	50	50	50	50	50	50	50	50	10	25	10	25	25	10	10
5-day	75	75	50	50	50	50	50	50	50	50	50	50	50	50	50	25	25	25	25	25	25	25

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).*
A new set of performance indicators that is established by combining international standards and the specific circumstances in the Lower Mekong Basin, is applied officially for the flood season of 2013 onward.

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 2015 from June to October.

2015	FF completed and sent (time)	stations without forecast	FF2 completed and sent (time)	Weather informaition 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	*10:11*	*0*	*-*	*17*	*08:15*	*07:43*	*07:42*	*07:08*	*08:31*	*07:40*	*07:09*	*3*	*0*	*3*	*0*	*688*	*17*	*0*
July	*10:20*	*0*	*-*	*15*	*08:15*	*07:42*	*07:09*	*07:11*	*08:41*	*07:47*	*07:09*	*1*	*1*	*0*	*0*	*670*	*4*	*4*
August	*10:15*	*0*	*-*	*15*	*08:15*	*07:40*	*07:17*	*07:08*	*08:32*	*07:39*	*07:10*	*11*	*0*	*1*	*0*	*713*	*0*	*39*
September	*10:14*	*0*	*-*	*19*	*08:15*	*07:38*	*07:15*	*07:10*	*08:40*	*07:45*	*07:09*	*1*	*0*	*1*	*14*	*568*	*18*	*0*
Octorber	*10:10*	*0*	*-*	*16*	*08:14*	*07:39*	*07:14*	*07:07*	*08:49*	*07:54*	*07:05*	*1*	*0*	*5*	*34*	*635*	*9*	*0*
Season	*10:13*	*0*	*-*	*82*	*08:15*	*07:40*	*07:18*	*07:07*	*08:39*	*07:43*	*07:08*	*17*	*1*	*10*	*139*	*3460*	*48*	*68*

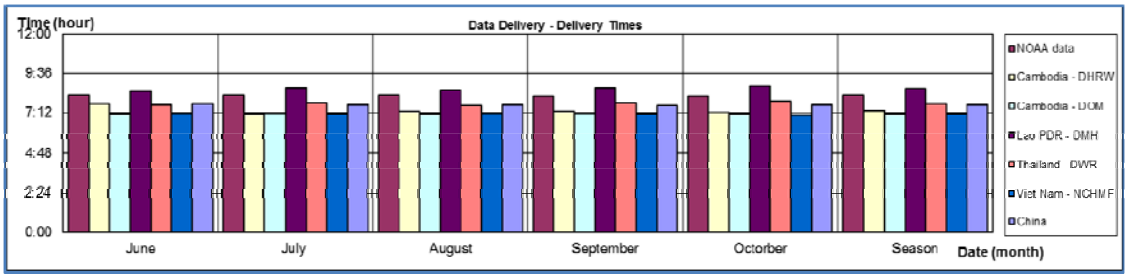


Figure B2 Data delivery times for flood season 2015 from June to October.

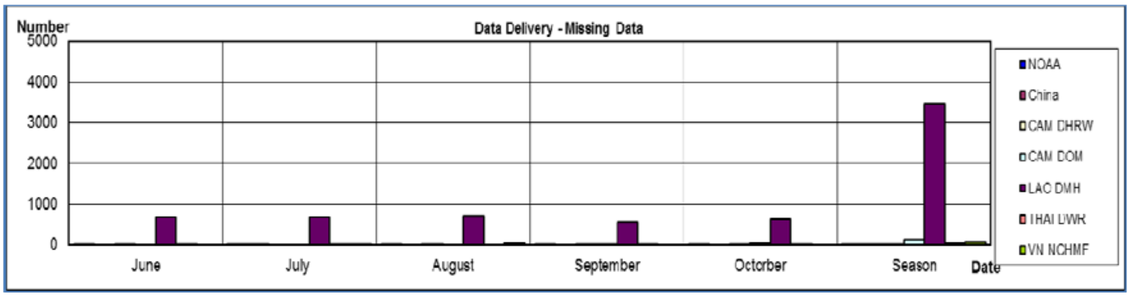


Figure B3 Missing data for flood season 2015 from June to October

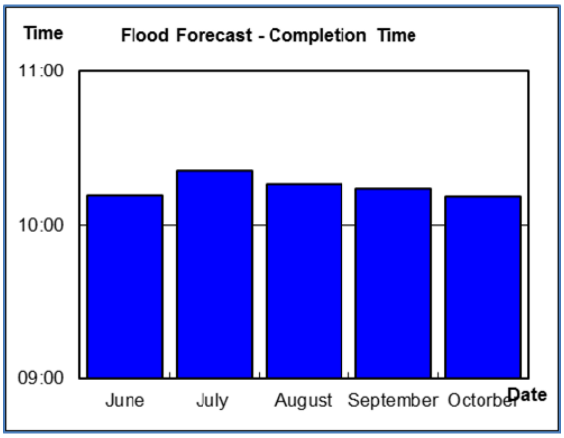


Figure B4 Flood forecast completion time.

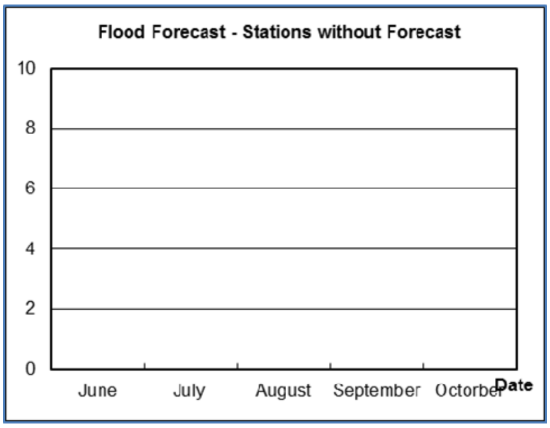


Figure B5 Flood forecast stations without forecast

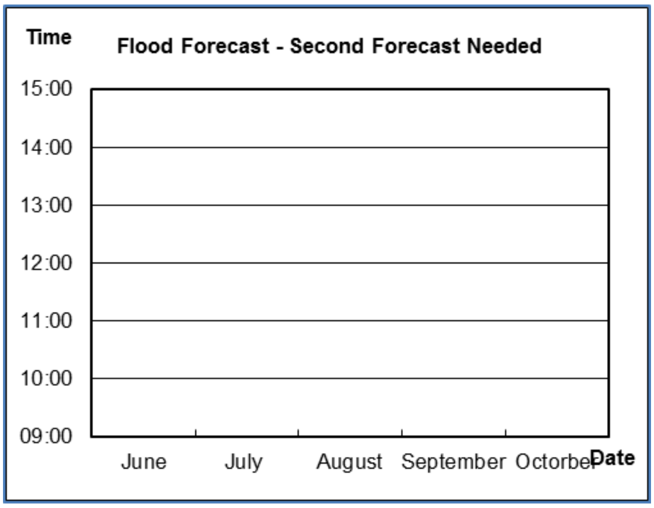
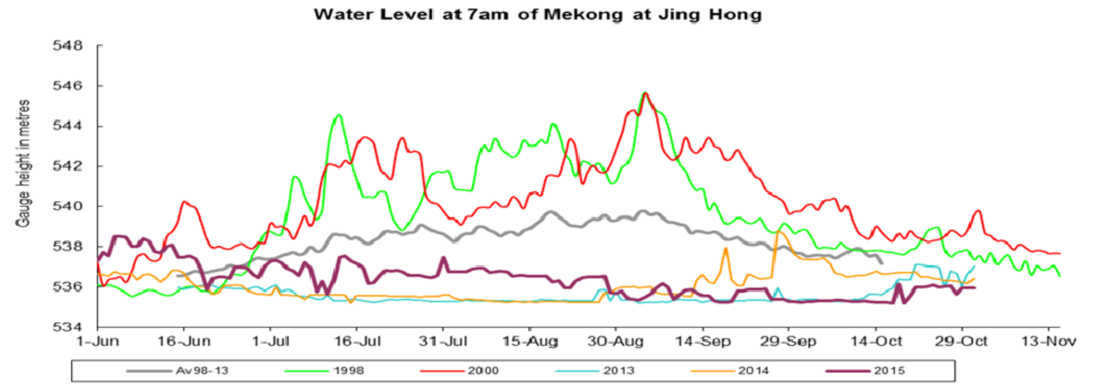


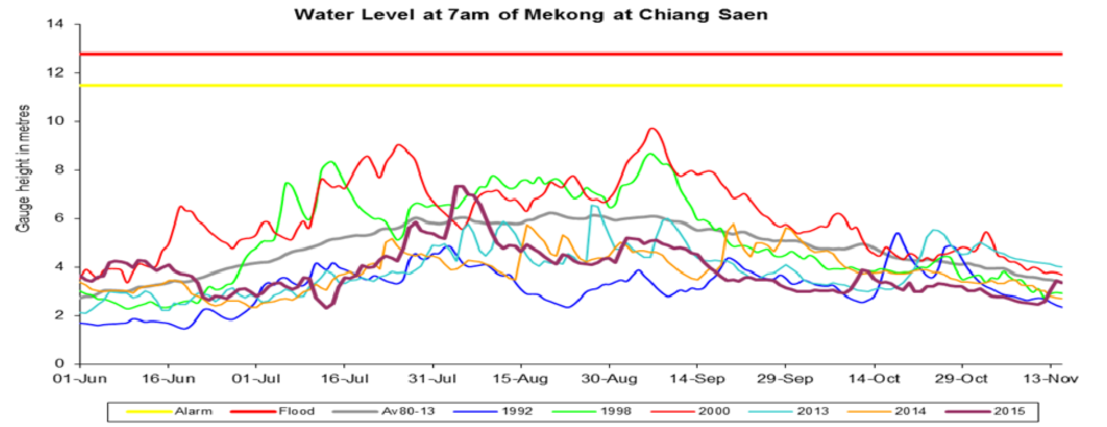
Figure B6 Second forecast needed

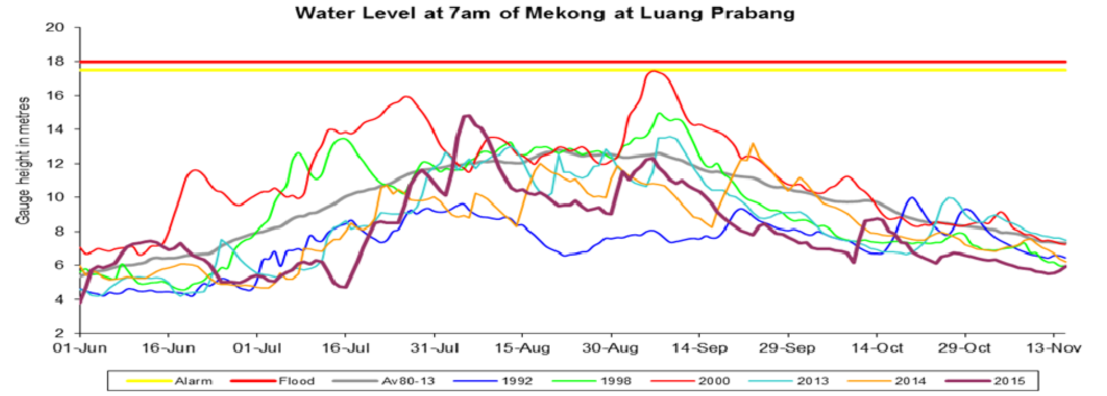
Annex C Season Water Level Graphs

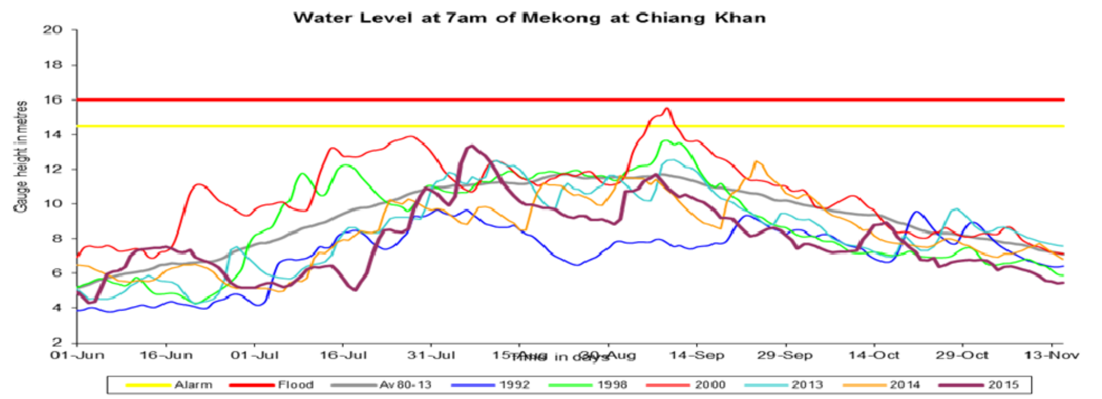
Annex C has the water level graphs of the report date at each of the mainstream stations covering the entire flood season 2015 as well a number of chosen characteristic years. The water level graphs have been distributed daily by email together with the Flood Bulletins.

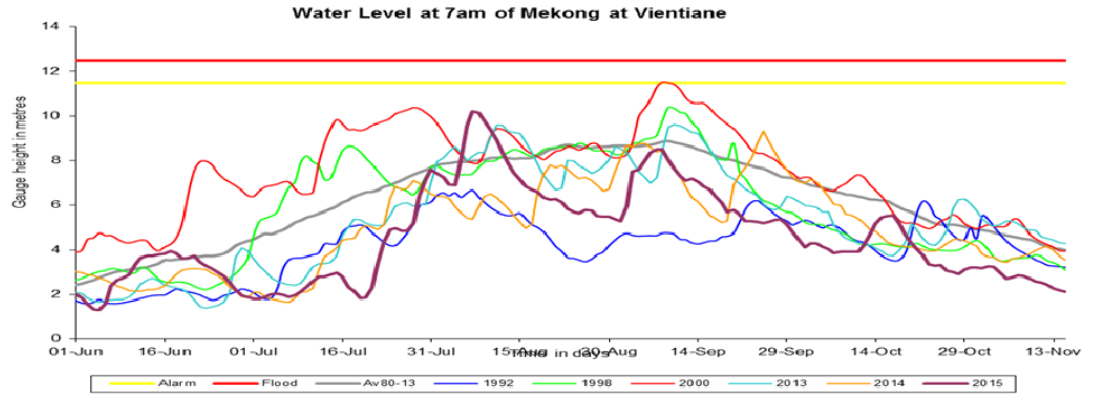
HYDROGRAPHS OF THE MEKONG AT MAINSTREAM STATIONS IN FLOOD SEASON FROM 1 JUNE TO OCTOBER








Water Level at 7am of Mekong at Chiang Khan
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm Flood Av 80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Mekong at Vientiane
Gauge height in metres
Time in days
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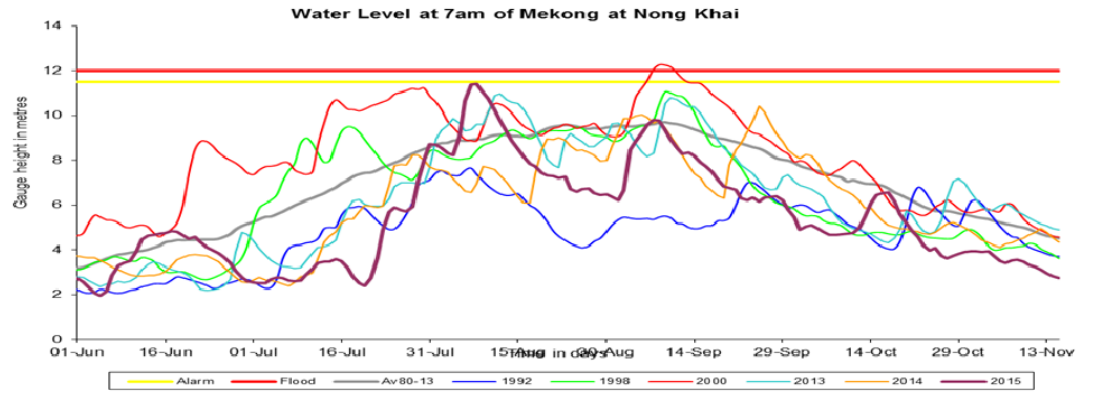
Alarm Flood Av 80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Mekong at Nong Khai
Gauge height in metres
Time in days
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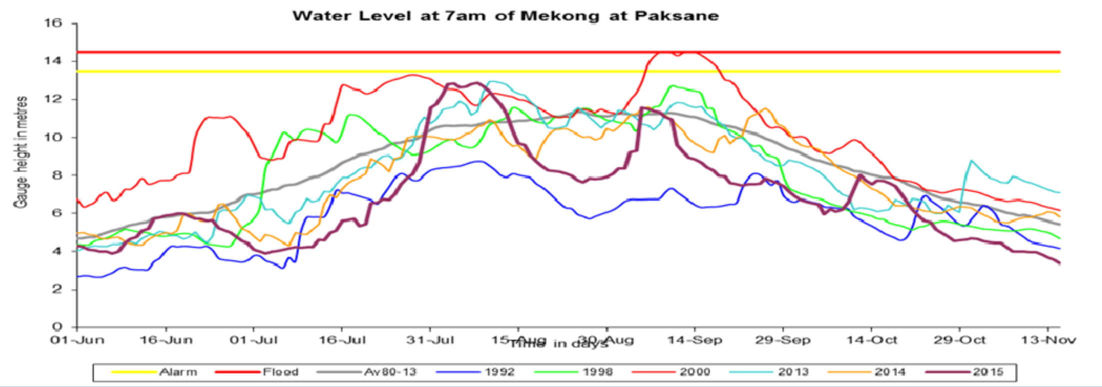
Alarm Flood Av 80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Mekong at Paksane
Gauge height in metres
Time in days
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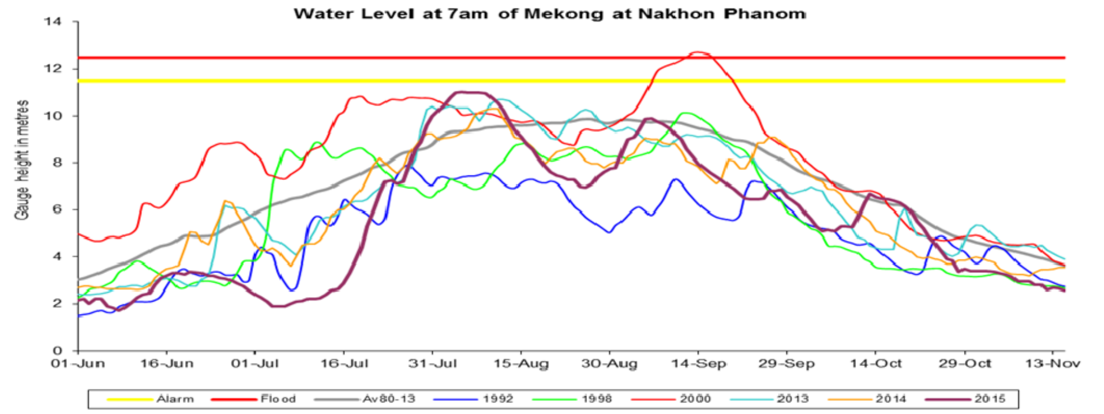
Alarm Flood Av 80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Mekong at Nakhon Phanom
Gauge height in metres
0
2
4
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01-Jun
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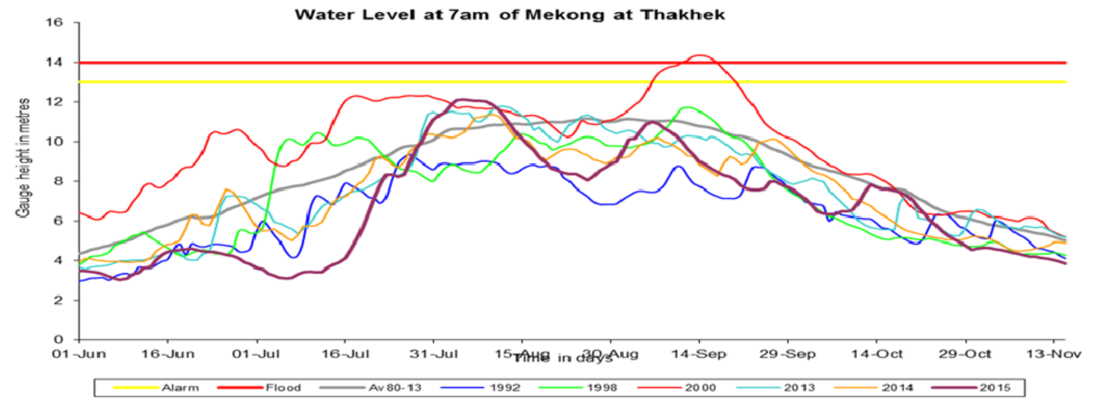
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov
Alarm
Flood
Av80-13
1992
1998
2000
2013
2014
2015


Water Level at 7am of Mekong at Thakhek
Gauge height in metres
0
2
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01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
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13-Nov
Time in days
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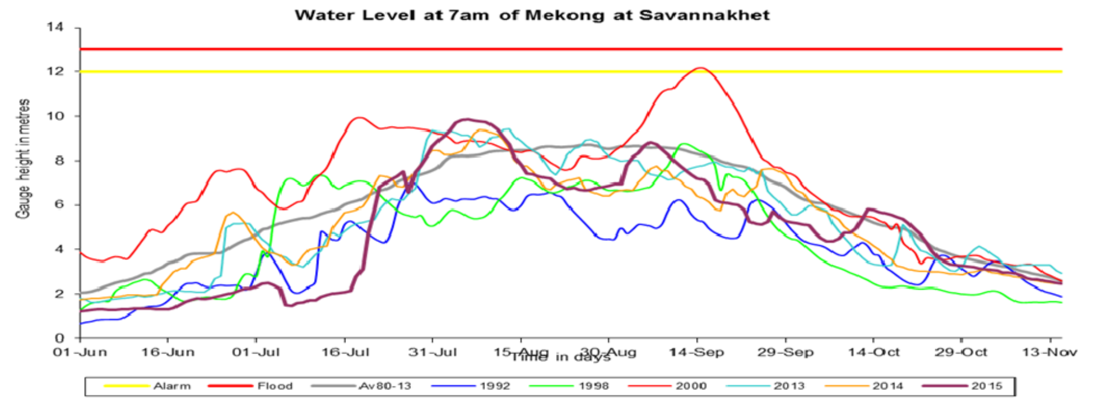
2014
2015


Water Level at 7am of Mekong at Savannakhet
Gauge height in metres
0
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16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
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14-Sep
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14-Oct
29-Oct
13-Nov
Time in days
Alarm
Flood
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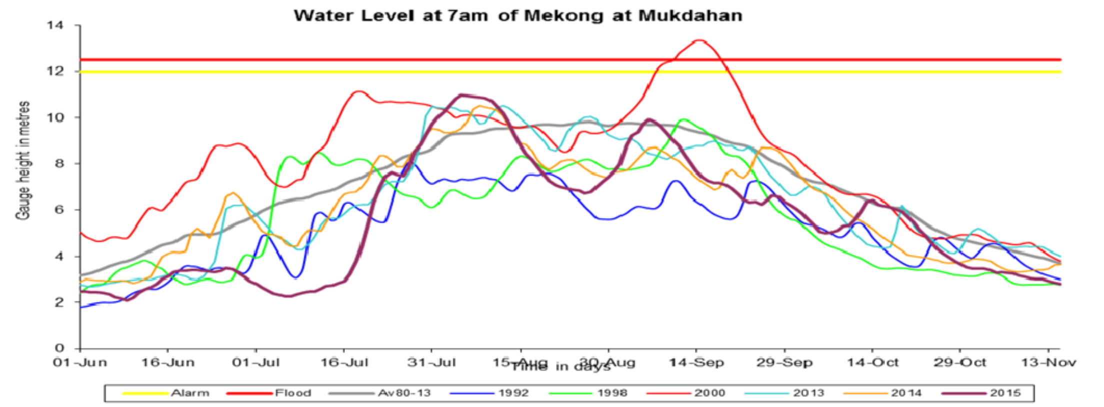
Water Level at 7am of Mekong at Mukdahan
Gauge height in metres
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01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov
Time in days
Alarm
Flood
Av80-13
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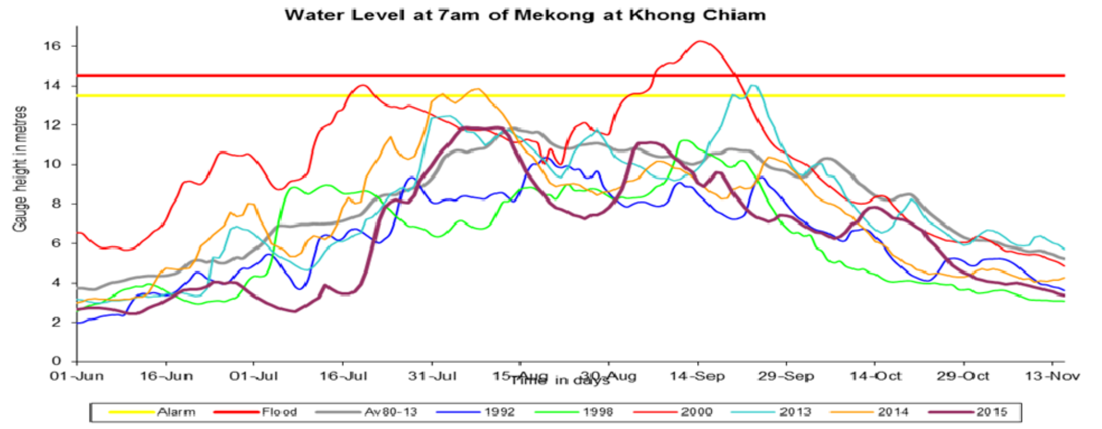
2014
2015


Water Level at 7am of Mekong at Khong Chiam
Gauge height in metres
0
2
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01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
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13-Nov
Time in days
Alarm
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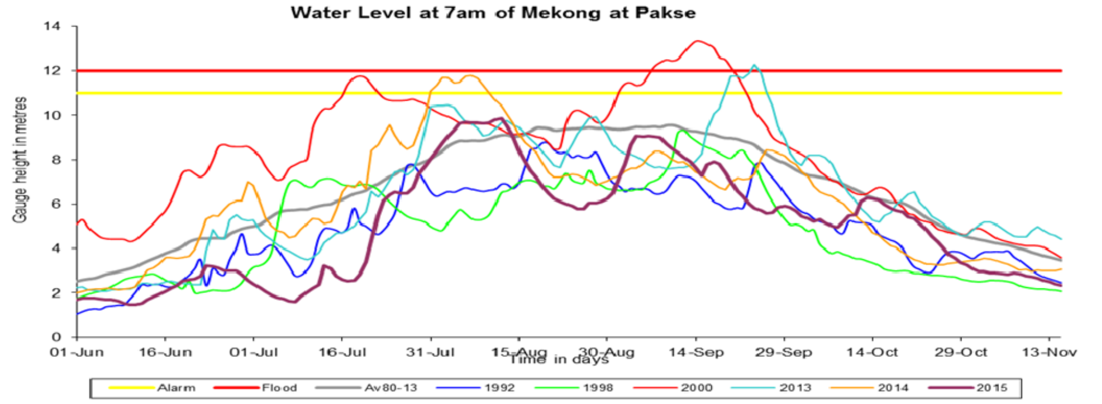
Water Level at 7am of Mekong at Pakse
Gauge height in metres
0
2
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8
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01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
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13-Nov
Time in days
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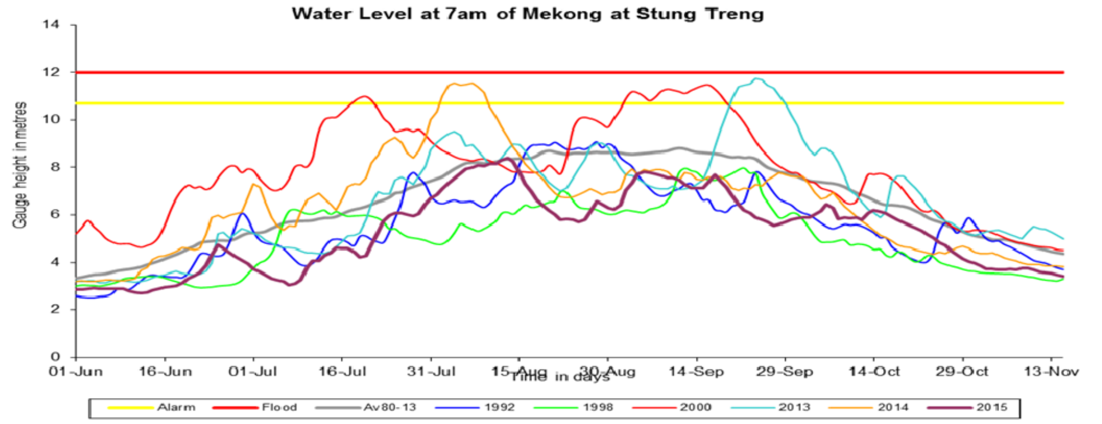
2014
2015


Water Level at 7am of Mekong at Stung Treng
Gauge height in metres
0
2
4
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8
10
12
14
01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov
Time in days
Alarm
Flood
Av80-13
1992
1998
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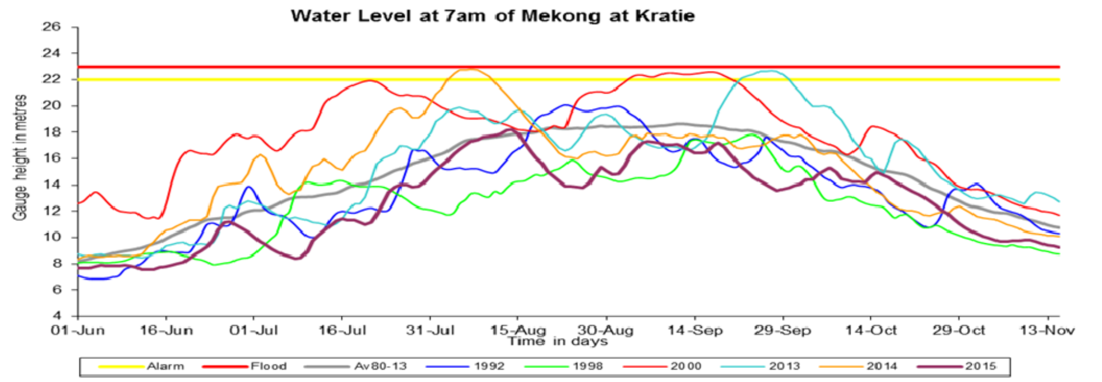
2013
2014
2015


Water Level at 7am of Mekong at Kratie
Gauge height in metres
4
6
8
10
12
14
16
18
20
22
24
26
01-Jun
16-Jun
01-Jul
16-Jul
31-Jul
15-Aug
30-Aug
14-Sep
29-Sep
14-Oct
29-Oct
13-Nov
Time in days
Alarm
Flood
Av80-13
1992
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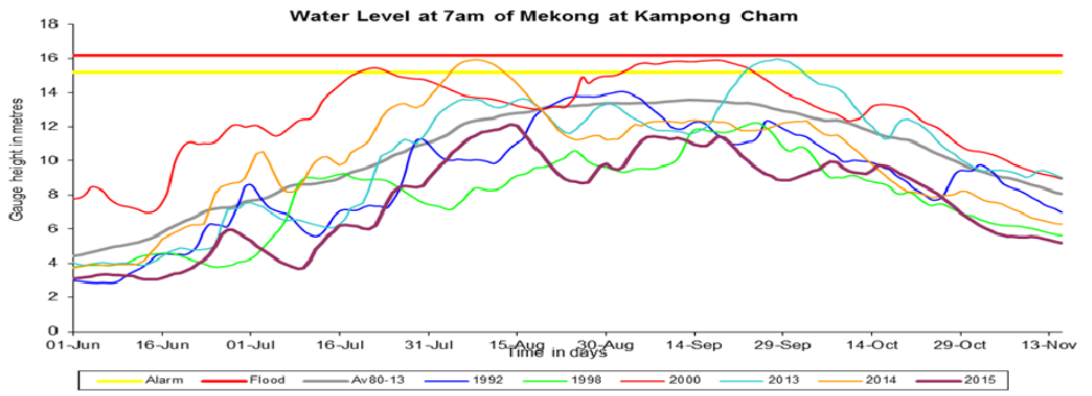
2015


Water Level at 7am of Mekong at Kampong Cham
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm
Flood
Av80-13
1992
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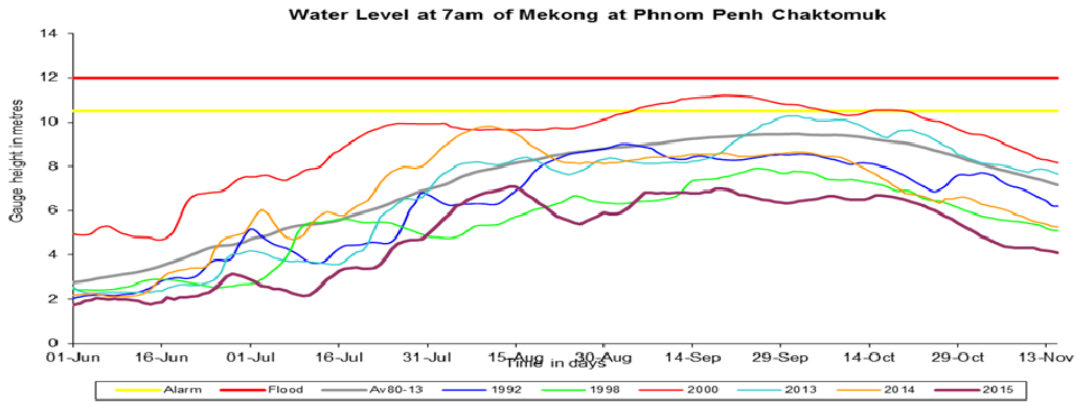
Water Level at 7am of Mekong at Phnom Penh Chaktomuk
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm
Flood
Av80-13
1992
1998
2000
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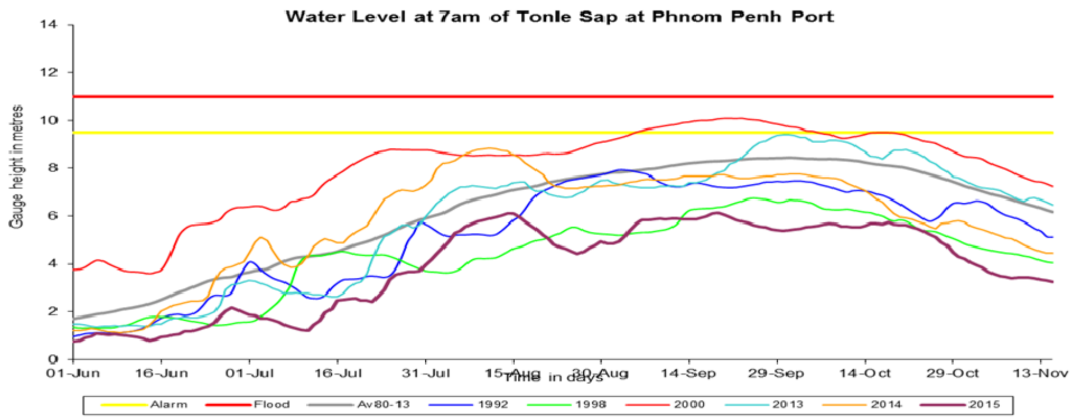
2014
2015


Water Level at 7am of Tonle Sap at Phnom Penh Port
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm
Flood
Av80-13
1992
1998
2000
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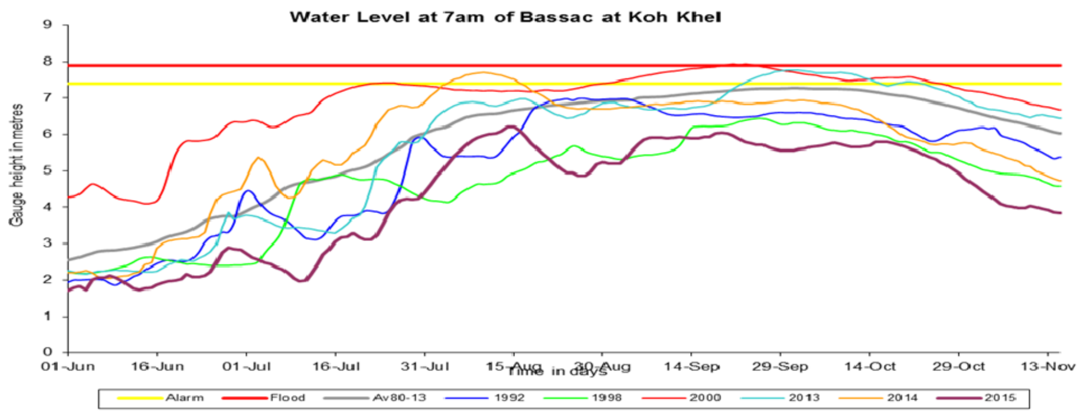
2015


Water Level at 7am of Bassac at Koh Khel
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm
Flood
Av80-13
1992
1998
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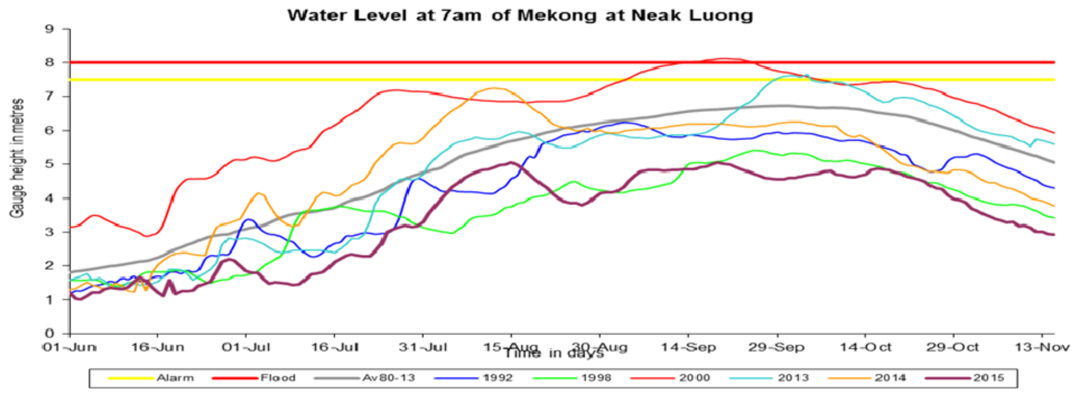
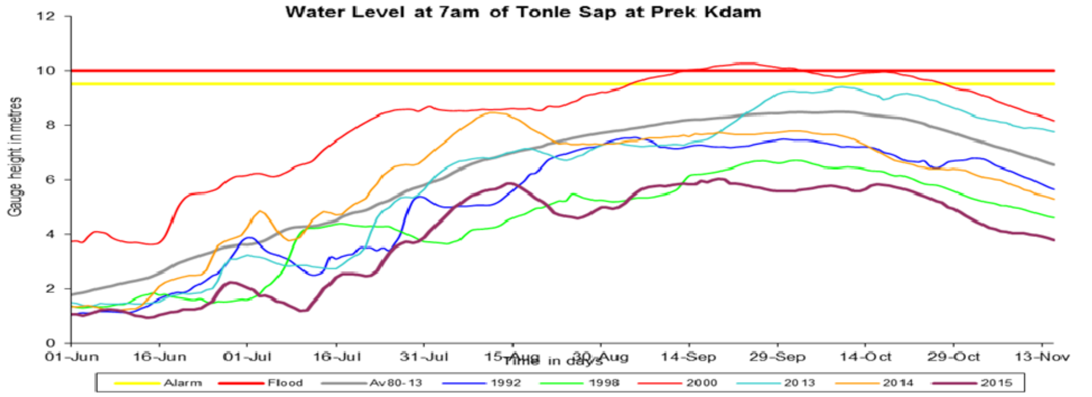
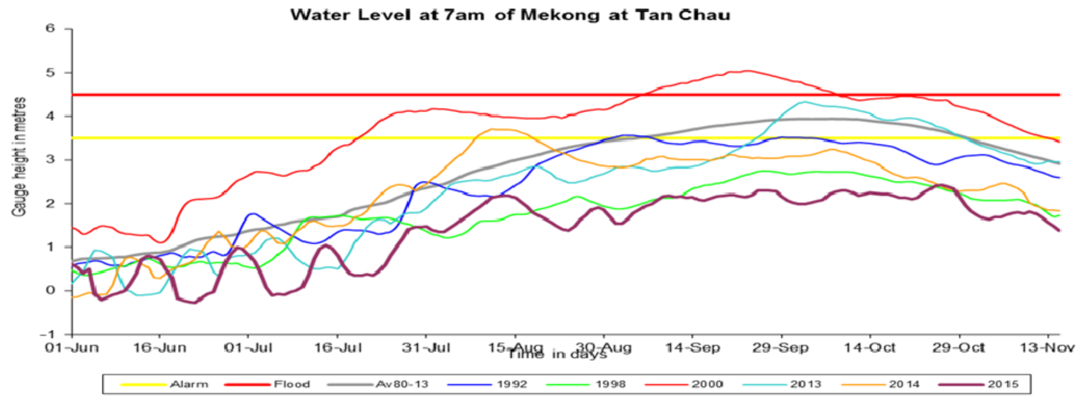
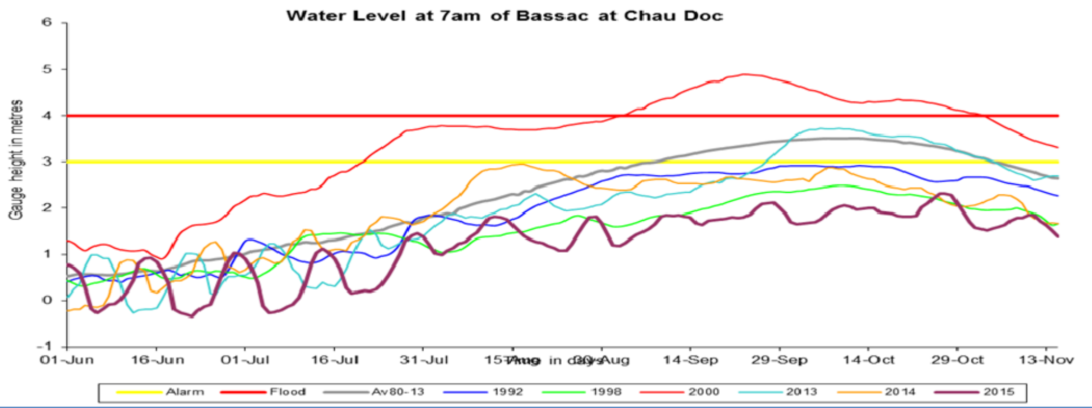

Water Level at 7am of Mekong at Neak Luong
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm Flood Av80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Tonle Sap at Prek Kdam
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm Flood Av80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Mekong at Tan Chau
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm Flood Av80-13 1992 1998 2000 2013 2014 2015


Water Level at 7am of Bassac at Chau Doc
Gauge height in metres
Time in days
01-Jun 16-Jun 01-Jul 16-Jul 31-Jul 15-Aug 30-Aug 14-Sep 29-Sep 14-Oct 29-Oct 13-Nov
Alarm Flood Av80-13 1992 1998 2000 2013 2014 2015