



Mekong River Commission

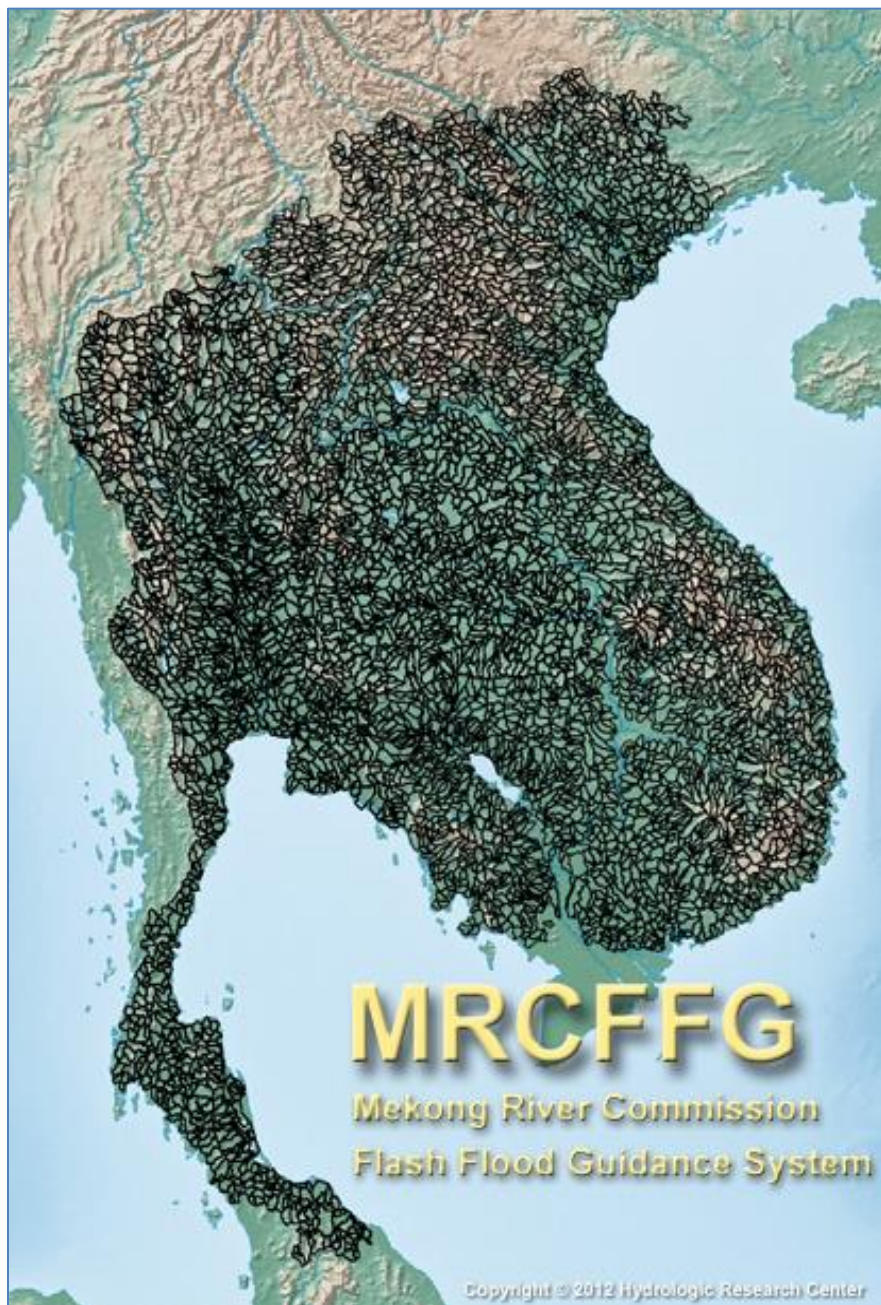
Technical Division (TD)

Regional Flood Management and Mitigation Center (RFDMC)

Evaluation Report on Flash Flood Guidance System for Flood Season 2018

Cover from 1st June – 31st December 2018

Draft Version



Prepared by
Regional Flood Management and Mitigation Centre
March 2019



**Certification of Approval
of Internal FMMP Technical Document**

Evaluation Report on Flash Flood Guidance System for Flood Season 2018

Cover from 1st June – 31st December 2018

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List of Abbreviations

ASM	Average Soil Moisture
FFG	Flash Flood Guidance
FFGS	Flash Flood Guidance System
FMMP	Flood Management and Mitigation Programme (MRC)
FTP	File transfer protocol
HE-sat	Hydro-estimator Satellite Precipitation
HRC	Hydrological Research Centre in San Diego, California (USA)
Hydmet	Rainfall and water level station data transfer software (MRC)
ITCZ	Inter Tropical Convergence Zone
LMB	Lower Mekong Basin
LMRB	Lower Mekong River Basin
MAP	Mean Areal Precipitation
MCs	MRC Members' Countries
Mekong-FFS	Mekong River Flood Forecasting System
MRC	Mekong River Commission
MRCFFG	MRC Flash Flood Guidance
MRCFFGS	Mekong River Commission's Flash Flood Guidance System
MRCFFGCS	Mekong River Commission Flash Flood Guidance Computational Server
MRCFFGDS	Mekong River Commission Flash Flood Guidance Dissemination Server
MRCS	Mekong River Commission Secretariat
OFDA	Office of US Foreign Disaster Assistance
RFDMC	Regional Flood Management and Mitigation Centre
TMD	Thai Meteorological Department
USAID	US Agency for International Development
UTC	Coordinated Universal Time

1. Introduction

As in many parts of the world, flash floods are destructive in the countries of the Lower Mekong River Basin (LMB). To respond to regional and national needs and in order to address the problem of flash floods in each member state of the MRC, the Mekong River Commission (MRC) and the US Agency for International Development (USAID), the Office of US Foreign Disaster Assistance (OFDA), with the technical support from the Hydrologic Research Centre (HRC), through a program with the U.S. National Weather Service (U.S.NWS), have jointly implemented a flash flood mitigation program in Cambodia, Lao PDR, Thailand, and Vietnam.

The MRC Flash Flood Guidance System (MRCFFGS) is designed as a diagnostic tool for meteorological and hydrologic services to analyse weather-related events that can initiate flash floods (e.g., heavy rainfall, rainfall on saturated soils) and then importantly to make a rapid evaluation on the potential for a flash flood for a location inside LMB. The system provides values of flash flood guidance and flash flood threat for small stream basins - the basins most prone to flash flooding. Evaluations of the threat of flash flooding may provide estimations from one-hourly to six-hourly time scales (depending on timely reporting of hydrometeorological data).

The system has been started to develop since 2005 and fully completed in August 2009 including the capacity building for the MRCFFGS operators at 4 National Line Agencies (NLAs). From 2009 to now, the system has been improved and developed, especially since the beginning of 2018, the system has implemented the bias correction of high-resolution satellite rainfall for putting it into the system’s models. Today the system has a user-friendly interface (See figure 1-1), it also provides a lot of essential products to support the forecasters (e.g. products of rainfall estimate high-resolution satellite forecast).

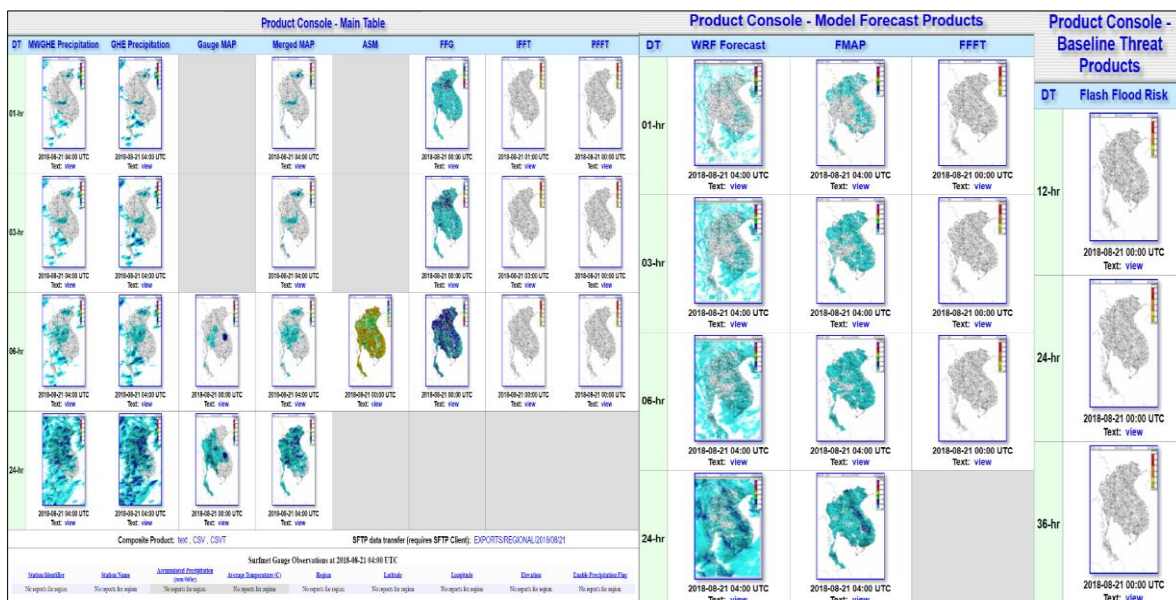


Figure 1-1: MRCFFG dissemination server user interface.

The MRCFFG system model is a soil accounting model that needs satellite rainfall estimates as input data and the output is a warning for the next 1 hour, 3 hour and 6 hours for basins with a mean area of approximately 150-200 km² in size that have a plausible chance of suffering from flash floods. The rainfall threshold needed to release a warning depends on the hydrological characteristics of the watershed. This threshold or FFG number is the volume of rainfall of a given duration (1-6 hours) over a given small catchment that is just enough to cause bank-full flow at the outlet. The primary purpose of the MRCFFG system is to provide near real-time information guidance products pertaining to the imminence of potential small-scale flash flooding. The system provides the necessary products to support the development of warnings for flash floods from intense rainfall events with satellite and gauge-based rainfall estimates (see Figure 1-2: The key technical Components of Flash Flood Guidance System)

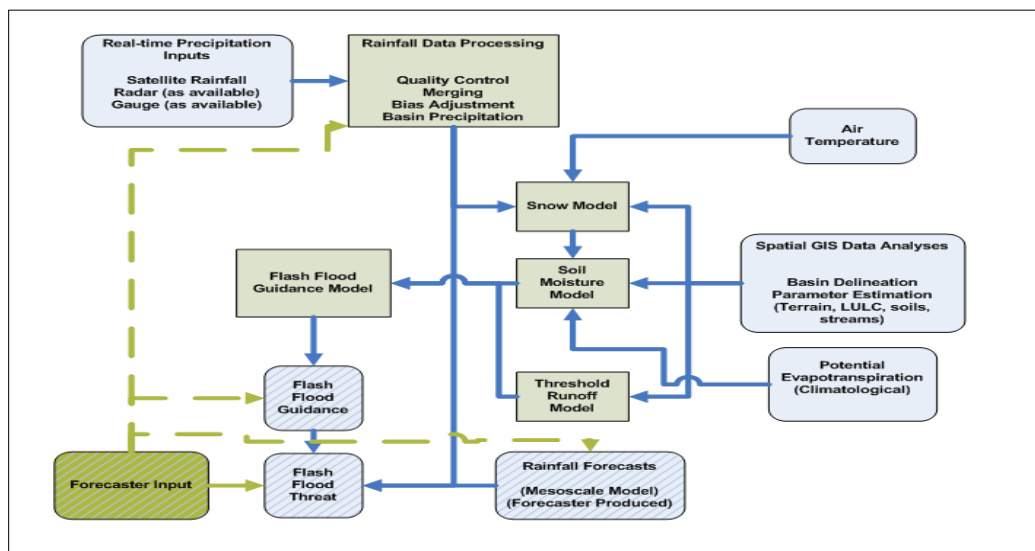


Figure 1-2: Key Technical Components for Flash Flood Guidance System (source: HRC)

The MRCFFG system is designed to provide FFG information on a small basin scale across the four riparian countries from various hydro-meteorological sources. FFG is an index that indicates how much rainfall is needed to cause minimal flooding in that basin. The FFG value indicates the total volume of rainfall over the given duration which is just enough to cause bank-full flow in the draining stream outlet. Consequently, rainfall volumes of the same duration that are greater than the FFG value indicate a likelihood overbank flows at the draining stream outlet. The FFG warnings scale is shown in figure 1-3.

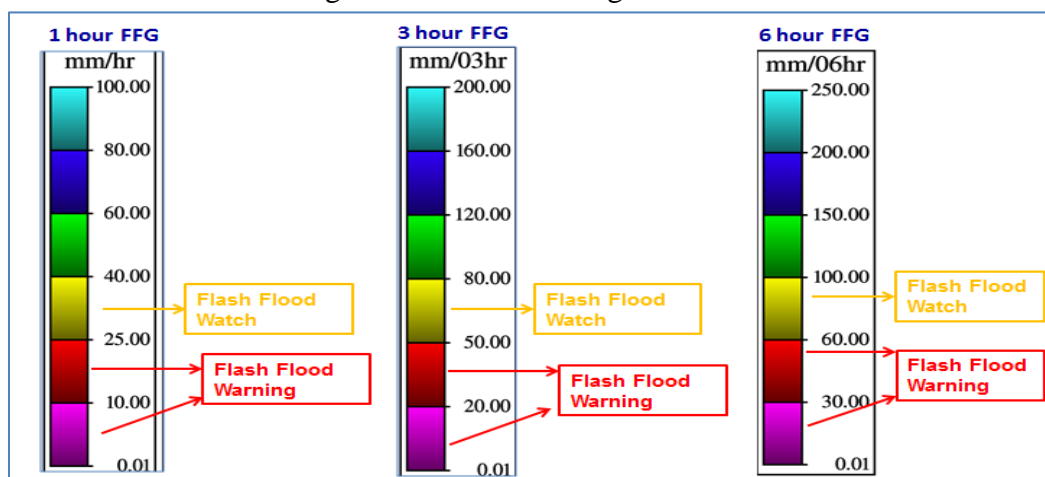


Figure 1-3: FFG warnings scale

The computer server was installed and located in RFDMC since mid – May 2018, during the 2018 flood season, the forecaster of RFDMC has continued operating routinely the MRCFFG system daily for the provision of flash flood guidance products. The information on flash flood risk areas that were detected by the MRCFFG system was uploaded on the MRC flood forecasting webpage in parallel with the river flood forecast (see Figure 1-1). The warning that the MRCFFG system has identified as being ‘critical’ is daily collected in the excel and Google Earth KML format file can be downloaded from its website (see figure 1-4). Information regarding ‘critical’ weather conditions and risk of flash floods is disseminated through e-mail to alert the national line agencies, NGOs and the public at large.

Mekong River Commission
for sustainable development

[MRC Website](#) [LMB](#) [Stations](#) [Monitoring Bulletin](#) [Flash Flood Product](#) [Monitoring Portal](#) [About Us](#)

Flash Flood Guidance

2018-07-20 07:00 Submit

Products of the MRC Flash Flood Guidance System (MRCFFGS) On 2018-07-20 at 00:00 UTC (07:00 local time).
[The webpage was updated on 2018-07-20 07:45]

Figure 1: 1 Hourly Flash Flood Guidance (FFG) on 20 July 2018 at 00:00 UTC (07:00 AM local time). There are some high - risk areas to flash flood occurrence in Lao PDR, Viet Nam. Please download the file attached as below for more detail.

Figure 2: 3 Hourly Flash Flood Guidance (FFG) on 20 July 2018 at 00:00 UTC (07:00 AM local time). There are some high - risk areas to flash flood occurrence in Lao PDR, Viet Nam. Please download the file attached as below for more detail.

Figure 3: 6 Hourly Flash Flood Guidance (FFG) on 20 July 2018 at 00:00 UTC (07:00 AM local time). There are some high - risk areas to flash flood occurrence in Lao PDR, Viet Nam, Thailand, and Cambodia. Please download the file attached as below for more detail.

Figure 4: The last 6 Hourly Average Soil Moisture (ASM) condition (upper soil zone) up to 20 July 2018 at 00:00 UTC (07:00 AM local time). The high of ASM fraction occurred in some areas of Lao PDR and Viet Nam

Figure 5: The last 24 hourly Mean Areal Precipitation (MAP) from 00:00 UTC (07:00 AM local time) on 19 July 2018 to 00:00 UTC (07:00 AM local time) on 20 July 2018. The heavy rainfall occurred in some areas in Lao PDR and Viet Nam due to the last 24 hours.
[Click on this link to download the flash flood risk areas in excel format](#)

Figure 6: The last 01 hourly Mean Areal Precipitation (MAP) on 20 July 2018 00:00 UTC (07:00 AM local time). The moderate rainfall occurred due to last 01 hour in Lower Mekong Basin.

KML file: [FFG-01hr](#) | [FFG-03hr](#) | [FFG-06hr](#) |

Figure 1-1: MRCFFG system on the MRC flood forecasting website

The first evaluation report on MRCFFG system was issued in 2011. The report has been produced to evaluate the performance of MRCFFG system for the 2011 flood season from May until 31 October. The present report is the eighth evaluation report of MRCFFG system. The purpose of this report is to evaluate the performance of MRCFFG system in areas of the MRC member countries for the detection of the risk areas for potential flash floods during the 2018 flood season from May until the late of December. The FFG warnings are issued for the respective national territories of Cambodia, Lao PDR and Viet Nam. The RFDMC provides flash flood risk information for Thailand only in the Thai territory located within the Lower Mekong Basin (LMB)

2. Methodology to Evaluate Flash Flood Guidance Product

The methodology for evaluation of flash flood guidance products used in the flash flood report is based on two concepts:

- (i) The first concept evaluates the feed-back of the FFGS detected risk areas from the information sources like the media or the press. As the link between the regional flood center and the local people is not fully established, the feed-back information on flash flood areas was mainly collected from the national media, such as online newspapers.
- (ii) The second concept evaluates the FFG results through the recorded water levels that are available in the operational database of RFDMC. If MRCFFG system detected flash flood warnings in the sub-areas where the gauge station is available, the MRCFFG results can be evaluated by comparing with the water level data of the gauge station located in the downstream part of sub-catchments.

The record daily rainfall of observed stations, where available at the flash flood risk areas also used as the support data for evaluate the flash flood occurred. However, occasionally it is difficult to evaluate the FFG results using the media information, because flash floods occurred in areas that are difficult to access and why the reporting of FFG results is lacking. Although the MRCFFG system often successfully had indicated a flash flood risk in the flooded areas, database information of occurred flash floods was not accurate and complete, which makes validation of the system difficult.

3. Flash Flooding in the Mekong Region during the Flood Season 2018

3.1 Weather phenomena impact to flash flood in the Mekong Region during flood season 2018

The climate of the LMB is under the influence of monsoon winds of seasonal characters (i.e. southwest monsoon and northeast monsoon). The southwest monsoon which usually starts in mid-May and ends in mid-October brings a stream of warm moist air from the Indian Ocean towards the LMB causing abundant rain over the Mekong region. Rainfall during this period is not only caused by the southwest monsoon but also by the ITCZ and tropical storms which

produce a large amount of rainfall. The northeast monsoon normally starts in mid-October and ends in mid-February bring the cold and dry air from the anticyclone in China’s mainland over major parts of the Mekong Region.

During the year 2018 there were 29 tropical storms which developed over the Pacific Ocean and or over the East Sea (see table 3.1-1 and figure 3.1-1). There were seven tropical storms, namely (1) EWINAR, (2) GAEMI, (3) SONTINH, (4) BEBINCA, (5) MANGKHUT, (6) BARIAT, (7) TORAJI, and (8) USAGI which caused serious flash floods affecting the LMB. Figure 3.1-1 represents the track of the tropical storm during the year 2018. The other cause of flash floods in the Lower Mekong region is the ITCZ, low pressure and tropical depression which also led to flash flood occurrence at some areas in the Mekong mainstream and its tributaries. Figure 3.1-2 represents an example of the weather chart on 16 July 2018 during the ITCZ occurrence in the Mekong region. The scattered moderate rainfall that occurred at some mainstream and tributaries of the Mekong River from May to November 2018 is shown in figure 3.1-3.

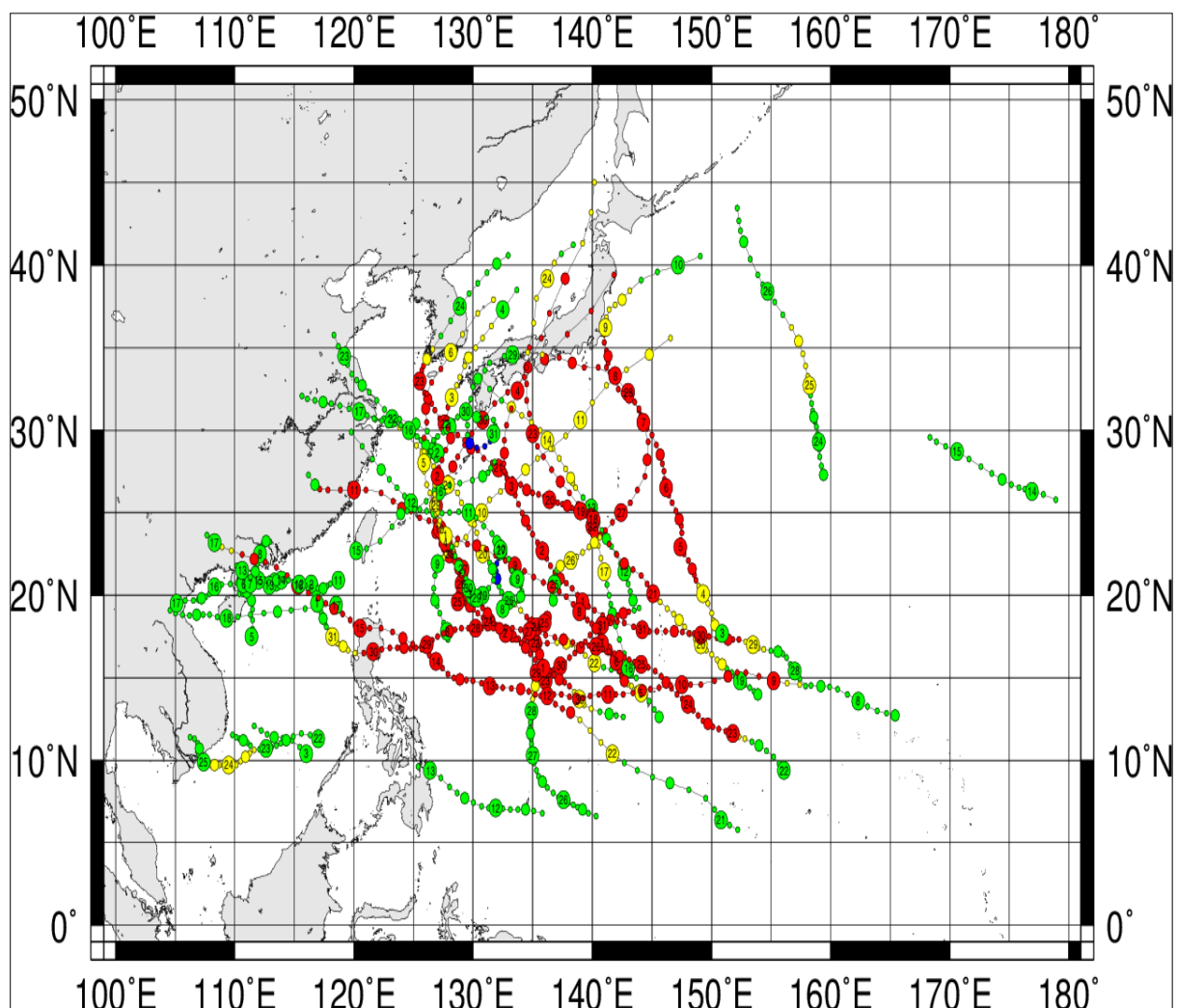


Figure 3.1-1 Tropical storm track for Western Pacific in 2018

(Source: Digital typhoon, National Institute of Informatics, Japan)

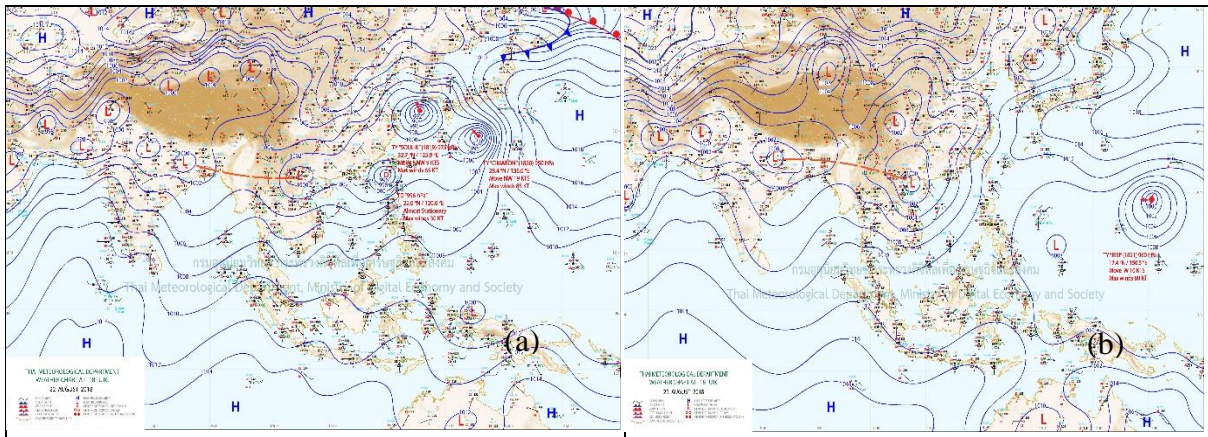


Figure 3.1-2 Weather Chart issued (a) at 18:00 UTC on 22 August 2018, (b) at 12:00 UTC on 29 August 2018.

(Source: the Thai Meteorological Department)

Table 3.1-1: Tropical storm track developed over the Pacific Ocean and East Sea during flood season 2018

(Source: Digital typhoon, National Institute of Informatics, Japan)

No	Name	Birth (UTC) (mm-dd-yy hh)	Death (UTC) (mm-dd-yy hh)	Duration
1	BOLAVEN	1/3/18 12:00 AM	1/4/18 12:00 AM	1 Days 0 Hours
2	SANBA	2/11/18 6:00 AM	2/13/18 6:00 AM	2 Days 0 Hours
3	JELAWAT	3/25/18 6:00 AM	4/1/18 12:00 AM	6 Days 18 Hours
4	EWINIAR	6/5/18 12:00 AM	6/8/18 6:00 PM	3 Days 18 Hours
5	MALIKSI	6/7/18 6:00 PM	6/11/18 6:00 PM	4 Days 0 Hours
6	GAEMI	6/15/18 12:00 AM	6/17/18 12:00 AM	2 Days 0 Hours
7	PRAPIROON	6/29/18 12:00 AM	7/4/18 6:00 AM	5 Days 6 Hours
8	MARIA	7/4/18 12:00 PM	7/11/18 6:00 PM	7 Days 6 Hours
9	SON-TINH	7/17/18 12:00 AM	7/19/18 12:00 AM	2 Days 0 Hours
10	AMPIL	7/18/18 12:00 PM	7/23/18 12:00 PM	5 Days 0 Hours
11	WUKONG	7/23/18 12:00 PM	7/27/18 12:00 AM	3 Days 12 Hours
12	JONGDARI	7/24/18 12:00 PM	8/3/18 12:00 AM	9 Days 0 Hours
13	SHANSHAN	8/3/18 12:00 AM	8/10/18 6:00 AM	7 Days 6 Hours
14	YAGI	8/8/18 12:00 AM	8/13/18 12:00 AM	5 Days 0 Hours
15	LEEPI	8/11/18 12:00 PM	8/15/18 12:00 AM	3 Days 12 Hours
16	BEBINCA	8/13/18 12:00 AM	8/17/18 6:00 AM	4 Days 6 Hours
17	HECTOR	8/13/18 6:00 PM	8/15/18 12:00 PM	1 Days 18 Hours
18	RUMBIA	8/15/18 6:00 AM	8/18/18 12:00 AM	2 Days 18 Hours
19	SOULIK	8/16/18 12:00 AM	8/24/18 6:00 PM	8 Days 18 Hours
20	CIMARON	8/18/18 12:00 PM	8/24/18 12:00 PM	6 Days 0 Hours
21	JEBI	8/27/18 6:00 PM	9/5/18 12:00 AM	8 Days 6 Hours
22	MANGKHUT	9/7/18 12:00 PM	9/17/18 6:00 AM	9 Days 18 Hours
23	BARJAT	9/11/18 12:00 AM	9/13/18 6:00 AM	2 Days 6 Hours
24	TRAMI	9/21/18 6:00 AM	10/1/18 12:00 AM	9 Days 18 Hours
25	KONG-REY	9/29/18 6:00 AM	10/6/18 12:00 PM	7 Days 6 Hours
26	YUTU	10/22/18 12:00 AM	11/2/18 6:00 AM	11 Days 6 Hours
27	TORAJI	11/17/18 6:00 AM	11/18/18 12:00 AM	0 Days 18 Hours
28	MAN-YI	11/20/18 6:00 PM	11/27/18 6:00 AM	6 Days 0 Hours
29	USAGI	11/22/18 12:00 AM	11/26/18 12:00 AM	4 Days 0 Hours

3.2 Flash flood operation at RFDMC during flood season 2018

The complicated of climate situation during the flood season 2018 as mentioned above the situation whereby the flash flood situation the flood season in 2018 has some complicated and special points as follows:

- The total number of major flash flood events across the Mekong region was 24 events (see table...), more than the LTA (Base on the data in performance evaluation report from 2010 to 2018)
- Most high-intensity flash floods are mainly concentrated in the rainy months when extreme climatic conditions such as typhoons from Pacific Ocean as well as the East Sea, Southwest monsoon, ITCZ those are causes heavy rainfall in the Mekong region (July and August). There are severe flash flood events occurred in the mountains of Viet Nam and Lao PDR.
- Especially in this flood season, even October is the time of flood season ended, to mid-November still appeared of typhoons on Southern of Vietnam, then its circulation caused heavy rainfall, therefore, a major flash flood occurred in Central Highlands part

of Vietnam. This unusual time and space of this weather element is also a special feature for the occurrence of flash floods in 2018.

Table 3.2-1: The number of warning issued that were detected by the MRCFFG in the flood season 2018 in the Mekong Region.

Country	Total (May to mid of November 2018)
Viet Nam	127 districts
Thailand	70 districts
Lao PDR	990 villages (190 districts)
Cambodia	12 villages (3 districts)

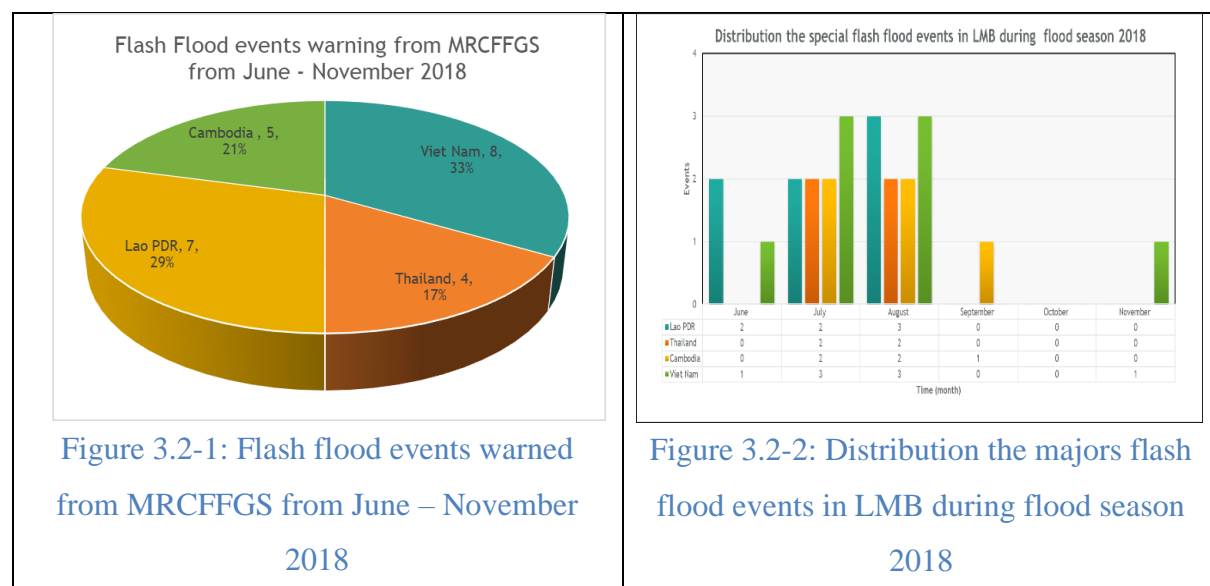


Table 3.1-2: Calendar date of flash flood recorded in the LMB during flood 2018

2018 June							2018 July							2018 August							
MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	
28	29	30	31	01	02	03	25	26	27	28	29	30	01	30	31	01	02	03	04	05	
04	05	06	07 L,C	08	09	10	02	03	04	05	06	07	08	06	07	08	09	10	11	12	
11	12	13	14	15	16	17	09	10	11	12	13	14	15	13	14	15	16	17	18 L,T,C,V	19	
18 L	19	20	21	22	23	24 V	16	17	18	19 L,T,C,V	20 L,T,C,V	21	22	20	21	22	23 L,C	24	25	26	
25	26	27	28	29	30	01	23	24	25	26	27	28	29	27	28	29	30	31 L,T,V	01	02	
02	03						30 V	31						03	04						
2018 September							2018 October							2018 November							
MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	
27	28	29	30	01	02	03	01	02	03	04	05	06	07	29	30	01	02	03	04	05	
03	04	05	06	07	08	09	08	09	10	11	12	13	14	05	06	07	08	09	10	11	
10	11	12	13	14	15	16	15	16	17	18	19	20	21	12	13	14	15	16	17	18	
17	18	19	20	21	22	23 C	22	23	24	25	26	27	28	19	20	21	22	23	24	25	
24	25	26	27	28	29	30	29	30	31	01	02	03	04	26 V	27	28	29	30	01	02	
01	02						05	06						03	04						
Note: :Tropical Storm :Inter Tropical Convergence Zone (ITCZ) and Low Pressure							L Lao PDR V: Viet Nam L: Lao PDR T Thailand C: Cambodia T: Thailand														

4. Flash flood events on 24th June 2018 in the Northern part of Viet Nam, caused by ITCZ.

4.1 Weather condition from 18th to 25th June 2018

The Inter Tropical Convergence Zone (ITCZ) laid across the middle of Myanmar, the upper North of Thailand, the North of Lao PDR and Viet Nam while the moderate Southwest monsoon prevailed over Andaman Sea, the Gulf of Thailand, Thailand and Indochina Peninsular at the surface. The trough laid across Myanmar, Thailand and Indochina Peninsular at the height of 1.5km (850 hPa). Figure 4.1-1 shown the Weather map.

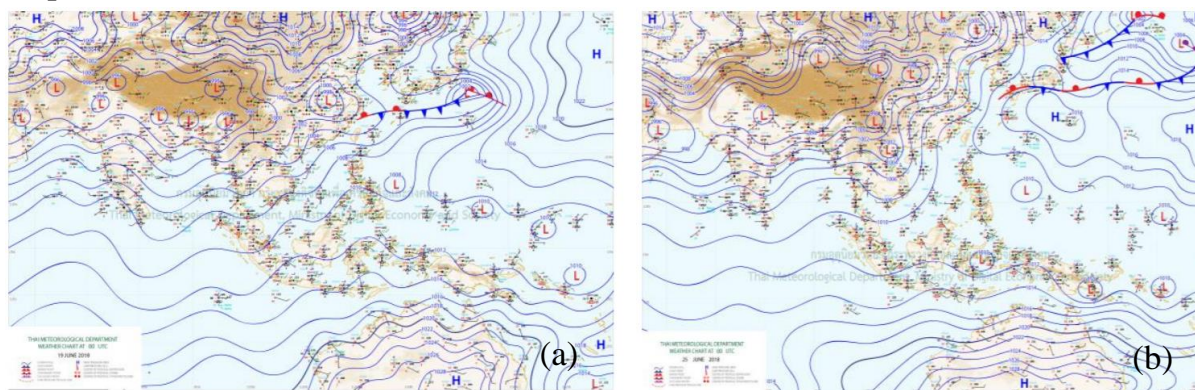


Figure 4.1-1: Weather map for (a) 19th June 2018 and (b) 25th June 2018

4.2 Heavy rainfall from 18th to 25th June 2018

During period time, the weather was influenced by ITCZ, trough of low pressure and moderate Southwest monsoon in the Mekong Region. However, on the mainstream of

LMB not much heavy rain occurred, except the total accumulated rainfall at Paksane was 102.9 mm. But in the norther part of Viet Nam, the heavy rain occurred at that time in some areas such as: the daily accumulated rainfall on 25th June 2018 at Tam Duong 231 mm, Sin Ho 142 mm. The rainfall distribution over the LMB is depicted in figure 4.2-1.

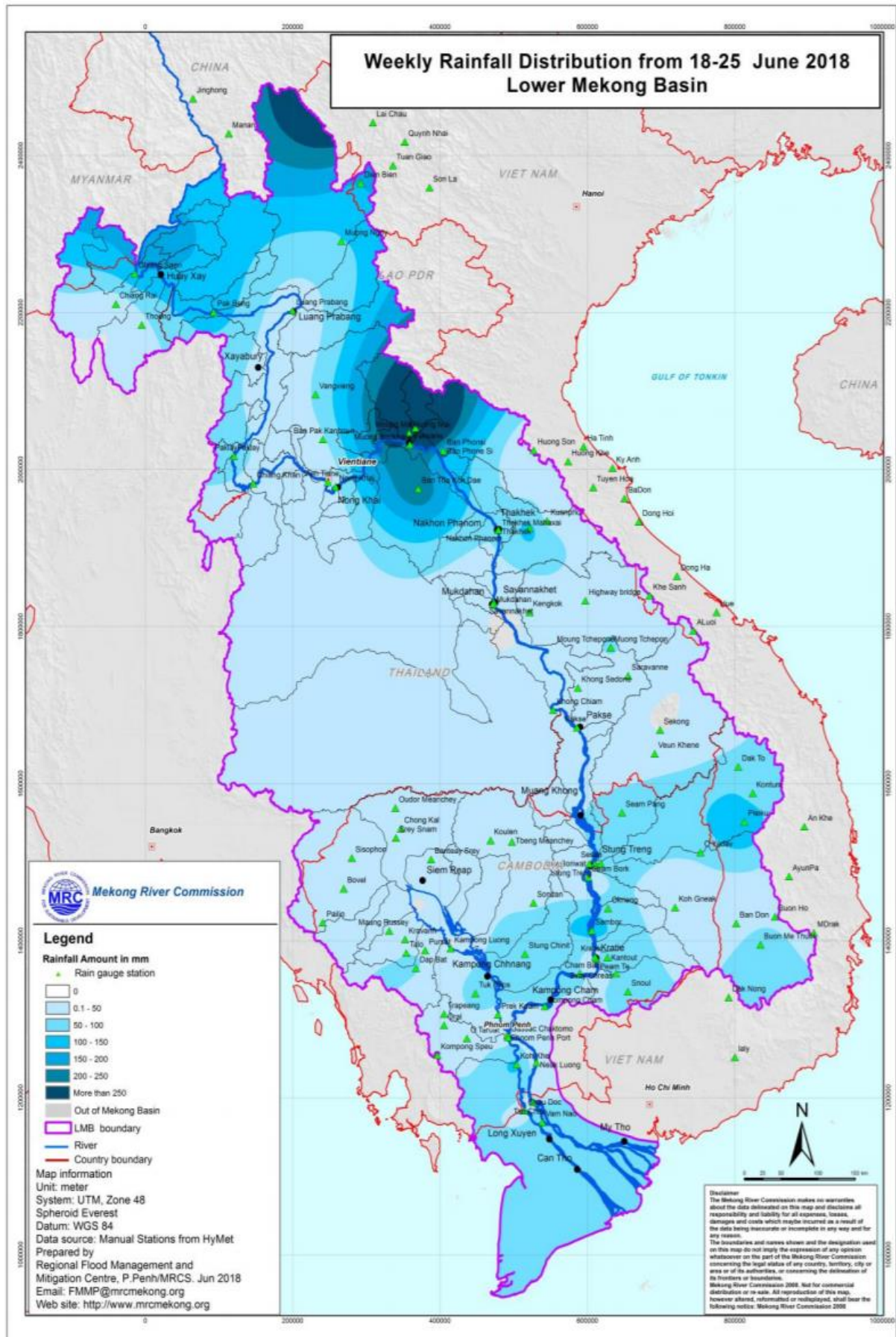


Figure 4.2-1: Rainfall distribution in LMB from 18th – 25th June 2018.

4.3 Flash flood in Northern part of Viet Nam on 24th June 2018.

From analyzing the system's products while making flash flood guidance from MRCFFGS and based on actual measurements available in RFDMC and found the meteorological factors ad mentioned above. RFDMC made decision the warning flash flood guidance for 1,3, and 6 hours as shown in the table 4.3-2.

Table 4.3-1: Flash flood guidance detected by MRCFFG system in Viet Nam on 24th June 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products		24/06/2018 00:00 UTC time							
1hour Flash Flood Guidance in Vietnam			3hours Flash Flood Guidance in Vietnam			6hours Flash Flood Guidance in Vietnam			
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value	
Yen Bai	Mu Cang Chai	24.78	Yen Bai	Mu Cang Chai	34.58	Yen Bai	Mu Cang Chai	45.51	
						Bac Kan	TX. Bac Kan	58.05	

Conclusions

- During the period 18th – 25th July 2017, the strong ITCZ operated in the Mekong Region, it caused heavy rain in this region.
- Heavy rain at some areas in the Northern part of Viet Nam and LBM, such as accumulated rainfalls recorded from Hydmet Database.
- Some flash flood risk areas, detected by the FFG system on 24th June 2018 at 00:00 UTC, corresponded with the reported flash flood areas.

5. Flash flood events on 19th – 20th July 2018 in the Mekong Region, caused by typhoon “SONTINH”

5.1 Weather condition from 18th – 23rd July 2018

An area of low pressure strengthened into a tropical depression on July 15, to the northwest of Manila, Philippines. Accordingly, the Joint Typhoon Warning Center (JTWC) designated it as 11W while the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) gave it the local name Henry. As the system moved westward at high speed, it gradually intensified as its convective structure improved, and strengthened a tropical storm by July 17, with the Japan Meteorological Agency (JMA) assigning the system the international name Son-Tinh.

Thereafter, however, Son-Tinh weakened slightly as it neared Hainan island due to moderate vertical wind shear. Continuing to struggle to maintain intensity amid increasing wind shear, Son-Tinh crossed over Hainan island at around 03:00 UTC on July 18; despite land interaction the system continued to maintain its overall convective organization. Later that day, as Son-Tinh emerged from land into the Gulf of Tonkin. Before making landfall in Northern Vietnam, the JMA reported that Son-Tinh reached peak intensity with 10-minute sustained winds of 75 km/h (45 mph) and a central

pressure of 994 hPa (29.4 inHg). Once inland over Northern Vietnam, Son-Tinh began to weaken quickly. Both the JMA, RFE and JTWC issued their final warnings on Son-Tinh on July 19 as the system degenerated into an area of low pressure embedded in the monsoon. The JTWC, however, continued to track Son-Tinh's remnants for the next two days.

Through July 19 and 20, Son-Tinh's remnants curved northwards and then eastwards over Northern Vietnam, before moving southeastward back into the Gulf of Tonkin on July 21. Persistent convection developed over the system, aided by a tropical upper tropospheric trough to the northeast, prompting the JTWC to begin issuing advisories on Son-Tinh once again on July 21. The track of SONTINH is shown in figure 5.1-1.

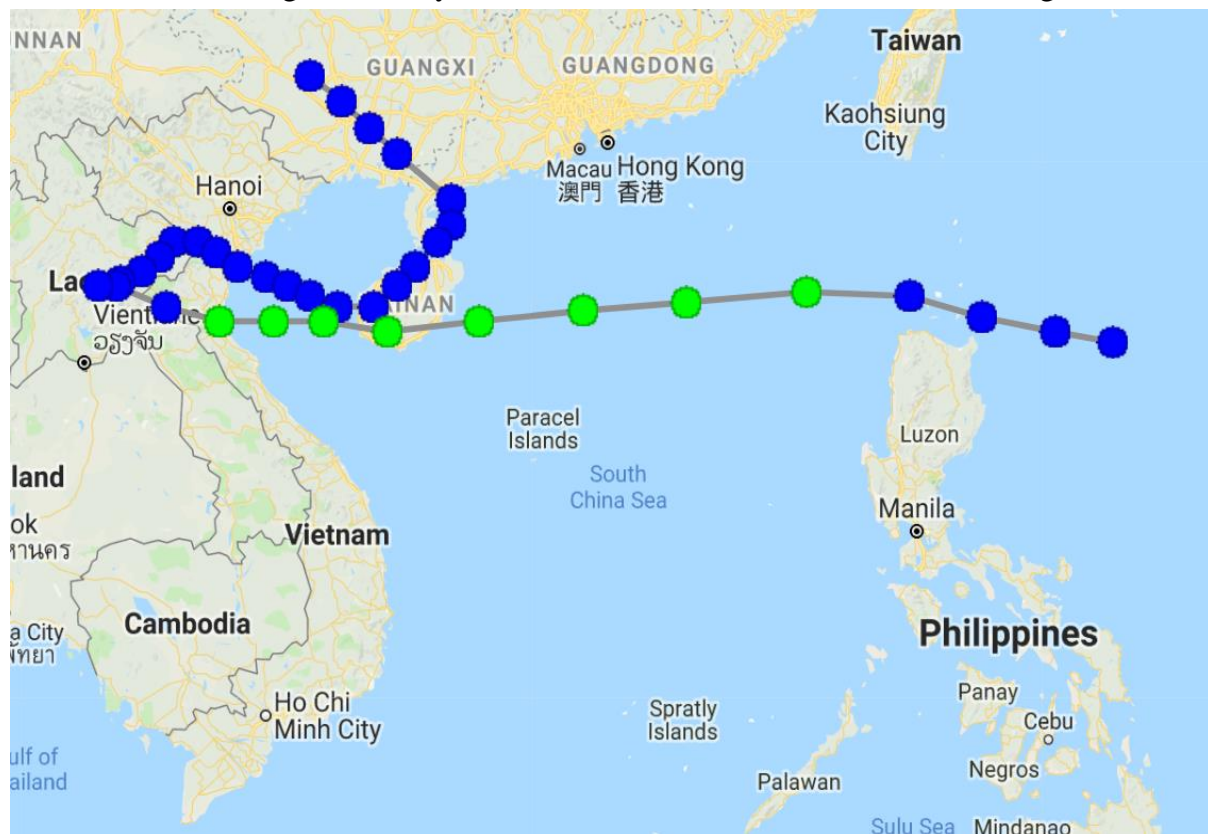


Figure 5.1-1: The tracks of tropical typhoon “SONTINH”

Also, during this period, on the Mekong regions, low pressure was hit in the upper part of the LMB. Figure 5.1-2, the weather map for 18th July and 21st July 2018 is referenced from Thailand Meteorology Department (TMD).

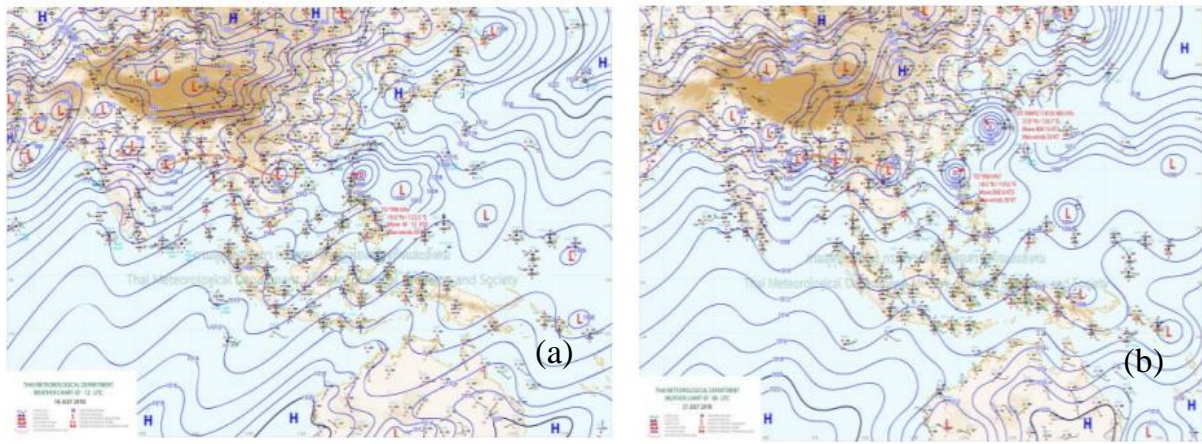


Figure 5.1-2: Weather map for (a) 18th July 2018 and (b) 21st July 2018

5.2 Heavy rainfall during 16th – 23rd July 2018

During this period, the weather conditions as mentioned above is the reason heavy rain in the Northern part of LMB. Consequently, there was heavy rainfall between Luang Prabang and Nakhon Phanom catchment areas and some parts at the Khong Chiam and Pakse areas (see table 5.2-1 and figure 5.2-1)

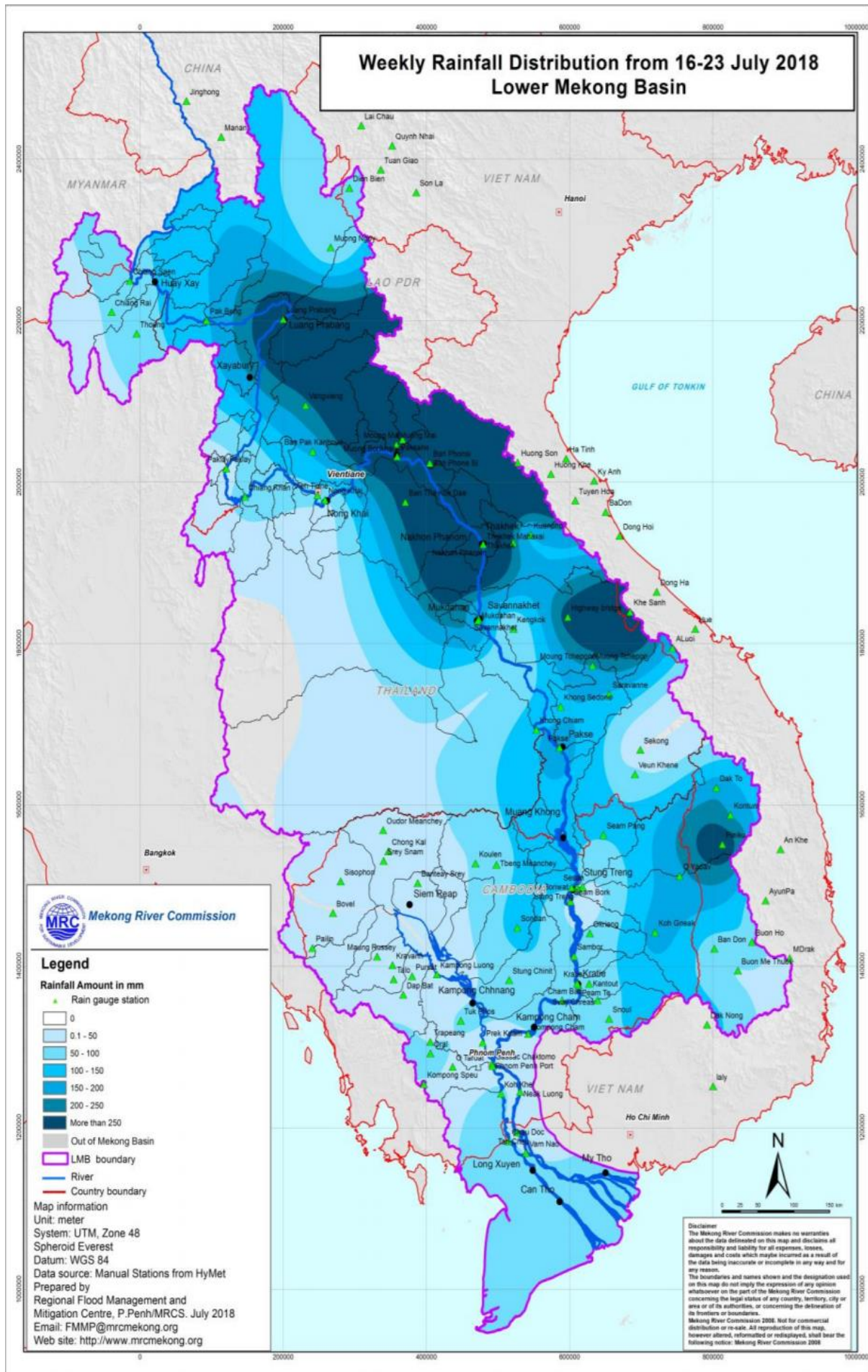


Figure 5.2-1: Rainfall distribution during 16th – 23rd July 2018 in LBM

Table 5.2-1: Observed rainfall in maintream stations along LMB during 16th -23rd July 2018

2018	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
16/07/2018	6.5	0	9		4.76	0	34.8	0	192.1	0	nr	0	51.5	11	3.4	nr	nr	-	nr	nr	nr	nr	nr
17/07/2018	19	0	nr	6	nr	nr	34.2	184.8	222	122.9	nr	6.7	5.7	14	10.2	20.5	2.7	-	3.1	0.8	nr	2.4	11
18/07/2018	14	7.6	nr	34.3	3.2	6.4	12.9	7.3	8.7	36.2	88.9	21.4	43.6	12.4	19	1.8	0	-	17.9	1.1	4.3	1.4	5.2
19/07/2018	3.5	0	1.8	1.3	nr	2.1	22	0	18.8	47.7	18.2	58.1	44.4	26	7.2	7.4	10.5	-	19	7.4	12.4	29.2	33.8
20/07/2018	32	22.2	133.6	1.8	54.6	25.6	102.2	2.2	4.6	0	nr	15.8	nr	11.5	8	5.3	5.5	-	20.6	7.5	14.5	0	3
21/07/2018	20.5	31.4	81.2	3.3	nr	2.2	54.2	3.2	3.5	0	nr	21	10	30	nr	nr	nr	-	nr	0	nr	nr	0
22/07/2018	7.5	15.4	2.6	7.5	1.8	3.7	16.3	19.1	22.8	3.5	3.6	1	4.2	nr	39	12.7	12.7	-	nr	0	nr	nr	nr
23/07/2018	0	0	nr	0	nr	0	0.2	25.9	18.4	4.6	5.6	3.1	1.5	nr	nr	nr	1	-	nr	4.3	nr	nr	3

5.3 Flash Flood in Mekong Region on 19th -20th July 2018.

 Table 5.3-1: Flash flood guidance detected by MRCFFG system in Viet Nam on 19th – 20th July 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products		19/07/2018 00:00 UTC time		3hours Flash Flood Guidance in Vietnam		6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Quang Binh	Minh Hoa	17.7	Quang Binh	Minh Hoa	25.54	Quang Binh	Minh Hoa	34.24
Ha Tinh	Huong Son	14.11	Ha Tinh	Huong Son	21.61	Ha Tinh	Huong Son	30.14
Nghe An	Con Cuong	19.82	Nghe An	Con Cuong	28.02	Hoa Binh	Da Bac	57.83
Ha Tinh	Huong Son	14.68	Nghe An	Tuong Duong	39.13	Thanh Hoa	Muong Lat	54.67
Ha Tinh	Huong Son	23.4	Nghe An	Con Cuong	35.85	Nghe An	Con Cuong	37.14
Ha Tinh	Huong Khe	19.99	Ha Tinh	Huong Son	22.31	Nghe An	Tuong Duong	50.85
Quang Binh	Minh Hoa	24.98	Ha Tinh	Huong Son	32.5	Nghe An	Con Cuong	48.48
			Ha Tinh	Huong Khe	28.79	Ha Tinh	Huong Son	55.37
			Quang Binh	Minh Hoa	34.5	Ha Tinh	Huong Son	52.65
						Ha Tinh	Huong Son	31.09
						Ha Tinh	Huong Son	42.56
						Ha Tinh	Huong Khe	38.62
						Quang Binh	Minh Hoa	45.25

Date of FFG products		20/07/2018 00:00 UTC time		3hours Flash Flood Guidance in Vietnam		6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Quang Binh	Minh Hoa	21.06	Quang Binh	Minh Hoa	29.2	Quang Binh	Minh Hoa	38.21
Ha Tinh	Huong Son	16.37	Ha Tinh	Huong Son	24.09	Ha Tinh	Huong Son	32.84
Thanh Hoa	Muong Lat	24.99	Hoa Binh	Da Bac	36.6	Hoa Binh	Da Bac	46.39
Nghe An	Tuong Duong	24.77	Nghe An	Que Phong	39.31	Son La	Bac Yen	59.6
Nghe An	Con Cuong	19.79	Nghe An	Que Phong	38.79	Nghe An	Que Phong	49.95
Ha Tinh	Huong Son	23.71	Thanh Hoa	Muong Lat	33.83	Nghe An	Que Phong	50.03
Ha Tinh	Huong Khe	22.87	Nghe An	Tuong Duong	34.2	Nghe An	Que Chau	54.75
			Nghe An	Con Cuong	27.96	Thanh Hoa	Quan Son	54.27
			Nghe An	Tuong Duong	39.33	Thanh Hoa	Muong Lat	43.84
			Ha Tinh	Huong Son	39.57	Nghe An	Que Phong	51.2
			Ha Tinh	Huong Son	32.82	Nghe An	Tuong Duong	44.61
			Ha Tinh	Huong Khe	31.89	Nghe An	Con Cuong	37.04
						Nghe An	Tuong Duong	54.1
						Nghe An	Tuong Duong	51.02
						Nghe An	Con Cuong	56.27
						Ha Tinh	Huong Son	50
						Ha Tinh	Huong Son	42.87
						Ha Tinh	Huong Khe	41.93
						Quang Binh	Minh Hoa	55.54

 Table 5.3-2: Flash flood guidance detected by MRCFFG system in Thailand on 19th – 20th July 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products		19/07/2018 00:00 UTC time		3hours Flash Flood Guidance in Thailand		6hours Flash Flood Guidance in Thailand		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
			Tak	Tha Song Yang	38.27	Tak	Tha Song Yang	47.9
			Chiang Mai	Omko	37.9	Chiang Mai	Omko	50.71
						Tak	Tha Song Yang	55.41
						Chiang Mai	Omko	47.5

Date of FFG products		20/07/2018 00:00 UTC time		3hours Flash Flood Guidance in Thailand		6hours Flash Flood Guidance in Thailand		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
						Tak	Tha Song Yang	58.19
						Chiang Mai	Omko	53.51
						Chiang Mai	Omko	56.47
						Phetchaburi	Nong Ya Plong	57.99

Table 5.3-3: Flash flood guidance detected by MRCFFG system in Lao PDR on 19th – 20th July 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG product 19/07/2018 00:00 UTC time								
1hour Flash Flood Guidance in Lao			3hours Flash Flood Guidance in Lao			6hours Flash Flood Guidance in Lao		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
Bolikhamxay	Viengthon	20.36	Bolikhamxay	Viengthon	34.54	Bolikhamxay	Viengthon	57.53
Bolikhamxay	Viengthon	19.51	Bolikhamxay	Viengthon	29.04	Bolikhamxay	Viengthon	44.98
Bolikhamxay	Viengthon	17.8	Bolikhamxay	Viengthon	28.16	Bolikhamxay	Viengthon	38.79
Bolikhamxay	Khamkheut	21.83	Bolikhamxay	Viengthon	25.04	Bolikhamxay	Viengthon	37.71
Bolikhamxay	Khamkheut	16.88	Bolikhamxay	Khamkheut	30.99	Bolikhamxay	Viengthon	33.53
Bolikhamxay	Khamkheut	23.1	Bolikhamxay	Khamkheut	25.38	Bolikhamxay	Khamkheut	41.26
Bolikhamxay	Khamkheut	18.12	Bolikhamxay	Khamkheut	31.55	Bolikhamxay	Khamkheut	58.75
Khammuane	Nakai	23.67	Bolikhamxay	Khamkheut	26.02	Bolikhamxay	Khamkheut	35.01
Bolikhamxay	Khamkheut	16.37	Khammuane	Nakai	32.76	Bolikhamxay	Khamkheut	41.13
Bolikhamxay	Khamkheut	24.58	Bolikhamxay	Khamkheut	24.73	Bolikhamxay	Khamkheut	35.07
Bolikhamxay	Pakkading	21.83	Bolikhamxay	Khamkheut	34.63	Khammuane	Nakai	42.75
Khammuane	Hinboon	17.01	Bolikhamxay	Pakkading	29.92	Bolikhamxay	Khamkheut	34.05
Khammuane	Hinboon	17.53	Bolikhamxay	Pakkading	35.33	Bolikhamxay	Khamkheut	46.16
Champasak	Paksong	13.88	Khammuane	Hinboon	25.13	Bolikhamxay	Pakkading	39.4
Champasak	Paksong	13.36	Khammuane	Hinboon	25.55	Bolikhamxay	Pakkading	45.88
Bolikhamxay	Khamkheut	24.21	Champasak	Paksong	19.65	Khammuane	Hinboon	33.92
Khammuane	Nakai	22.78	Champasak	Paksong	18.78	Khammuane	Hinboon	33.91
Bolikhamxay	Khamkheut	17.38	Bolikhamxay	Khamkheut	34.95	Champasak	Paksong	26.14
Bolikhamxay	Khamkheut	19.29	Khammuane	Nakai	32.63	Champasak	Paksong	24.57
			Khammuane	Nakai	39.37	Bolikhamxay	Khamkheut	47.46
			Bolikhamxay	Khamkheut	25.4	Khammuane	Nakai	43.87
			Bolikhamxay	Khamkheut	27.93	Khammuane	Nakai	55.6
						Khammuane	Nakai	52.38
						Bolikhamxay	Khamkheut	34.44
						Bolikhamxay	Khamkheut	37.87

Date of FFG product 20/07/2018 00:00 UTC time								
1hour Flash Flood Guidance in Lao			3hours Flash Flood Guidance in Lao			6hours Flash Flood Guidance in Lao		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
Bolikhamxay	Viengthon	23.8	Bolikhamxay	Viengthon	33.12	Bolikhamxay	Viengthon	57.58
Bolikhamxay	Viengthon	18.93	Bolikhamxay	Viengthon	27.27	Bolikhamxay	Viengthon	43.32
Bolikhamxay	Viengthon	20.78	Bolikhamxay	Viengthon	29.49	Bolikhamxay	Viengthon	36.99
Bolikhamxay	Viengthon	21.72	Bolikhamxay	Viengthon	30.56	Bolikhamxay	Viengthon	39.25
Bolikhamxay	Khamkheut	18.73	Bolikhamxay	Viengthon	34.27	Bolikhamxay	Viengthon	40.3
Bolikhamxay	Khamkheut	22.28	Bolikhamxay	Khamkheut	27.55	Bolikhamxay	Viengthon	44.03
Bolikhamxay	Khamkheut	18.97	Bolikhamxay	Khamkheut	35	Bolikhamxay	Khamkheut	37.46
Bolikhamxay	Khamkheut	18.98	Bolikhamxay	Khamkheut	30.62	Bolikhamxay	Khamkheut	57.1
Bolikhamxay	Khamkheut	23.07	Bolikhamxay	Khamkheut	26.93	Bolikhamxay	Khamkheut	45.46
Bolikhamxay	Pakkading	18.41	Bolikhamxay	Khamkheut	27.57	Bolikhamxay	Khamkheut	40.07
Khammuane	Hinboon	16.23	Bolikhamxay	Khamkheut	32.89	Bolikhamxay	Khamkheut	36.01
Khammuane	Hinboon	17.09	Xaysomboun	Hom	38.97	Khammuane	Nakai	52.12
Huaphanh	Xamtay	24.63	Bolikhamxay	Pakkading	25.91	Bolikhamxay	Khamkheut	37.11
Huaphanh	Xamtay	17.41	Bolikhamxay	Pakkading	35.67	Bolikhamxay	Khamkheut	44.17
Huaphanh	Xamtay	17.96	Khammuane	Hinboon	24.28	Xaysomboun	Hom	48.3
Bolikhamxay	Viengthon	24.47	Khammuane	Hinboon	25.09	Bolikhamxay	Pakkading	34.77
			Champasak	Paksong	32.15	Bolikhamxay	Pakkading	46.25
			Huaphanh	Xamtay	33.64	Khammuane	Hinboon	33
			Huaphanh	Xamtay	25.33	Khammuane	Hinboon	33.43
			Huaphanh	Xamtay	26.8	Champasak	Paksong	52.44
			Bolikhamxay	Viengthon	33.31	Champasak	Paksong	38.96
			Bolikhamxay	Khamkheut	36.02	Huaphanh	Xamtay	44.28
			Bolikhamxay	Khamkheut	38.39	Huaphanh	Xamtay	34.72
						Huaphanh	Xamneua	59.49
						Huaphanh	Xamtay	37.06
						Bolikhamxay	Viengthon	43.61
						Khammuane	Nakai	56.17
						Bolikhamxay	Khamkheut	46.03
						Bolikhamxay	Khamkheut	49.21

Table 5.3-4: Flash flood guidance detected by MRCFFG system in Cambodia on 19th – 20th July 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products 19/07/2018 00:00 UTC time								
1hour Flash Flood Guidance in Cambodia			3hours Flash Flood Guidance in Cambodia			6hours Flash Flood Guidance in Cambodia		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
Pursat	Veal Veang	24.49	Pursat	Veal Veang	35.7	Kampong Speu	Aoral	52.14
			Pursat	Veal Veang	33.34	Pursat	Veal Veang	44.37
						Pursat	Veal Veang	42.85

Date of FFG products 20/07/2018 00:00 UTC time								
1hour Flash Flood Guidance in Cambodia			3hours Flash Flood Guidance in Cambodia			6hours Flash Flood Guidance in Cambodia		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
						Pursat	Veal Veang	57.48

5.4 Conclusions

- The circulation after SONTINH typhoon and the high pressure of depression are the causes of heavy rain in wide area of Mekong region in this period.
- In some areas in the mountain in the Mekong region, the soil moisture is saturated and combined add more the heavy rain at the same time, therefore these areas the flash flood has been appeared.
- The MRCFFGS detected correctly several locations that are likely to occur the flash floods.

6. Flash flood events on 18th August 2018 in the Mekong Region, caused by typhoon “BEBINCA”

6.1 Weather condition during 13th – 20th August 2018

Typhoon “BEBINCA”: Late on August 9, accordingly the JMA began to monitor a tropical depression over the East Sea. The system generally moved northward slowly under a subtropical, and then turned to northeast on the next day. Despite moving over warm waters, the depression remained poorly organized. It moved ashore near Hailing Island, Yanjing, Guangdong Province (China) at 10:35 AM. On August 11 (02:35 UTC). The depression made an anti-clockwise loop inland and moved back to the sea later that day. The system moved slowly southeastward, because in the northwestern Pacific prohibited the extension of the subtropical ridge, therefore the steering current remained weak for days in the South China Sea. After moving back to the sea, the depression gained some organization, and the JTWC finally classified it as a tropical depression and gave the numerical designation 20W on August 12. After maintaining tropical depression status for more than 3 days, 20W finally intensified to a tropical storm and the JMA gave the international name **BEBINCA** early on August 13. Throughout that day, Bebinca's low-level circulation center (LLCC) was exposed because of moderate to strong easterly wind shear. Despite this, the JTWC upgraded the system to a tropical storm later that day. **BEBINCA** remained a sheared cyclone on August 14, while continued to slowly drift to the east. After made landfall in Japan and dissipated, the subtropical ridge can finally extend and build over China, and Bebinca began to curve back to the west. Although wind shear remained strong on August 15, and the system was able to develop a central dense overcast. **BEBINCA** made its second landfall in Leizhou, Guangdong (China) at 9:40 p.m. CST (13:40 UTC), and emerged to the Gulf of Tonkin about four hours later (source JMA and JTWC) Once moving into the warm waters of the Gulf of Tonkin, Bebinca began another intensification trend. This prompted the JMA to upgrade **BEBINCA** to a severe tropical storm, but it was revoked in the post-storm analysis.

BEBINCA weakened slightly before making its third and final landfall in Nam Dinh province, Vietnam at 5:30 a.m ICT on August 17 (22:30 UTC on August 16), with

winds of 75 km/h (45 mph). Then **BEBINCA** weakened quickly once moving inland, and the JTWC issued its final warning early on August 17. The JMA also downgraded Bebinca to a tropical depression, and Bebinca dissipated later that day, over Lao PRD (Figure 6.1-1).



Figure 6.1-1: The track of tropical typhoon “BEBINCA”

Southwest monsoon: Base on the weather map form TDM, in fact during this period, the abundant rainfall occurred due to the influential southwest monsoon prevailing over Lower Mekong Basin together with low-pressure air mass cells (see figure 6.1-2)

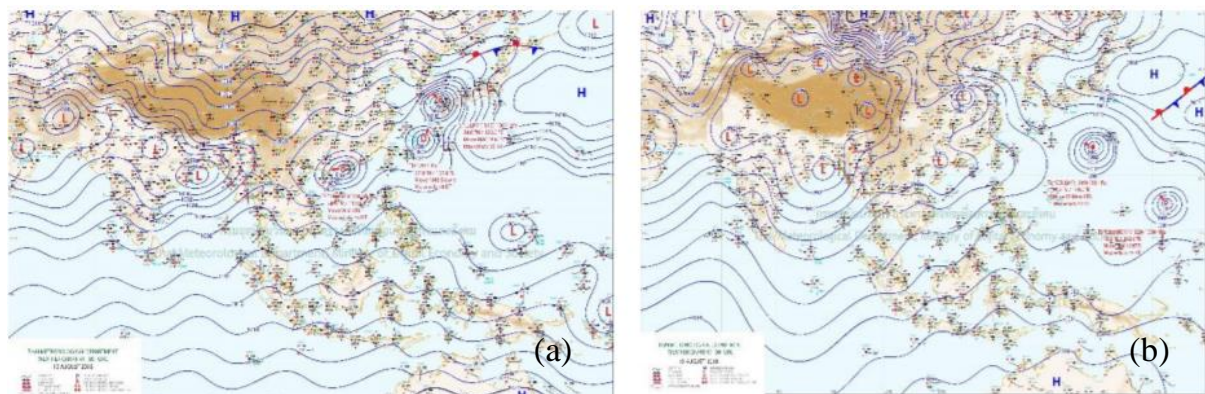


Figure 6.1-2: Weather map for (a) 15th August 2018 and (b) 18th August 2018

6.2 Heavy rain during 13th – 20th August 2018

During this period, caused by the weather condition as mentioned there was moderate rainfall over in the LMB and some areas in the Mekong Region. According the observed from Hydmet database the daily accumulate rainfall at Pakseane to Pakse and the 3S area showed high rainfall between 100 mm to 250mm (see figure 6.2-1 and table 6.2-1 for more detail the distribution rainfall during 13th – 20th August 2018).

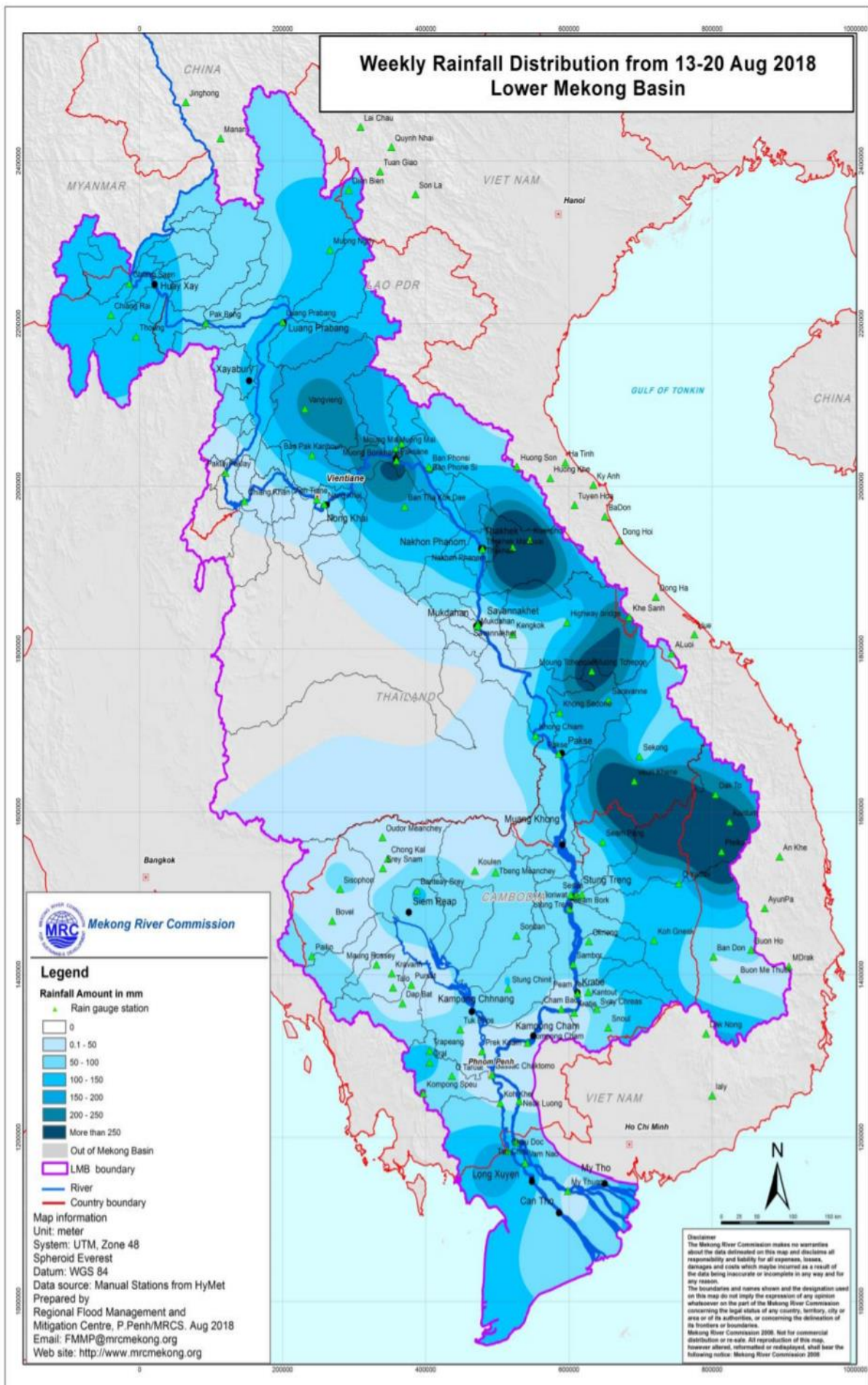


Figure 6.2-1: Rainfall distribution during 13th – 20th August 2018 in LBM

Table 6.2-1: Observed rainfall in maintream stations along LMB during 13th -20th August 2018

2018.00	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
08/13/18	0.00	1.70	5.80	0.00	0.80	6.30	32.90	56.60	58.60	3.40	3.00	4.10	nr	8.50	nr	nr	7.20	-	3.10	0.60	nr	8.00	0.50
08/14/18	7.00	45.40	7.80	0.80	32.60	26.80	113.70	50.80	55.20	28.40	nr	18.00	9.20	9.50	nr	nr	nr	-	nr	nr	3.20	0.00	3.60
08/15/18	0.50	26.00	12.80	0.00	1.40	3.90	10.70	3.70	4.20	4.30	4.20	25.90	71.10	36.50	nr	nr	0.70	-	1.50	8.20	nr	7.00	18.00
08/16/18	8.50	0.00	1.80	0.00	nr	0.00	2.10	0.40	0.40	0.00	0.60	1.80	16.80	3.00	14.40	0.30	nr	-	nr	nr	nr	0.00	0.00
08/17/18	5.50	7.20	40.20	3.90	16.80	8.80	27.20	4.10	4.20	1.30	7.80	1.50	nr	5.60	nr	nr	nr	-	nr	0.00	nr	nr	nr
08/18/18	0.00	28.50	20.80	10.50	2.50	4.20	10.80	0.90	7.80	0.00	nr	21.50	nr	18.50	nr	4.70	11.60	-	8.90	6.80	7.30	12.90	16.00
08/19/18	2.00	16.30	nr	0.70	68.30	1.40	4.70	1.40	nr	2.50	nr	41.00	nr	7.50	20.20	nr	9.10	-	25.00	25.00	nr	31.40	105.00
08/20/18	0.00	0.00	0.40	0.00	nr	0.00	10.90	7.50	20.20	5.30	nr	0.00	3.20	46.00	nr	14.00	0.50	-	nr	0.00	15.20	31.80	23.00

6.3 Flash Flood in Mekong Region on 18th August 2018

Base on the product from MRCFFGS; the Mean Areal Precipitation (MAP) of 24h pervious (00:00 UTC 17 August 2018 to 00:00 UTC 18 August 2018) and generate of Average Soil Moisture (ASM) for 06hrs pervious (figure 6.3-1). The flash flood guidance was issued as possibly in some areas in the next 01, 03 and 06 hours (the result was shown in figure 6.3-2) and table 6.3-1, table 6.3-2, table 6.3-3, table 6.3-4)

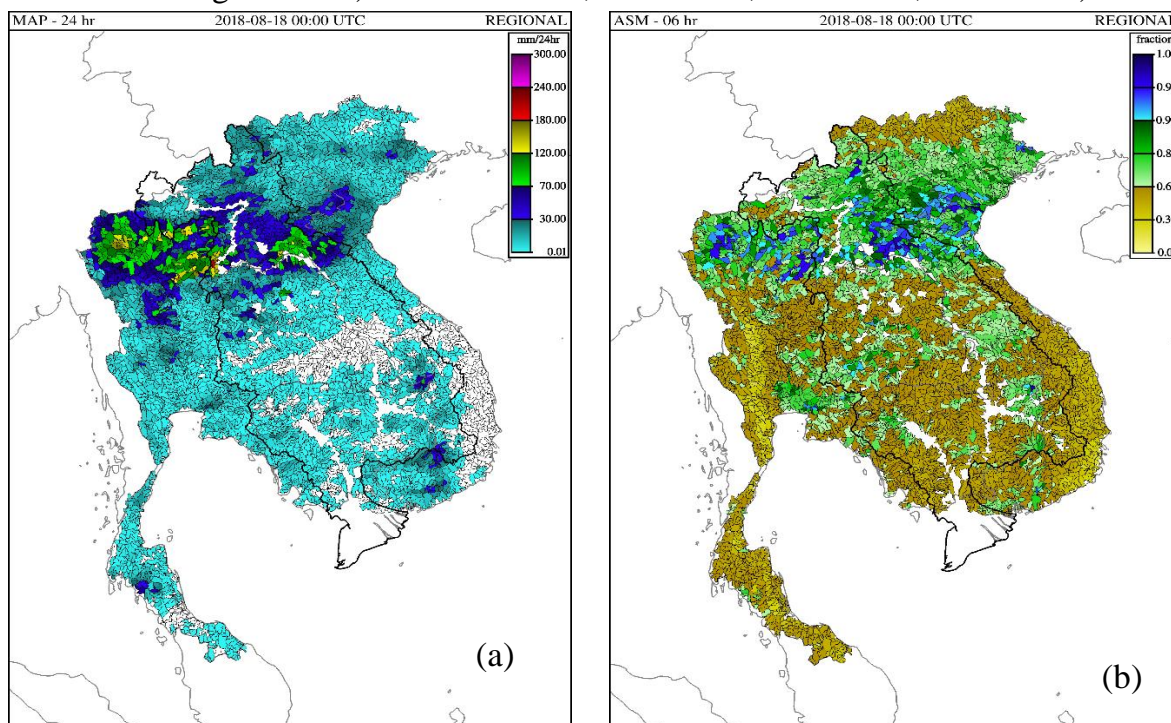


Figure 6.3-1: MRCFFGS's Product (a) MAP 24h pervious and (b) ASM 06h pervious

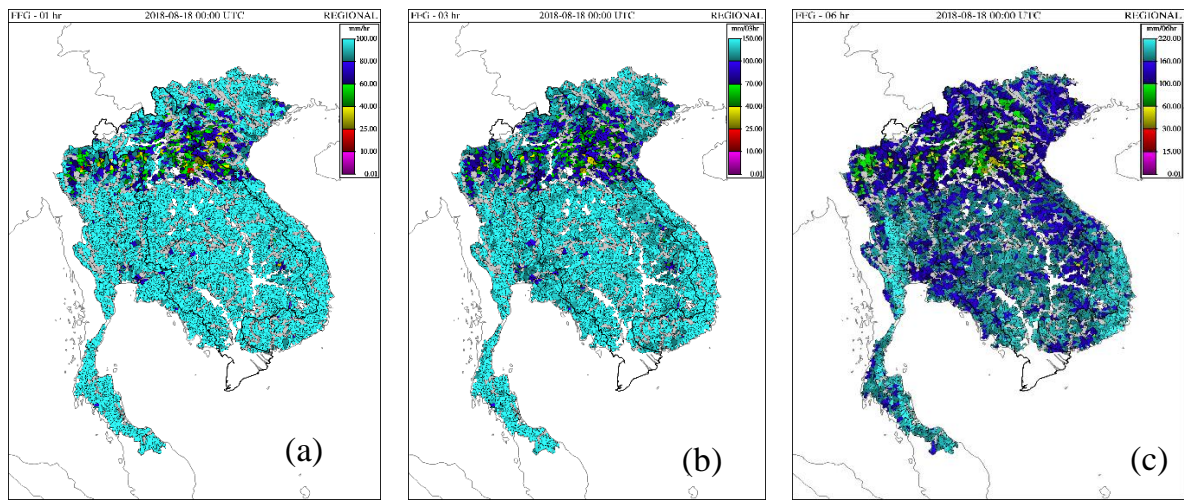


Figure 6.3-2: Flash Flood Guidance for the next (a) 01hr, (b) 03 hr and (c) 06 hr

Table 6.3-1 Flash flood guidance detected by MRCFFG system in Viet Nam on 18th August 2018 at 00 UTC (07: 00 AM Local time)

1hour Flash Flood Guidance in Vietnam			3hours Flash Flood Guidance in Vietnam			6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
			Nghe An	Que Phong	36.36	Lang Son	Loc Binh	53.66
			Nghe An	Con Cuong	36.3	Nghe An	Que Phong	51.9
						Nghe An	Tuong Duong	57.36
						Thanh Hoa	Quan Son	54.51
						Thanh Hoa	Muong Lat	56.3
						Nghe An	Que Phong	45.71
						Nghe An	Con Cuong	45.11
						Hoa Binh	Ky Son	50.78

Table 6.3-2 Flash flood guidance detected by MRCFFG system in Thailand on 18th August 2018 at 00 UTC (07: 00 AM Local time)

1hour Flash Flood Guidance in Thailand			3hours Flash Flood Guidance in Thailand			6hours Flash Flood Guidance in Thailand		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Chiang Rai	Wiang Pa Pao	18.88	Mae Hong Pai		35.54	Phitsanulok	Chat Trakan	55.48
Chiang Rai	Wiang Pa Pao	18.09	Mae Hong Khun Yuam		35.48	Mae Hong Son	Pai	45.25
Lampang	Muang Phan	15.14	Lampang Ngao		38.77	Chiang Mai	Mae Chaem	51.36
Chiang Mai	Omko	20.59	Chiang Rai Wiang Pa Pao		39.47	Mae Hong Son	Khun Yuam	45.4
Chiang Mai	King Amphoe Maewan	20.42	Chiang Rai Wiang Pa Pao		27.03	Lampang	Ngao	49.59
Chiang Mai	Chom Thong	24.74	Chiang Rai Wiang Pa Pao		26.33	Chiang Rai	Wiang Pa Pao	50.51
Chiang Mai	King Amphoe Maewan	16.81	Lampang Muang Phan		23.07	Chiang Rai	Wiang Pa Pao	36.43
Chiang Mai	Mae Rim	17.68	Chiang Ma Omkoi		27.27	Chiang Rai	Wiang Pa Pao	35.51
Chiang Mai	Mae Taeng	20.06	Chiang Ma King Amphoe Maew		29.5	Lampang	Muang Phan	32.17
Chiang Mai	Muang Chiang Mai	18.46	Chiang Ma Chom Thong		33.42	Mae Hong Son	Sobmuai	54.4
Lampang	Muang Phan	20.23	Chiang Ma King Amphoe Maew		24.98	Chiang Mai	Omkoi	34.89
Chiang Mai	San Khamphang	23.24	Chiang Ma Mae Rim		26.35	Chiang Mai	King Amphoe M	39.77
Lampang	Chae Hom	17.18	Chiang Ma Mae Taeng		28.45	Chiang Mai	Chom Thong	43.55
Chiang Mai	King Amphoe Maeon	22.59	Chiang Ma Muang Chiang Mai		27.28	Chiang Mai	King Amphoe M	34.41
			Lampang Muang Phan		28.66	Chiang Mai	Mae Rim	36.02
			Chiang Ma San Khamphang		31.25	Chiang Mai	Mae Rim	58.12
			Lampang Chae Hom		26.02	Chiang Mai	Mae Taeng	38.03
			Chiang Ma King Amphoe Maeon		32.26	Chiang Mai	Muang Chiang I	37.45
			Nan Tha Wang Pha		35.89	Lampang	Muang Phan	38.04
			Nan Pua		38.44	Chiang Mai	San Khamphan	40.19
			Uttaradit Tha Pla		36.6	Lampang	Chae Hom	36.19
						Chiang Mai	King Amphoe M	54.49
						Chiang Mai	King Amphoe M	43.33
						Chiang Mai	King Amphoe M	59.6
						Lampang	Mae Mo	57.53
						Nan	Tha Wang Pha	45.22
						Nan	Ban Luang	58.26
						Nan	King Amphoe B	55.18
						Nan	Pua	48.05
						Uttaradit	Tha Pla	46.74

Table 6.3-3 Flash flood guidance detected by MRCFFG system in Lao PDR on 18th August 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products 18/08/2018 00:00 UTC time								
1hour Flash Flood Guidance in Lao			3hours Flash Flood Guidance in Lao			6hours Flash Flood Guidance in Lao		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
Bolikhamxay	Thaphabat	20.11	Xaysomboun	Thathom	33.01	Xaysomboun	Thathom	57.59
Xaysomboun	Hom	19.75	Xaysomboun	Thathom	36.97	Xaysomboun	Thathom	41.48
			Bolikhamxay	Thaphabat	26.79	Xaysomboun	Thathom	46.09
			Xiengkhuang	Khoun	35.92	Bolikhamxay	Viengthou	55.4
			Xaysomboun	Thathom	37.56	Bolikhamxay	Viengthou	50.67
			Xaysomboun	Hom	26.98	Bolikhamxay	Thaphabat	34.44
			Bolikhamxay	Thaphabat	34.61	Xiengkhuang	Khoun	43.48
			Xaysomboun	Xaysombou	35.19	Xaysomboun	Thathom	58.8
			Xaysomboun	Xaysombou	37.58	Xaysomboun	Thathom	46.81
			Champasak	Paksong	38.08	Xaysomboun	Xaysombou	56.57
						Bolikhamxay	Bolikhanh	57.72
						Xaysomboun	Hom	34.97
						Bolikhamxay	Thaphabat	43.47
						Xaysomboun	Phoun	52.92
						Xaysomboun	Xaysombou	55.07
						Xaysomboun	Xaysombou	44.24
						Xaysomboun	Xaysombou	55.32
						Xaysomboun	Xaysombou	46.97
						Vientiane	Vangvieng	58.28
						Xayaboury	Phieng	54.36
						Luangprabang	Pak xeng	55.6
						Huaphanh	Viengthou	57.47
						Luangprabang	Nan	49.99
						Xiengkhuang	Phookood	52.34
						Luangprabang	Phoukhoun	55.57
						Vientiane	Kasy	58.17
						Champasak	Paksong	45.89
						Huaphanh	Xamtay	57.81
						Xiengkhuang	Nonghed	55.93
						Huaphanh	Xamtay	51.51
						Huaphanh	Xamtay	55.27
						Huaphanh	Huameuang	59.46
						Huaphanh	Xamtay	57.45
						Huaphanh	Xamtay	55.22
						Xiengkhuang	Nonghed	55.78
						Xiengkhuang	Nonghed	56.81
						Xiengkhuang	Nonghed	53.64
						Xiengkhuang	Nonghed	58.9
						Bolikhamxay	Khamkheut	57.9

Table 6.3-4: Flash flood guidance detected by MRCFFG system in Cambodia on 18th August 2018 at 00 UTC (07: 00 AM Local time)

Date of FFG products 18/08/2018 00:00 UTC time								
1hour Flash Flood Guidance in Cambodia			3hours Flash Flood Guidance in Cambodia			6hours Flash Flood Guidance in Cambodia		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
						Ratana Kiri	Ta Veang	57.25

6.4 Conclusions

- The circulation after BEBINCA typhoon and the high pressure of depression are the causes of heavy rain in wide area of Mekong region in this period.

- In some areas in the mountain in the Mekong region, the soil moisture is saturated and combined add more the heavy rain at the same time, therefore these areas the flash flood has been appeared.

- The MRCFFGS detected correctly several locations that are likely to occur the flash floods.

7. Flash flood events on 31st August 2018 in Viet Nam and Lao PDR, caused by Southwest Monsoon

7.1 Weather condition during 27th August – 03rd September 2018

During period the monsoon trough lies across Myanmar, Laos and Viet Nam while the **southwest monsoon** prevails across the Andaman Sea, Thailand and the Gulf of Thailand will strengthen. Continuous rain with isolated heavy rain is likely the North, the East and the South. During this period, also the moderate high pressure areas from China covers Lao PDR and Viet Nam. The weather maps were referenced from Thailand Meteorology Department (TMD) of the 29th August and 01st September 2018 in the Figures 1 & 2 as follows

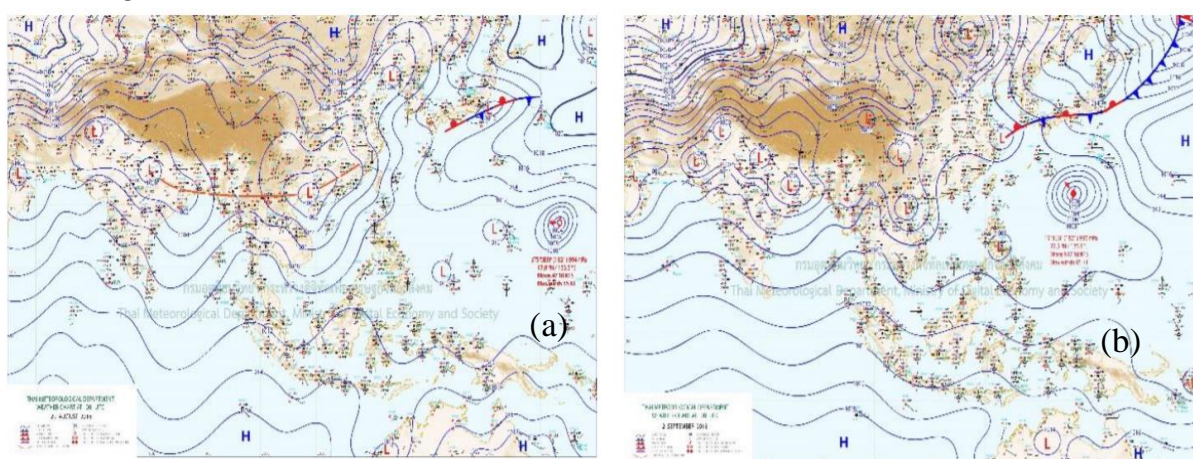


Figure 7.1-1 Weather map for (a) 29th August 2018 and (b) 01st September 2018

7.2 Heavy rain during

During last week, the weather was scattered thundershowers with moderate rain of the Southwest monsoon. Consequently, in this week there was moderate rainfall covered from upper part of Luang Prabang and Vientiane to Khong Chiam and Pakse. The rainfall distribution of this period is shown in Figure 7.2-1 and daily rainfall at key stations in the Lower Mekong Basin are shown table 7.2-1.

Table 7.2-1: Observed rainfall in mainstream stations along LMB during 13th -20th August 2018

2018	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
27/08/2018	3.5	37.4	nr	1.3	6.5	0	52	9.1	12.9	1.6	nr	13.5	36.8	5	nr	1	nr	-	nr	nr	nr	0.8	nr
28/08/2018	0	1.2	nr	0	8.8	12	1.2	17.8	19.7	6.5	nr	32.4	35.5	50	nr	1.6	2.1	-	nr	nr	nr	8	5
29/08/2018	2	0	12.4	0	nr	0	41.8	0.6	2.3	2.4	nr	0.8	nr	nr	nr	nr	-	nr	nr	nr	nr	nr	0
30/08/2018	8.5	4	24.2	4	4.7	11	17.8	8.4	7.6	0.6	4.4	16.8	15	1.5	2	2.7	nr	-	nr	0	nr	nr	nr
31/08/2018	36	9.5	34.9	14	48.5	30	1.8	5.3	5.2	0.9	nr	0	2.4	nr	nr	nr	nr	-	nr	10.2	nr	nr	nr
01/09/2018	15	5.6	1.2	2.2	nr	0	41	1.9	2.9	1	nr	0	nr	nr	nr	nr	nr	-	nr	1.8	nr	nr	nr
02/09/2018	12	5.6	nr	0	nr	0	29.3	0.2	0.2	0	nr	0	nr	nr	nr	1	nr	-	nr	1.6	nr	nr	0.4
03/09/2018	9	19.3	23.2	3.8	nr	0	65.8	0	2.7	0	nr	35.5	7.4	1	10.8	nr	1.1	-	43.8	12	5.3	0.9	0

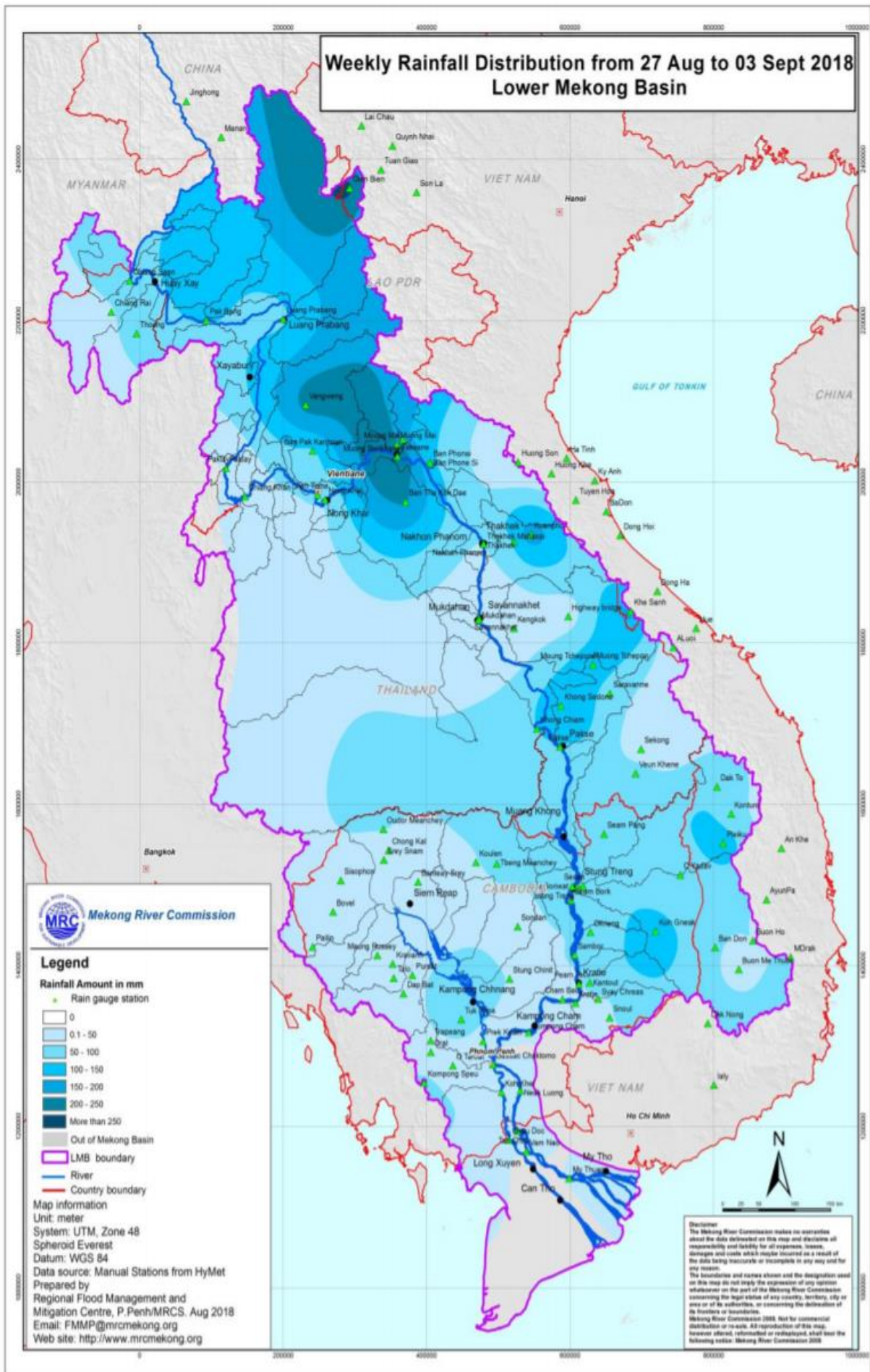


Figure 7.2-1 Rainfall distribution during 29th August – 03rd September 2018 in LMB

7.3 Flash flood events on 31st August 2018 in Viet Nam and Lao PDR.

During period, the local heavy rains due to the meteorological factors as mentioned above, and base on the satellite product analysis, soil moisture previous 06 hours from MRCFFGS, the soil maybe has been saturated in some areas in the northern part of Vietnam and upper parts of Lao PDR (see figure 7.3-1) The products of FFG from MRCFFGS for the next 01, 03 and 06 hr products on 31st 2018 was awarded warning for LMB (Figure 7.3-2). Some of those detection results (including time and space) are also corrected with newspaper and actual the flash flood occurred in the Mekong region (see annex...1)

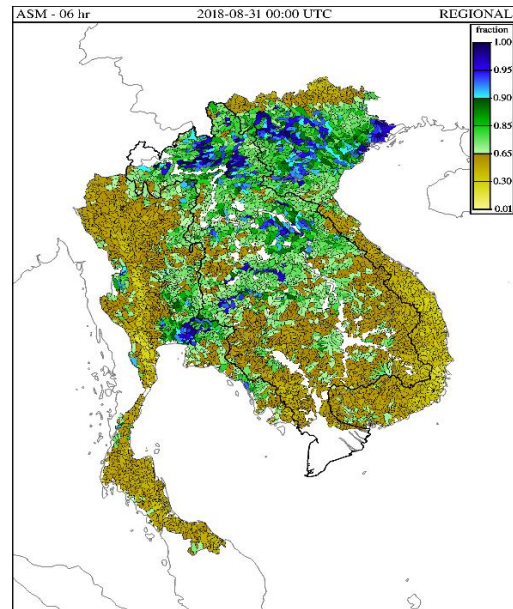


Figure 7.3-1 ASM 06h pervious ar 00:00 UTC on 31st August 2018.

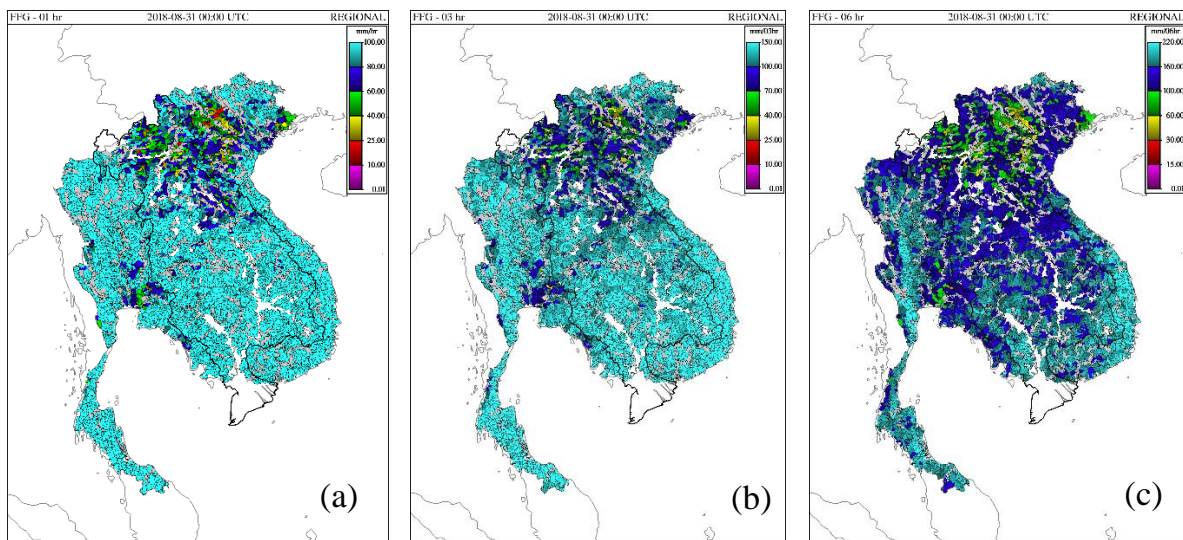


Figure 7.3-2: Flash Flood Guidance for the next (a) 01hr, (b) 03 hr and (c) 06 hr on 31 August 2018 in LMB.

Table 7.3-1: Flash flood guidance detected by MRCFFG system in Viet Nam on 31st August 2018 at 00 UTC (07: 00 AM Local time)

1hour Flash Flood Guidance in Vietnam			3hours Flash Flood Guidance in Vietnam			6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Yen Bai	Tram Tau	23.36	Quang Ninh	TX. Cam Pha	35.9	Quang Ninh	TX. Cam Pha	46.08
Lao Cai	Than Uyen	11.47	Yen Bai	Tram Tau	31.2	Yen Bai	Tram Tau	39.57
Yen Bai	Tram Tau	21.02	Lao Cai	Than Uyen	32.28	Lao Cai	Than Uyen	38.64
Son La	TX. Son La	20.85	Son La	Bac Yen	38.36	Son La	Bac Yen	47.61
Son La	Mai Son	21.06	Hoa Binh	Da Bac	37.82	Son La	Bac Yen	56.81
Son La	Song Ma	18.64	Lao Cai	Than Uyen	15.9	Hoa Binh	Da Bac	47.07
			Yen Bai	Mu Cang Chai	38.42	Hoa Binh	Da Bac	57.28
			Son La	Thuan Chau	36.22	Lao Cai	Than Uyen	20.75
			Yen Bai	Tram Tau	28.55	Yen Bai	Mu Cang Chai	47.32
			Son La	TX. Son La	28.68	Son La	Muong La	51.11
			Son La	Mai Son	28.71	Son La	Thuan Chau	46.39
			Son La	Mai Son	37.97	Yen Bai	Tram Tau	36.65
			Son La	Bac Yen	34.81	Son La	TX. Son La	37.37
			Nghe An	Tuong Duong	35.29	Son La	Mai Son	37.35
			Lai Chau	Dien Bien Dong	36.62	Son La	Mai Son	47.6
			Son La	Song Ma	26.56	Son La	Bac Yen	43.47
						Son La	Phu yen	50.96
						Son La	Phu yen	56.63
						Son La	Moc Chau	58.44
						Hoa Binh	Mai Chau	52.05
						Bac Kan	TX. Bac Kan	59.02
						Quang Ninh	TX. Uong Bi	49.94
						Nghe An	Tuong Duong	43.6
						Thanh Hoa	Muong Lat	58.13
						Lai Chau	Dien Bien Dong	46.34
						Son La	Song Ma	35.13
						Son La	Song Ma	50.78
						Thanh Hoa	Muong Lat	53.41
						Thanh Hoa	Quan Hoa	59.75
						Thanh Hoa	Quan Son	55.05
						Thanh Hoa	Muong Lat	57.21
						Hoa Binh	Ky Son	51.89

Table 7.3-2: Flash flood guidance detected by MRCFFG system in Lao PDR on 31st August 2018 at 00 UTC (07: 00 AM Local time).

1hour Flash Flood Guidance in Lao			3hours Flash Flood Guidance in Lao			6hours Flash Flood Guidance in Lao		
Provinces	Districts	FFG value	Provinces	Districts	FFG value	Provinces	Districts	FFG value
Luangprabang	Pak xeng	19.57	Luangprabang	Pak xeng	26.7	Xiengkhuang	Khoune	51.42
Oudomxay	Pakbeng	23.19	Khammuane	Hinboon	39.18	Xaysomboun	Phoun	56.71
			Luangnamtha	Viengphou	35.67	Vientiane	Vangvieng	55.34
			Luangnamtha	Namtha	35.93	Luangprabang	Luangprab	52.93
			Oudomxay	Pakbeng	31.26	Luangprabang	Pak xeng	34.67
						Luangprabang	Park Ou	50.14
						Luangprabang	Phonxay	50.86
						Luangprabang	Phonxay	52.23
						Luangprabang	Phonxay	57.66
						Luangprabang	Xieng nge	53.46
						Luangprabang	Nan	50
						Khammuane	Hinboon	47.87
						Luangnamtha	Viengphou	50.42
						Luangnamtha	Viengphou	45.29
						Luangnamtha	Namtha	45.44
						Oudomxay	Hoon	58.4
						Oudomxay	Pakbeng	39.94
						Huaphanh	Xamtay	57.67
						Xiengkhuang	Nonghed	54.12
						Huaphanh	Xamtay	50.31
						Huaphanh	Xamtay	50.66
						Huaphanh	Xamtay	53.92
						Huaphanh	Xamtay	53.79

7.4 Conclusions

- The Southern Monsoon phenomena is the causes of heavy rain in wide area of Mekong region in this period.
- In some areas in the mountain in the Lao PDR and Viet Nam, the flash flood occurred on 31st August 2018.
- The MRCFFGS detected correctly several locations that are likely to occur the flash floods.

8. Flash flood events on 26th November 2018 in Central Highland of Viet Nam, caused by typhoon USAGI

8.1 Weather Condition during

Typhoon USAGI: According the Central Pacific Hurricane Center, on 03 November began monitoring a disturbance that had formed in the central of Pacific sea. This disturbance soon moved out of the basin and into the West Pacific without further development on November 6. Tracking westward, the system did not organize until late on November 18, when it reached tropical depression status. The beginning named the system Tropical Depression is "Samuel" and issued warnings for Mindanao and Visayas. Samuel made landfall on November 20 in the Philippines, crossing the archipelago and weakening slightly. Samuel began to strengthen over the East Sea and was subsequently named "USAGI".

USAGI underwent rapid intensification and became a severe tropical storm on November 21 while moving slowly. By November 22, **USAGI** (Samuel) intensified into a Category 1 typhoon. On November 24, **USAGI** weakened back to a severe tropical storm while heading to Vietnam because of the land interaction (see figure 8.1-1)

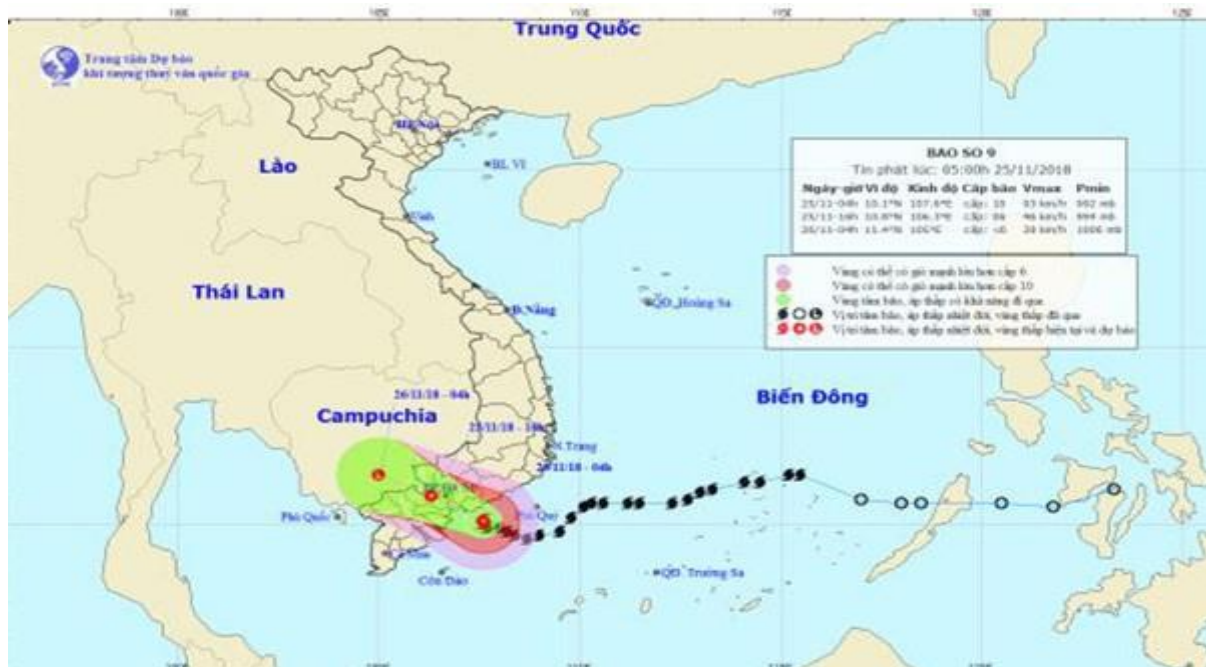


Figure 8.1-1: The track of typhoon “USAGI”

8.2 Flash flood event on 26th November 2018 in southern part of Viet Nam.

Date of FFG products			26/11/2018 00:00 UTC time					
1hour Flash Flood Guidance in Vietnam			3hours Flash Flood Guidance in Vietnam			6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Ninh Thuan	Ninh Hai	23.59	Ninh Thuan	Ninh Hai	32.01	Phu Yen	Tuy Hoa	47.33
Ninh Thuan	Ninh Son	21.51	Ninh Thuan	Ninh Son	29.46	Ninh Thuan	Ninh Hai	41.33
Binh Thuan	Tuy Phong	19.72	Lam Dong	Don Duong	37.71	Lam Dong	Don Duong	56.11
Binh Thuan	Bac Binh	24.33	Binh Thuan	Tuy Phong	27	Ninh Thuan	Ninh Son	38.2
			Binh Thuan	Bac Binh	37.36	Lam Dong	Don Duong	48.09
			Binh Thuan	Bac Binh	33.38	Binh Thuan	Tuy Phong	35.06
						Binh Thuan	Bac Binh	47.34
						Binh Thuan	Bac Binh	43.52
						Binh Thuan	Bac Binh	57.92
						Binh Thuan	Tanh Linh	52.78
						Binh Thuan	Ham Thuan Nam	57.28

8.4 Conclusions

- The appearing of the storm in November in the East Sea were not abnormal climate characterizes but also it landed in the South of Vietnam was more abnormal climate's character of tropical typhoon in the East Sea.
- The influence by typhoon's circulation has caused unusually heavy rainfall in southern part of Vietnam, then flash and landslide occurred in some areas in this region.
- The MRCFFGS detected some flash flood areas by the locations, however by the time to occur has underestimate by actual happened of flash flood event.

9. Conclusions and recommendations

9.1 Conclusions

Flash floods in the Mekong region is a recurrent event which has the potential to adversely affect economic, human, lives, properties, and infrastructures. Currently, the Lower Mekong region have become increasingly more concerned with flash floods, and are looking for ways to improve flood preparedness to limit the extent of damage. According to the media reported (see appendix 1), flash floods and landslides occur very often in mountainous areas of the upper and central of Mekong region.

Since 2010, the MRCFFG system has been operating successfully. It provides products to support the development of warning and estimate the risk of flash flooding from rainfall events in the sub-basins of the MRC member countries. The main aim of this report is to evaluate the performance of MRCFFG system in village and district areas of the MRC member countries for the detection of the risk areas of potential flash floods during the 2018 flood season from May until the late of November.

This report is the fifth evaluation report of MRCFFG system. The report does not cover all of the flash flooding that occurred in 2018 flood season, it is based on the available flash flood information that was collected from the media (see appendix 1). However, it is difficult to evaluate the MRCFFG results using media information due to the fact that flash floods occurred in areas which are difficult to access and there are no reports available. The MRCFFG system often indicated a flash flood risk in the flooded areas, but it is lacking an accurate and complete database of flash flood events. This makes it difficult to put a number on the success rate.

There were 29 tropical storms which developed over the Pacific Ocean and or over the East Sea (see table 3.1-1 and figure 3.1-1). There were seven tropical storms, namely (1) EWINAR, (2) GAEMI, (3) SONTINH, (4) BEBINCA, (5) MANGKHUT, (6) BARIAT, (7) TORAJI, and (8) USAGI which caused serious flash floods affecting the LMB. Figure 3.1-1 represents the track of the tropical storm during the year 2018. The other cause of flash floods in the Lower Mekong region is the ITCZ, low pressure and tropical depression which also led to flash flood occurrence at some areas in the Mekong mainstream and its tributaries. Figure 3.1-2 represents an example of the weather chart on 16 July 2018 during the ITCZ occurrence in the Mekong region.

Most of the flash flood risk areas in the Mekong region that were detected by the MRCFFG system occurred in the northern province of Viet Nam, and in the northern province of Lao PDR (see **Error! Reference source not found.**). Unfortunately during the flood season 2018 there were numerous periods in which “missing data” were reported, especially at Phongsaly, Muong Namtha, Oudomxay and Moug Ngoy stations located within the northern province of Lao PDR. Limiting the “missing data” in these areas is highly necessary in order to improve the verification of flash floods and getting ‘grip’ on the accuracy of the system in these areas.

According to the media reports (see appendix 1) several flash floods hit the coastline area during flood season 2018.

Finally, it can be stated that the MRCFFG system performance during flood season 2018 was capable of predicting expected rainfall amounts with reasonable accuracy; the system is potentially a very effective tool for flash flood forecasting in the Mekong region.

9.2 Recommendations

The recommendations would further develop the MRCFFG system for enhancing the accuracy of flash flood forecasting, and to reduce damage, the risk of lives, properties and also to avoid future catastrophes caused by flash floods are listed below:

1. Based on the results of MRCFFG system, there are many failing detection flash flood risk areas of the MRCFFG system (i.e. underestimated and overestimated). It is recommended that to improve the Mean Aerial Precipitation (MAP) product for reliable rainfall measurement needs to be reviewed the bias correction factor. Once, updated the bias correction factor, should re-run the MRCFFG system, review and verify the results.
2. In order to develop, implement and operate the MRCFFG system, the data and information such as daily, and/or hourly, monthly climatological data, precipitation data (hourly, daily, monthly), air temperature (hourly, daily, monthly), soil moisture data, the updated land use/land cover map, streamflow discharge data for tributary streams to Mekong River or upstream (hourly, daily, monthly), stream stage data (hourly, daily, monthly), radiation data for computation of evapotranspiration (daily, monthly), wind and humidity data for computation of potential evapotranspiration (daily, monthly), etc. are needed for system operations and bias correction. It is recommended that this information is significant to review bias correction factor for improving the MAP.
3. For the evaluation of effectively MRCFFG system and to improve the accuracy of the system, it is recommended that to build confidence in the system a more orderly way to collect the information of flash flood is needed. National flood relief authorities should build up a data base on the exact location of flash floods and the damage occurrences, and report to the RFDMC. Then the effectiveness of the system can be properly evaluated, and weaknesses of the system identified and rectified.
4. GIS database of village, district and province information is a significant input to address the high risk area of flash floods. Since 2010 until present, RFDMC still lack on the information about the village database in GIS format (ArcGIS point file) of Thailand and Viet Nam for the input into GIS database. With this information would help the capability MRCFFG system to issue a warning on possible flash floods occurrence in Thailand and Viet Nam. It is recommended that to figure it out how to coordinate with the line agencies concerned to provide and support the Thailand and Viet Nam village database (GIS point file).

5. The current GIS database such as the village, district and province name and boundary received from national line agencies in 2003. This information may not be consistent and out of date with the current GIS database of each country. It is recommended that the update GIS database is a significant input to issue the warnings on possible flash flood occurrences.
6. According to the flash flood information of the media reported (see appendix 1), flash flooding occurrences at many districts under flash flood watch (yellow color scale) (see **Error! Reference source not found.**). It is recommended that the routine daily operational flash flood forecasts should also take into account the flash flood watch warnings.
7. The RFDMC's MRCFFG system could contribute to the preparedness by offering the training courses in the use of the system and by urging the countries to alert flash flood warnings. It is recommended that to conduct refreshment training courses of MRCFFG system operation for the purpose to improve on FFG operation, and also to exchange the knowledge and experiences on FFG operation with National Center's and the RFDMC operators.
8. It is recommended that a strengthening of the staff at all levels to be able to handle flash flood forecasting and warnings.
9. For effective disaster flash flood risk reduction, it is recommended that the community awareness of flash flood with user agencies is needed.
10. During the serious weather conditions such as tropical storms, tropical depressions, ITCZ etc. Flash floods can occur at any time at any area of the Mekong region. It is recommended that the daily operational flash flood forecast should update the flash flood warnings on the MRC webpage and publish three times during daytime with 6 hourly intervals, at 07:00 am, 01:00 PM and at 07:00 PM, respectively.
11. Identifying areas prone to significant risk of flash floods requiring the local authorities to conduct flood hazard assessment through hydrological and other technical backup provided by relevant technical agencies.
12. It is recommended that the frequency of flash flood warnings mapping in Mekong region is needed. This information will define the risk areas of flash flooding under several weather conditions.

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Appendix A

Flash occurred in Viet Nam caused by typhoon SONTINH



Flash occurred in Lao PDR caused by typhoon SONTINH

TUESDAY
24 JUL 2018
1700HRS UTC +7

**EFFECT OF TROPICAL STORM 11
(SON-TINH)**
Member State under monitoring: Lao PDR
FLASH UPDATE #6

ONE ASIAN ONE RESPONSE

Lao PDR, Impact of Tropical Storm Son-Tinh
Source: NDMO, Min. of Labor & Social Welfare [24-Jul-2018]
Government of Lao PDR reported flooding in 349 villages, 41 districts in the following provinces: Attapeu, Savannakhet, Khammouan, Xayabuly, Bolikhamxay, Luang Prabang, Bokeo, Sekong, Xiengkhouang, Oudomxay (red areas in left figure).

- 2 death 34 missing
- 10,015 persons directly affected (3,452 families)
- 324 families (1,494 people) evacuated to temporary emergency shelter
- 243 houses damaged
 - 22 totally damaged
 - 223 partially damaged
- Damage to livelihood
 - Paddy fields inundated
- Affected of infrastructures and lifelines
 - 14 bridges damage
 - Road damage in Attapeu/Province only boat can access the affected areas
 - Access to natural water resources was cut-off
 - School buildings in affected areas are dysfunctional and used for evacuation centers
- Immediate Needs
 - Additional tent for 1,000 families in temporary emergency shelter area
 - Family kits for 1,000 families
 - Personal hygiene kit for 4,000 people
 - Housing repair kits
 - Field Office with Operation system and support equipment

Situation Overview in Lao PDR

- Due to the monsoon season and heavy rainfall resulting from TS Son-Tinh passing over Northern, Central and Southern Laos PDR between 18-19 July 2018.
- Flooding occurred in 10 provinces: Attapeu, Savannakhet, Khammouan, Xayabuly, Bolikhamxay, Luang Prabang, Bokeo, Sekong, Xiengkhouang, Oudomxay.
- Due to the heavy rainfall, there was an overflow from Xepien-Xenamnoy dam which resulted in flooding affecting downstream villages and more than 1,000 families were evacuated.

Response by Government of Lao PDR

- Provincial Committee on Disaster Prevention and Control Committee was activated with military and police assisting evacuation of villagers. Search and Rescue teams was deployed with helicopters and rescue boats.
- Prime Minister Office has declared Sanamxay District, Attapeu Province (approx. 829 km from Vientiane), as a disaster area.
- Prime Minister and Chair of Disaster Prevention and Control Committee with members visited Attapeu Province with relief items on 24 July 2018.
- The National Facal Point meeting had taken place on 24 July 2018.

Other sources

- Status of the river monitoring system is also available on [Mekong River Commission's portal](#).
- Hydrological stations which are being monitored real time can be accessed [here](#).

AHA Centre is in close contact with Department of Social Welfare and will provide additional updates when new information becomes available.

DISCLAIMER
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TUESDAY
24 JUL 2018
1700HRS UTC +7

**EFFECT OF TROPICAL STORM 11
(SON-TINH)**
Member State under monitoring: Lao PDR
FLASH UPDATE #6

ONE ASIAN ONE RESPONSE

24 Hour Accumulated Rainfall (mm) Forecast Valid from

24/07/2018 - 25/07/2018 00:00Z

25/07/2018 - 26/07/2018 00:00Z

26/07/2018 - 27/07/2018 00:00Z

Forecast generated by NERC of JICA AGRIUS

Current situation in affected areas
(Source: NDMO, Min. Labor & Social Welfare)

Forecast for the next 24 hours

- Based on the forecast by Lao PDR DMH, it is expected that there will be rain over the next 3 days across Northwestern Lao PDR bordering with Eastern Part of Thailand.
- This might increase the water levels of the Mekong river basin and likely exacerbate the situation as the floods start to subside.
- Mekong River Commission has a [near-real time monitoring portal](#) for hydrological levels along the basin
- Monitoring points to notes are: [Chiang Sean](#), [Phiengluang](#), [Mukdahan](#), [Pakse](#), [Khong Chiam](#)

Hydrological Stations
(ECWMP Forecast from Windy.com)

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Flood warnings as storm Son-Tinh moves into Thailand

PUBLISHED : 19 JUL 2018 AT 12:27

WRITER: ONLINE REPORTER



The 2-million-cubic-metre Huai Si Thon reservoir in Muang district, Kalasin, is overflowing after persistent rain brought by Tropical Storm Son-Tinh. (Photo by Yongyuth Phuphuangpet)

Tropical storm Son-Tinh landed in Vietnam and was expected to downgrade to a depression as it moved into the upper Northeast of Thailand on Thursday, with the forecast for heavy rain and flood warnings for most of the country.

Wanchai Sakudomchai, director-general of the Meteorological Department, said Son-Tinh hit Vinh city of Vietnam about 4am, bringing winds of around 70 kilometres per hour. It was moving westward at 20kph and expected to become a depression and then a low pressure system.

Fourteen dead, missing after Bebinca triggers flash flooding, landslides

Monday, August 20, 2018 09:39

Typhoon-triggered floods left 12 dead and two missing in Vietnam by August 19, according to the Office of the National Committee for Search and Rescue.



The committee said 10 people in the northern provinces of Son La, Hoa Binh, Yen Bai, Bac Giang, Phu Tho, Ninh Binh, Thanh Hoa and the central province of Nghe An were killed by flash flooding and landslides while two were missing by flood in Son La and Thanh Hoa provinces.

The National Center for Hydro Meteorological Forecasting said weather in the North was better on August 19 whereas the central was sunny. The water level in Nghe An and Thanh Hoa provinces ebbed yet flood in Thuong and Ca rivers continued to rise, weather forecasters warned

Flash flooding and landslide- triggers by Bebinca destroyed 3 houses and inundated around 3,422 houses in Yen Bai, Thanh Hoa, Nghe An, and Son La provinces.

Additionally, 401 cattle and 17,168 poultry were killed in the flood. Some 1,115 hectares of fish farm were affected badly.

While the North suffered flood, the Mekong delta province of Ca Mau experienced strong wind which killed two people.

The committee asked flood-hit provinces to mobilize all force to help people after the natural disaster especially in Son La, Thanh Hoa, Nghe An. Rescue mission must be performed to find missing residents.

Local governments should visit and give support to families of victims as well as province shelters to homeless inhabitants in districts Ky Son, Tuong Duong, Con Cuong, Tan Ky, Anh Son, Nghia Dan in Nghe An province which are isolated by flood.

Storm Bebinca takes toll on northern, north central regions

VNA SATURDAY, AUGUST 18, 2018 - 15:11:00 [PRINT](#)



*A road is damaged after heavy rain in Muong Lat district, Thanh Hoa province
(Photo: VNA)*

Hanoi (VNA) – At least six people have died and two others remain unaccounted for after storm Bebinca swept through the northern and north central regions of Vietnam on early August 17.

Four of the dead victims were in the north central province of Nghe An while the northern mountainous province of Son La and the north central province of Thanh Hoa each recorded one death. Son La and Nghe An also reported two missing as of the end of August 17, according the Central Steering Committee for Natural Disaster Prevention and Control.

Over 20 houses collapsed, 1,200 others were flooded, and 200 families were evacuated as a result of flooding in Son La, Phu Tho, Thanh Hoa and Nghe An provinces.

The natural disaster also washed away almost 7,400 head of livestock in Nghe An and affected over 720ha of aquatic farming in the localities.

Landslides on several stretches of national highways and local roads in Son La, Yen

Bai, Thanh Hoa and Nghe An have also blocked transport.

In Nghe An province, water levels in local rivers rose quickly, causing inundation in Quy Hop, Con Cuong, Tuong Duong, Que Phong and Ky Son districts.

“The inundation is more severe than in previous storms,” said Vo Sy Son, Vice Chairman of the People’s Committee of Quy Hop district.

Flooding and landslides on a large scale occurred in Chau Ly, Chau Thanh and Chau Hong communes, isolating many villages in these areas. Particularly, spillways in Chau Ly commune were all flooded, totally blocking off nearby villages.

According to the National Centre for Hydro-Meteorological Forecasting, Nghe An province received up to 280mm of rain.

Meanwhile, the districts of Lang Chanh and Ba Thuoc in Thanh Hoa province have been put on high alert of flash floods and landslides.

Downpours have also reportedly hit the northern provinces of Lang Son, Hoa Binh and Yen Bai. The districts of Cao Loc, Loc Binh and Chi Lang in Lang Son; Van Chan, Tram Tau, Nghia Lo and Mu Cang Chai in Yen Bai; and Da Bac, Mai Chau and Lac Thuy in Hoa Binh all have a high risk of landslides and flash floods.

Vietnam

Tropical Storm Bebinca made landfall in Vietnam on 17 August 2018 and resulted in heavy rainfall in several northern provinces.

Flooding and several landslides were reported in Son La, Nghe An and Thanh Hoa provinces. According to ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), 2 people died, 1 is missing, 65,890 people were affected and 6,354 displaced. Houses, crops, roads and 2 bridges also suffered damaged.

Laos

After floods from Tropical Storm Son-Tinh and the dam collapse in Attapeu province, heavy rain brought by Tropical Storm Bebinca from 18 August caused further flooding in Laos.

AHA Centre report that around 30,000 people were affected, mostly in Oudomxay and Luang Prabang provinces in the north of the country. Wide areas of crops and farm land damaged were also damaged.

Thousands of people in Laos are still recovering after the flooding caused Tropical Storm Son-Tinh and the **dam failure in Sanamxay District of Attapeu province on 23 July**.

The Red Cross said in a **report** of 17 August that at least 35 people were killed and 100 are missing in flooding after the dam collapse. More than 13,000 people have been affected across 13 villages in the area.



People are starting to return home after the flash flooding in Laos, but they face a massive clean-up. Roads were inundated following the dam collapse, cutting off access to some communities. The floodwaters also damaged 14 bridges and other infrastructure. Sanamxay district, Laos 31-07-2018. Credits: Bart Verweij/IFRC



People are starting to return home after the flash flooding in Laos, but they face a massive clean-up. Sanamxay district, Laos, 31-07-2018. Credits: Bart Verweij/IFRC

Thailand

In Thailand, floods were reported in Nan Province on 18 August 2018, after heavy rain caused the Nan River and its tributaries burst their banks. More than 1,000 homes were flooded in the seven districts of Chiang Klang, Pua, Tha Wang Pha, Mae Charim, Santisuk, Phu Phiang, and Muang. Around 44,000 people were affected.

The water levels at the Nan River kept stood at 8.30 metres at Kadiaeng as of 18 August.

Heavy rain wreaks havoc nationwide

VietNamNet Bridge – Heavy downpours and floods in northern mountainous and Cuu Long (Mekong) Delta provinces over the past days have wreaked havoc.



A local road is eroded in Muong Lat District in central Thanh Hoa Province which has been isolated due to heavy downpour and floods over the past days. — VNA/VNS Photo

As rain is forecast to continue in the coming days, flash floods and landslides are predicted, according to the National Centre for Hydro-Meteorological Forecasting.

According to reports from northern provinces of Bac Kan, Hoa Binh, Dien Bien, Son La, Thai Nguyen, central province of Thanh Hoa and Mekong Delta province of Long An, as of Thursday morning, downpour and floods made 124 houses collapse and inundated 174ha of paddy fields.

Nearly 5,000cu.m of rocks and soil have eroded. Falling rocks killed a two-year-old girl in Hoa Binh Province's Mai Chau District, while one person went missing and three others were injured.

Dien Bien Province, one of the hardest hit, had 700 landslide spots. Three commune's headquarters have been flooded by half a metre of mud. Total losses in the province have so far reached VND120 billion (US\$5.2 million).

The Directorate of Water Resources has warned that water levels in Mekong Delta localities might exceed level 3, the highest warning level. Floods are predicted to affect 165,200ha of autumn-winter rice crops in provinces located in the upstream of the river such as Dong Thap, Kien Giang, An Giang and Long An.

Six mountainous districts in central Nghe An Province – Ky Son, Tuong Duong, Con Cuong, Que Phong, Quy Chau and Quy Hop - are at risk of landslides and flashfloods, according to the centre.

As of Thursday morning, eroded roads connecting communes in the province had not been repaired. Cracks on National Highway No 7 caused by heavy rains between August 16 and 23 have not been repaired and are predicted to encroach upon a larger area.

The National Steering Committee on Natural Disaster Prevention has ordered safety measures to be taken in the Mekong Delta provinces of An Giang and Kien Giang to protect structures located by the rivers and dykes, as the Tra Su and Tha

ANNEX B: MRCFFGS Operation Output Product Descriptions

Annex B1: FFGS' Products descriptions

MRCFFG Operational Output Product Descriptions				
Label	Definition	Format	Updated	Description
HE Sat	Hydroestimator Satellite Precipitation	Images	Hourly	The images display gridded hourly, 3-hourly, 6-hourly and 24-hourly totals of precipitation (mm) ending on the current hour as estimated in real-time from geostationary satellites using the Hydroestimator algorithm. The satellite rainfall estimates are provided on a grid having approximately 10x10 km resolution which is displayed over a background of MRCFFG sub-basin boundaries. The HE Sat data products are updated every hour and reflect rainfall accumulations ending on the current product hour.
				SAT 01-hr: Total of precipitation as estimated by the Hydroestimator over the last hour ending on the current product hour. (mm/1hr)
				SAT 03-hr: Total of precipitation as estimated by the Hydroestimator over the last 3 hours ending on the current product hour. (mm/3hr)
				SAT 06-hr: Total of precipitation as estimated by the Hydroestimator over the last 6 hours ending on the current product hour. (mm/6hr)

				SAT 24-hr: Total of precipitation as estimated by the Hydroestimator over the last 24 hours ending on the current product hour. (mm/24hr)
.
Merged MAP	Mean Areal Precipitation	Text & Images	Hourly	Text tables and images of hourly, 3-hourly, 6-hourly and 24-hourly totals of mean areal precipitation (mm) for each MRCFFG catchment. It includes real-time or climatological bias adjustment of the real-time satellite rainfall and substitution of interpolated precipitation of 6-hourly rain gauge data for sub-basins with no available satellite information (either by unavailability or masking). The Merged MAP data products are updated every hour and reflect accumulations of basin-average precipitation of a given duration ending on the current product hour.
				MAP 01-hr: Total mean areal precipitation estimated over the last hour ending on the current product hour. (mm/1hr)
				MAP 03-hr: Total mean areal precipitation estimated over the last 3 hours ending on the current product hour. (mm/3hr)
				MAP 06-hr: Total mean areal precipitation estimated over the last 6 hours ending on the current product hour. (mm/6hr)
				MAP 24-hr: Total mean areal precipitation estimated over

				the last 24 hours ending on the current product hour. (mm/24hr)
.
ASM	Average Soil Moisture	Text & Images	00, 06, 12 & 18 UTC	Text tables and images provide soil water saturation fraction (dimensionless ratio of contents over capacity) for the upper zone (down to 20-30 cm depth) of the Sacramento Soil Moisture Accounting Model for each of the MRCFFG sub-basins. The products are updated every 6 hours at the model processing hour (i.e. 00, 06, 12 and 18 UTC).
				ASM 06-hr: Average soil water saturation at most recent model processing hour. (fraction of soil capacity in the upper zone)
.
FFG	Flash Flood Guidance	Text & Images	00, 06, 12 & 18 UTC	Text tables and images of hourly, 3-hourly and 6-hourly flash flood guidance (mm) for each MRCFFG sub-basin are provided. The FFG value indicates the total volume of rainfall over the given duration which is just enough to cause bankfull flow in the draining stream outlet. Consequently, rainfall volumes of the same duration that are greater than the FFG value indicate a likelihood of overbank flows at the draining stream outlet. Each of the FFG products is updated at every model processing hour (00, 06, 12 and 18 UTC). This product is

				appropriate to use in real time with nowcasts or forecasts of rainfall and other local information to estimate the risk of flash flooding in the MRCFFG sub-basins.
				FFG 01-hr: Required precipitation over the next hour following the most recent (current) model processing hour to cause bankfull flow. (mm/1hr)
				FFG 03-hr: Required precipitation over the next 3 hours following the most recent (current) model processing hour to cause bankfull flow. (mm/3hr)
				FFG 06-hr: Required precipitation over the next 6 hours following the most recent (current) model processing hour to cause bankfull flow. (mm/6hr)
				Prev FFG 01-hr: Required precipitation over the hour following the previous model processing hour to cause bankfull flow. (mm/1hr)
				Prev FFG 03-hr: Required precipitation over the 3 hours following the previous model processing hour to cause bankfull flow. (mm/3hr)
				Prev FFG 06-hr: Required precipitation over the 6 hours following the previous model processing hour to cause bankfull flow. (mm/6hr)

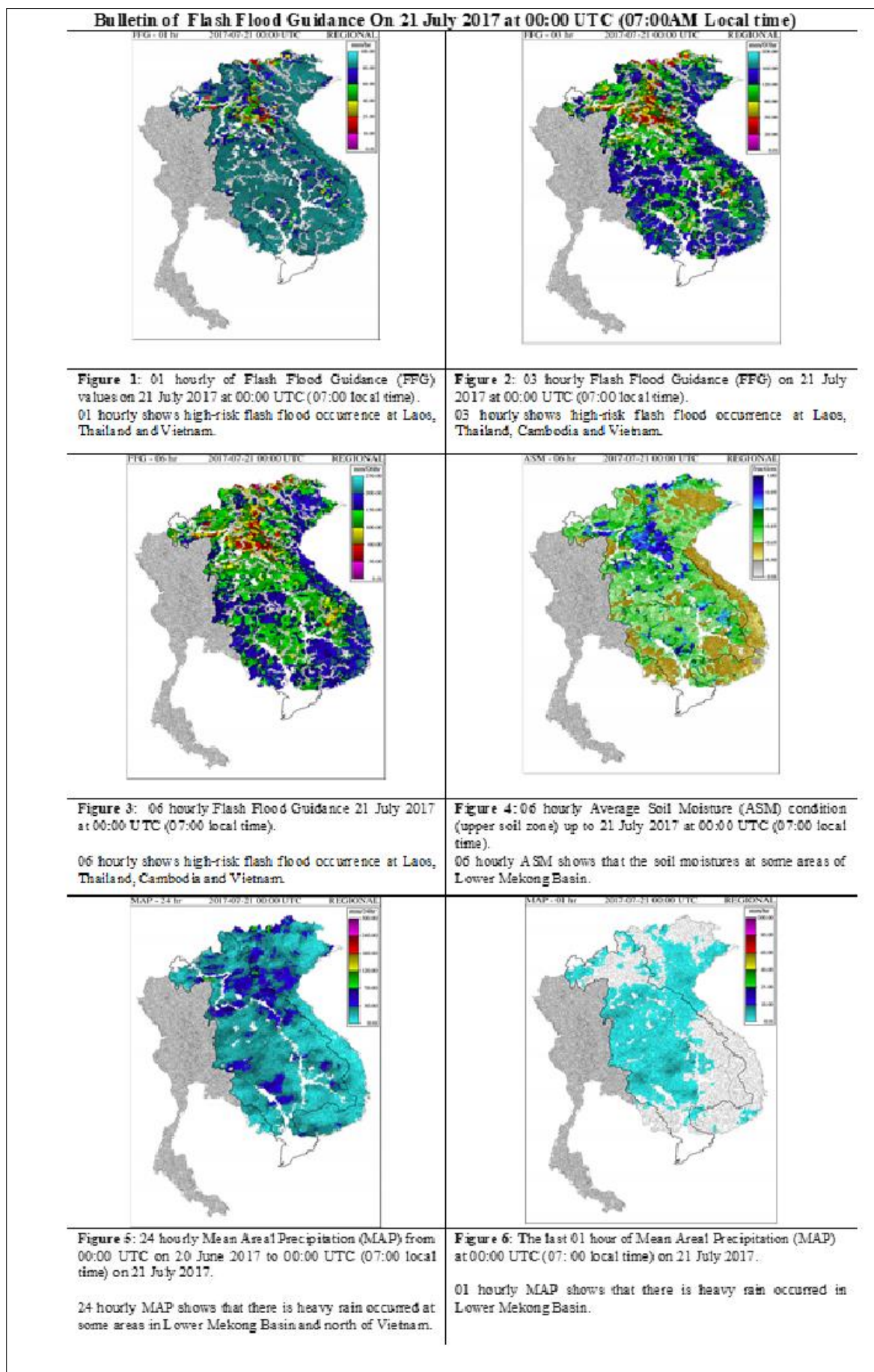
<p>PFFT</p>	<p>Persistence Flash Flood Threat</p>	<p>Text & Images</p>	<p>00, 06, 12 & 18 UTC</p>	<p>PFFT products include text tables and images of hourly, 3-hourly and 6-hourly flash flood threat (mm) for each MRCFFG catchment. The values indicate the difference of recent persisted merged estimates of mean areal rainfall of the given duration and the corresponding current FFG of the same duration for a given MRCFFG sub-basin. The last 1-hour, 3-hour and 6-hour durations of MAP are persisted and considered with current corresponding FFG in the computation of PFFT.</p>
				<p>For example, the 6-hr PFFT at 12:00 UTC = 06-hr MAP from 12:00 UTC - 06-hr FFG from 12:00 UTC</p>
				<p>In the images, an approximate measure of uncertainty in the PFFT estimates is indicated by the ranges in the color scale (with yellow indicating the range of values that are unlikely to be of concern for flash flooding and with orange and red indicating progressively higher risk of flooding for the sub-basin of interest). The hourly, 3-hourly and 6-hourly PFFT products are updated at model processing hours (00, 06, 12, 18 UTC). Note that this set of products uses a crude rainfall forecast and probably contains large uncertainties. PFFT is offered</p>

				as a baseline product that must be carefully evaluated by the forecaster in real-time.
				PFFT 01-hr: Difference of 01-hr FFG for current model processing hour and current 01-hr MAP persisted for the next 1 hour. (mm/1hr)
				PFFT 03-hr: Difference of 03-hr FFG for current model processing hour and current 03-hr MAP persisted for the next 3 hours. (mm/3hr)
				PFFT 06-hr: Difference of 06-hr FFG for current model processing hour and current 06-hr MAP persisted for the next 6 hours. (mm/6hr)
.
FFT	Flash Flood Threat	Text & Images	1, 3 and 6 hours after previous model processing hour	FFT products include text tables and images of hourly, 3-hourly and 6-hourly flash flood threat (mm) for each MRCFFG catchment. The values indicate the difference of the observed mean areal rainfall of the given duration and the corresponding past FFG of the same duration for a given MRCFFG sub-basin. The last 1-hour, 3-hour and 6-hour durations of FFG are considered with current corresponding MAP in the computation of FFT.

				For example, the 06-hr FFT at 12:00 UTC = 06-hr MAP from 12:00 UTC - 06-hr FFG from 6:00 UTC
				<p>The most recent FFT product for each time-scale is provided in the Baseline Threat Product table and displayed with the MAP and FFG products that were used in the respective calculation. In the images, an approximate measure of uncertainty in the FFT estimates is indicated by the ranges in the color scale (with yellow indicating the range of values that are unlikely to be of concern for flash flooding and with orange and red indicating progressively higher risk of flooding for the sub-basin of interest). The hourly, 3-hourly and 6-hourly FFT products are respectively updated at 1, 3, and 6 hours after the preceding model processing hour. FFT provides the forecaster with an idea of likely regions of imminent flash flood threats. Note that this set of products concerns the past and may not be appropriate to use for real-time warning. FFT is offered as a baseline product that must be carefully evaluated by the forecaster in real-time.</p>
				FFT 01-hr: Difference of 01-hr FFG from a previous model processing hour and 01-hr

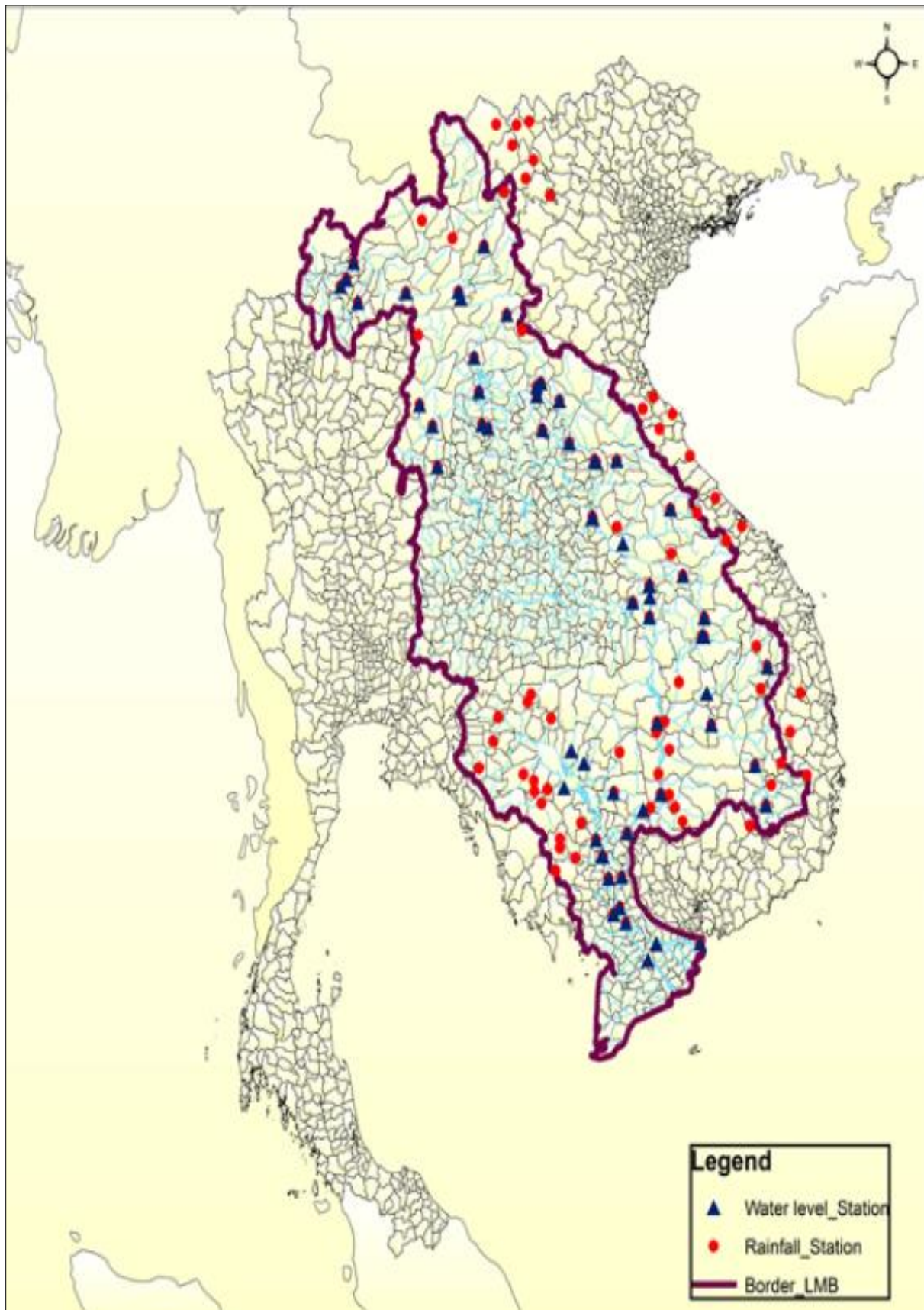
				MAP observed over the following 1 hour. (mm/1hr)
				FFT 03-hr: Difference of 03-hr FFG from a previous model processing hour and 03-hr MAP observed over the following 3 hours. (mm/3hr)
				FFT 06-hr: Difference of 06-hr FFG from a previous model processing hour and 06-hr MAP observed over the following 6 hours. (mm/6hr)

Annex B2: Template of FFG bulletin (word format)







ANNEX C: Hydmet database and daily operation of MRCFFGS

Annex C1: The map of rainfall and water level stations of the Hydmet database network



Annex C2: Daily Operation of The MRC FFG System

Color indicated in the work flow	Time frame for process the work	Work activities
	From 7:00 to 7:30 for morning operation From 13:00 to 13:30 for afternoon operation	Collect the information from web site www.tropicalstormrisk.com ; https://sharaku.eorc.jaxa.jp/GSMaP/index.htm ; https://www.windy.com/vi/-M%C6%B0a-s%C3%A9-rain?rain.51.383.0.517.5 and rainfall forecast from NOAA, and do analysis weather situation
	From 7:30 to 8:10 for morning operation From 13:30 to 14:00 for afternoon operation	Process 1,3,6-hour FFG according to the guideline for processing MRC FFG System Calculate the accumulated rainfall for observed (ground) rainfall which available in Hydmet database, and compare with the accumulate MAP and accumulate Global Hydro -Estimator
	From 8:10 to 8:30 for morning operation From 14:00 to 14:30 for afternoon operation	Prepare the Flash Flood warning text in word format and table in excel, map - KMZ of the warning by areas, send it to IT staff of RFMMC to upload to web site.
	With week after the issue the warning. The evaluation report should be kept for review and add the additional of data received for NLAs at the end of flood season	Contact to the national line agencies or the national FFG operator to request the flash flood information or also collect flash flood information from the online newspaper. Prepare the FFG evaluation report according to the guideline of FFG evaluation report

