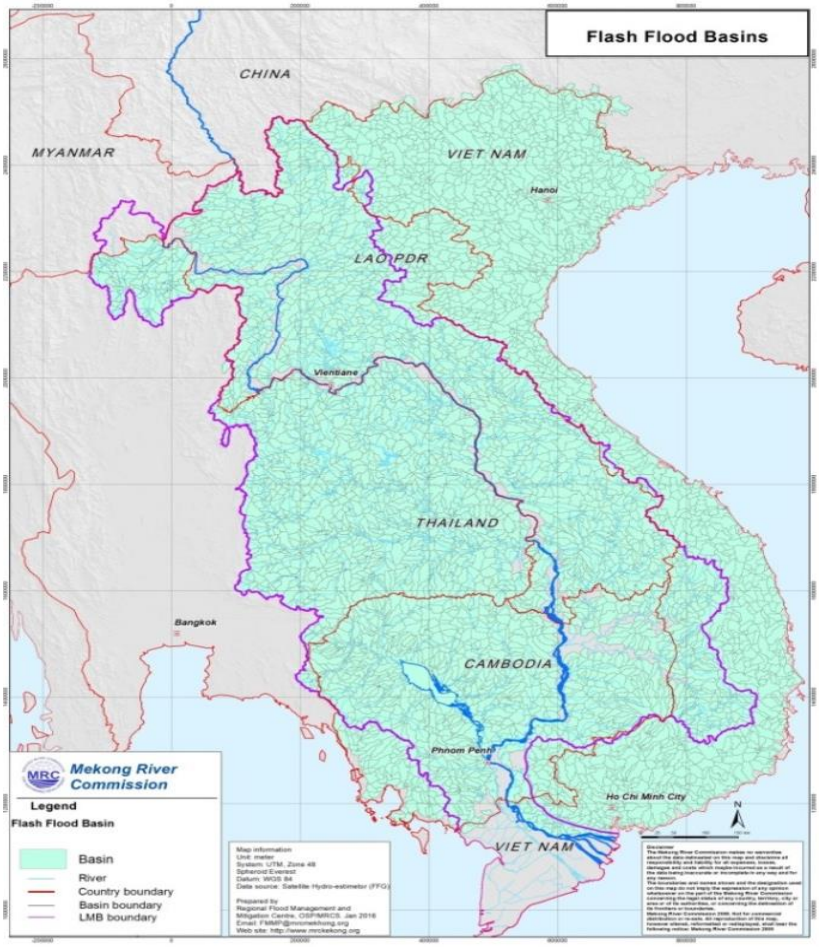
Mekong River Commission

Regional Flood Management and Mitigation Center

Evaluation Report on Flash Flood Guidance System for Flood Season 2017

(June - December 2017)

Draft



Prepared by

Regional Flood Management and Mitigation Center

March 2018

Contents

Figures:

Tables:

Acronyms

DMH	Department of Meteor-Hydrological
DWR	Department of Water Resources
FFGS	Flash Flood Guidance System
HRC	Hydrological Research Centre
ITCZ	Inter Tropical Convergence Zone
JMA	Japan Meteorological Agency
LMB	Lower Mekong Basin
LTA	Long Term Average
MC	Member Country
MOU	Memorandum of Understanding
MRC	Mekong River Commission
MRCFFGS	Mekong River Commission Flash Flood Guidance System
NCHMF	Centre for Hydro-Meteorological Forecasting
NLAs	National Line Agencies
NOAA	National Oceanic and Atmospheric Administration
OFDA	Office of US Foreign Disaster Assistance
PDR	People's Democratic Republic
RFMMC	Regional Flood Management and Mitigation Centre
TD	Tropical Depression
TMD	Thai Meteorological Department
TS	Tropical Storm
TY	Typhoon
USAID	US Agency for International Development
UTC	Universal Coordinated Time

Certification of Approval

of Internal FMMP Technical Document

Evaluation Report on Flash Flood Guidance System for Flood Season 2017

Cover from 1st June – 31st December 2018

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4.				
5.				

1. BACKGROUND INFORMATION

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 flood in each member state of the MRC, the Mekong River Commission (MRC) and the US Agency for International Development (USAID) 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 flash-flood mitigation program in Cambodia, Lao PDR, Thailand, and Viet Nam.

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 be occurred over 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). In late 2009 the computational and dissemination servers for the MRCFFG system were installed at MRC Regional Flood Management and Mitigation Centre (RFMMC) in Phnom Penh, Cambodia, which allowed the line agencies of the MRC member countries and the RFMMC to get access to the FFG products for training as well as for operational purposes.

During annual flood season in the LMB, the RFDMC provides information as well as publishes (see annex b) about daily flash flood guidance for Mekong Member Countries (MMCs) through website. MRCFFG System successfully detected several flash flood risk areas, especially during the severe weather condition such as low pressure, Inter Tropical Convergence Zone (ITCZ), or tropical storm.

Presently the MRCFFG system is put in an operational testing mode in order to fine-tuning as well as to gain further experience.

Since 2010 to 2017 flood season the Flash Flood Guidance System (FFGS) has been operating successfully. Reference is made to the records of tropical storms and records of tropical depressions in the Mekong regions in flood season.

The present evaluation report is a seventh evaluation report of MRCFFG system, it produced to evaluate the performance of FFGS for the detection of the risk areas of potential flash floods districts in Cambodia, Lao PDR, Thailand and Viet Nam during the period from 01st June to 31st December 2017.

2. METHODOLOGY TO EVALUATE FLASH FLOOD GUIDANCE PRODUCT

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

(i) The first concept evaluates the feed-back of the FFG System from the users or from other sources of information such as the media or the press. As the link between the regional flood center and the local people (through the focal person at national line agencies) is not yet fully established, the feed-back information on flash flood areas was mainly collected from the national media, such as online newspapers(Annex A).

(ii) The second concept evaluates the FFG System through the recorded water levels that are available in the operational database of RFDMC. If FFG occurs in the sub-areas where water level stations are available, the FFG product can be evaluated by studying the changing (rising) water level records of stations located in the downstream part of sub-catchments.

The record daily rainfall of the observed stations, where available at the flash flood risk areas also used as the support data for evaluate the flash flood occurred. The hydro meteorological data used for evaluation this report was received from national line agencies through the Hydmet database. According to the Memorandum of Understanding (MOU) on data exchange for the flood forecasting operation, the national line agencies provided the rainfall and water level data to MRC RFMMC about 160 stations. Annex C present the map of rainfall and water level stations of the Hymet database network , which used for the FFG system analysis.

3. FLASH FLOODING IN THE MEKONG REGION

In 2017, the number of storms operating in the Pacific Northwest region was less than the Long-Term Average (LTA) and had one more storm than in 2016; these were among 27 Typhoons (TY) and 04 Tropical Depressions (TD) (see table 3-1). Meanwhile, in the East Sea place was recorded that the operated of storms and tropical low pressures were larger than LTA. During the year, there were totally 16 TYs and 04 TDs operated in the East Sea, and there were 05 TYs directly and 04 TDs directly affected to Lower Mekong Basin (LMB) (see table 3-2 and figure 3-1).

Table 3-1: TYs and TDs operated in Pacific Northwest and East Sea in the year 2017

No	Month	ID	Typhoon and TD	Intensity		Time remaining		Duration (days)
				Pmin (mb)	Vmax (kts)	Form	To	
1	Apr		TD	1008	25	07h/14/4	07h/20/4	6
2	Apr	1701	MUIFA	1002	35	01h/26/4	19h/27/4	2
3	Jun	1702	MERBOK	990	50	07h/11/6	07h/13/6	2
4	Jul	1703	NANMADOL	985	55	01h/02/7	07h/05/7	3
5	Jul	1704	TALAS	990	50	07h/15/7	16h/17/7	2
6	Jul	1705	NORU	930	100	01h/21/7	01h/09/8	19
7	Jul	1706	KULAP	1002	40	07h/21/7	19h/25/7	4
8	Jul	1707	ROKE	1002	35	07h/22/7	13h/23/7	1
9	Jul	1708	SONCA	990	45	07h/23/7	19h/25/7	2
10	Jul	1709	NESAT	960	80	07h/26/7	01h/31/7	5
11	Jul	1710	HAITANG	985	45	07h/29/7	13h/31/7	2
12	Aug	1711	NALGAE	990	45	01h/02/8	07h/06/8	4
13	Aug	1712	BANYAN	970	75	13h/11/8	13h/17/8	6
14	Aug	1713	HATO	960	80	07h/20/8	07h/24/8	4
15	Aug	1714	PAKHAR	985	55	19h/24/8	19h/27/8	3
16	Aug	1715	SANVU	955	80	07h/28/8	19h/03/9	6
17	Aug	1716	MAWAR	990	50	19h/31/8	07h/04/9	4
18	Sep	1717	GUCHOL	1000	35	01h/05/9	01h/06/9	1
19	Sep	1718	TALIM	935	95	13h/09/9	19h/18/9	9
20	Sep	1719	DOKSURI	955	80	13h/12/9	07h/16/9	4
21	Sep		TD	1002	30	07h/23/9	13h/25/9	2
22	Sep		TD	998	30	07h/07/10	10h/10/10	3
23	Oct	1720	KHANUN	950	80	13h/12/10	13/16/10	4
24	Oct	1721	LAN	925	95	19h/15/10	13h/23/10	8
25	Oct	1722	SAOLA	975	60	07h/24/10	19h/29/10	5
26	Oct		TD	1006	25	13h/30/10	07h/02/11	3
27	Nov	1723	DAMREY	970	70	01h/02/11	19h/04/11	3
28	Nov	1724	HAIKUI	998	40	13h/09/11	13h/12/11	3
29	Nov	1725	KIROGI	1000	35	01h/18/11	01h/19/11	1
30	Dec	1726	KAI-TAK	996	40	01h/14/12	07h/22/12	8
31	Dec	1727	TEMBIN	975	70	19h/20/12	01h/26/12	6

Table 3-2: Typhoons and tropical Lower Pressures in EAST SEA – 2017

Month	Jan	Fed	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
TDs				1					1	2			4
Typhoons						1		1	4	3	3	3	16

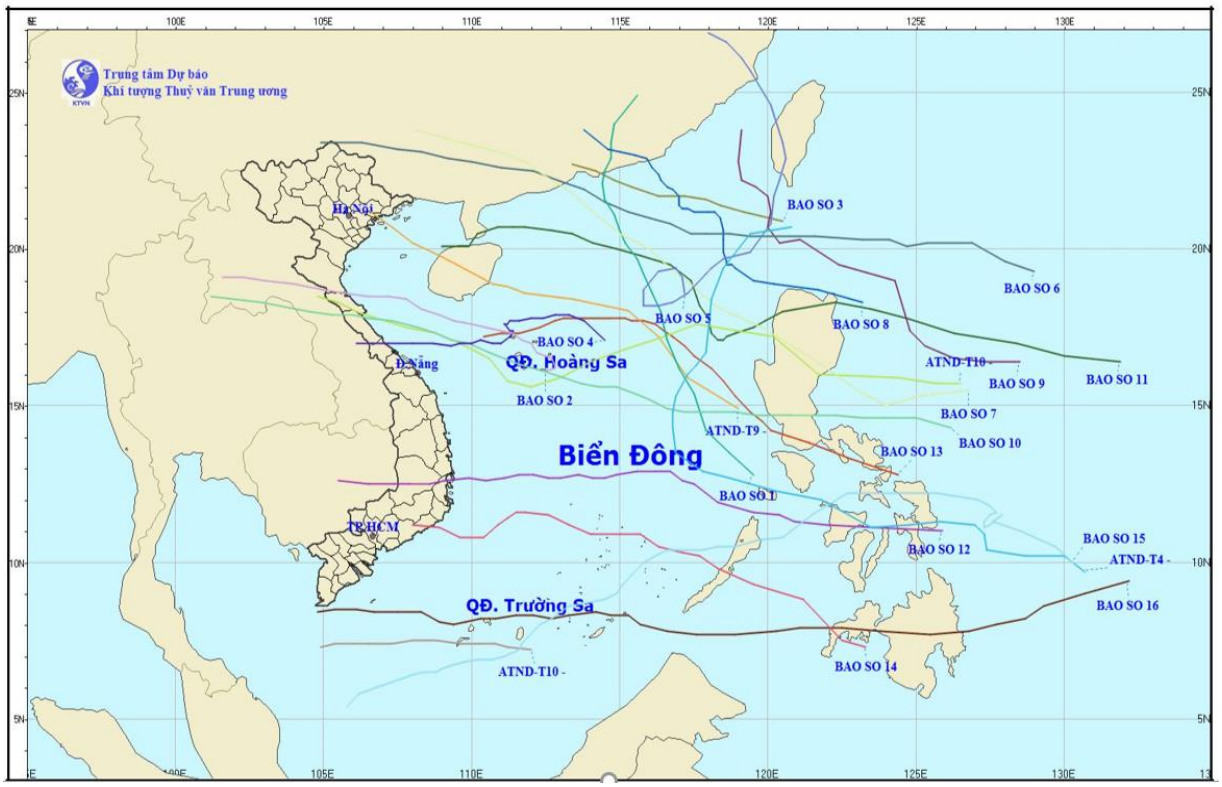
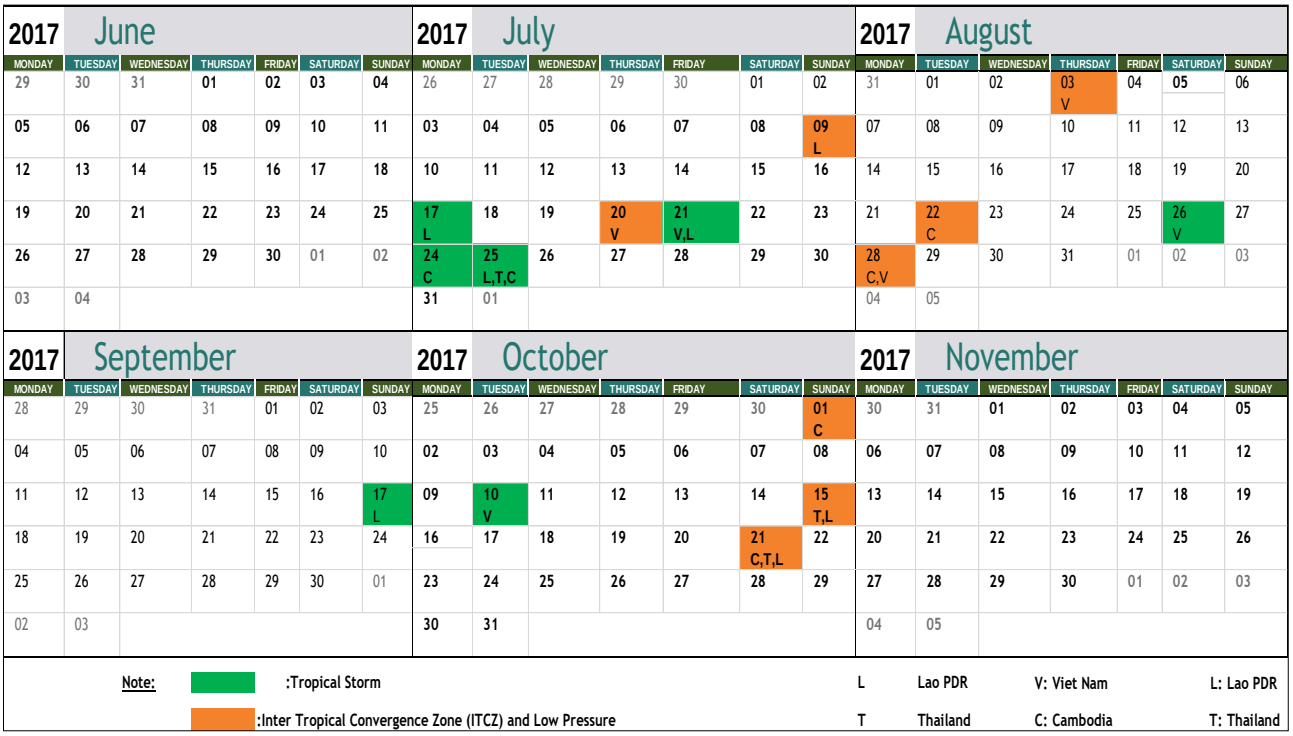


Figure 3-1: Track of TYs and TDs in East Sea in 2017 (source: National Center for Hydro-Meteorological Forecasting of Viet Nam)

The other cause of flash flood in the region was ITCZ, low pressure and tropical depression, which also led to flash flood occurrences at some Mekong tributaries. At least 21 flash floods have been occurred at the Mekong region during the flood season 2017, especially for the areas of the Viet Nam and Lao PDR. July and October 2017 were months where the flash flood has been seriously occurred in the LMB region. Figure 3-2 and table 3-3 present the calendar date recorded the flash flood occurred and distribution of flash flood in the LMB.



2017 June

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
29	30	31	01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	01	02
03	04					

2017 July

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
26	27	28	29	30	01	02
03	04	05	06	07	08	09 L
10	11	12	13	14	15	16
17 L	18	19	20 V	21 V,L	22	23
24 C	25 L,T,C	26	27	28	29	30
31	01					

2017 August

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
31	01	02	03 V	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22 C	23	24	25	26 V	27
28 C,V	29	30	31	01	02	03
04	05					

2017 September

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
28	29	30	31	01	02	03
04	05	06	07	08	09	10
11	12	13	14	15	16	17 L
18	19	20	21	22	23	24
25	26	27	28	29	30	01
02	03					

2017 October

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
25	26	27	28	29	30	01 C
02	03	04	05	06	07	08
09	10 V	11	12	13	14	15 T,L
16	17	18	19	20	21 C,T,L	22
23	24	25	26	27	28	29
30	31					

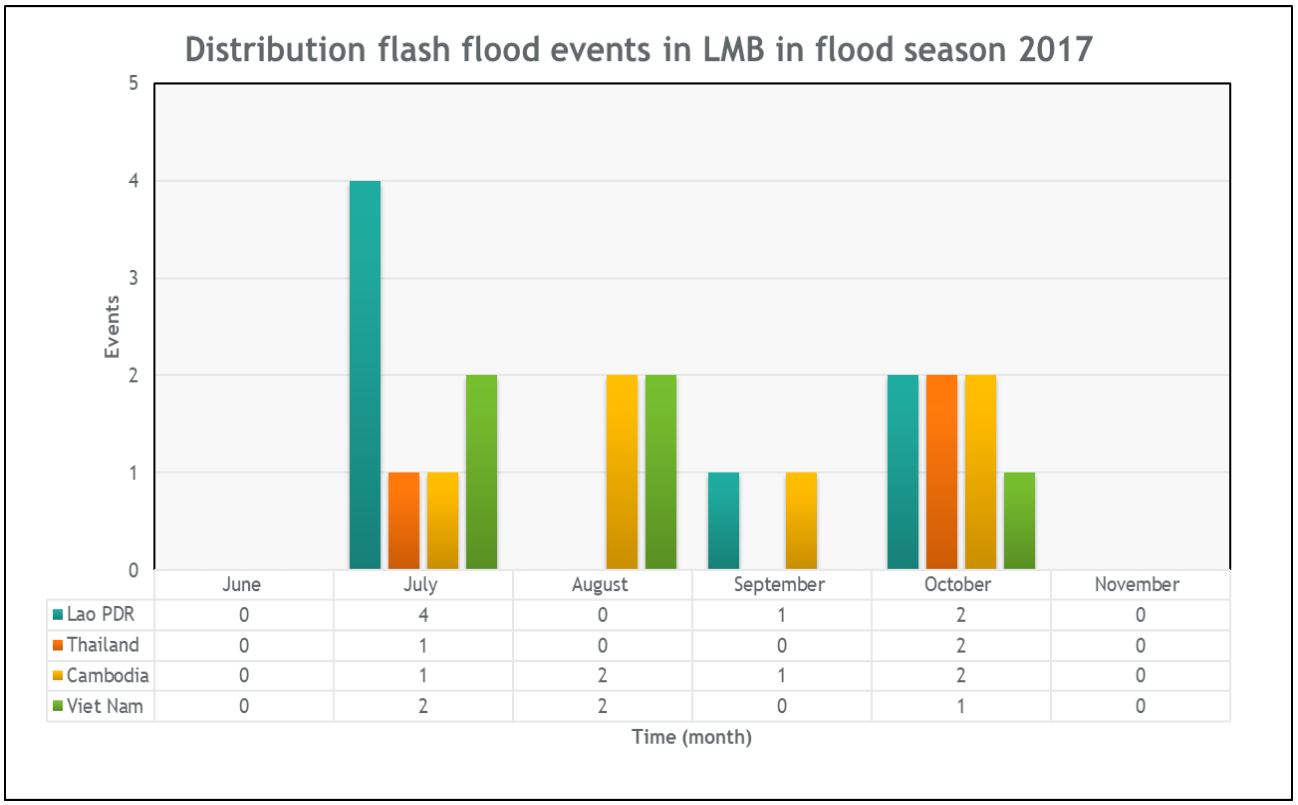
2017 November

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
30	31	01	02	03	04	05
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	01	02	03
04	05					

Note: :Tropical Storm; :Inter Tropical Convergence Zone (ITCZ) and Low Pressure

L Lao PDR T Thailand V: Viet Nam C: Cambodia L: Lao PDR T: Thailand

Figure 3.1 -2: Calendar date of flash flood recorded in the LMB



	June	July	August	September	October	November
Lao PDR	0	4	0	1	2	0
Thailand	0	1	0	0	2	0
Cambodia	0	1	2	1	2	0
Viet Nam	0	2	2	0	1	0

Figure 3.1-3: Distribution flash flood events in LMB in flood season 2017

Table 3-3: Distribution of flash flood in LMB in flood season 2017

Month	Total	Lao PDR	Thailand	Cambodia	Viet Nam
June	**0**	0	0	0	0
July	**8**	4	1	1	2
August	**4**	0	0	2	2
September	**2**	1	0	1	0
October	**7**	2	2	2	1
November	**0**	0	0	0	0
Total	**21**	**7**	**3**	**6**	**5**

3.1 Flash flood in the northern part of Viet Nam and Lao PDR, caused by low pressure during 9 July 2017

3.1.1 Weather condition during 03rd – 10th 2017

During the week (3rd – 10th July 2017), the southwest monsoon prevailing over the Andaman Sea and Thailand was strengthened during the second half of the period coupled with the low-pressure cell covered upper Vietnam during the first half of the period (see figure 3-4 and figure 3-5)

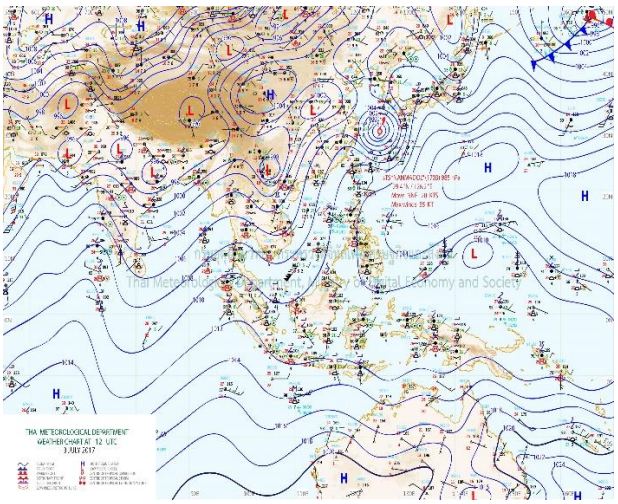


Figure 3-4: Weather map on 03 July 2017

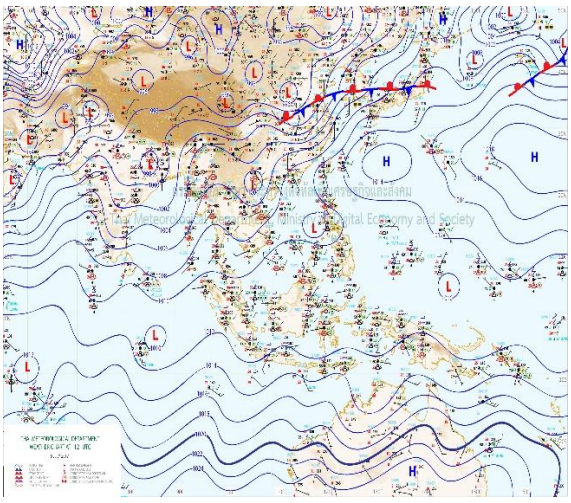


Figure 3-5: Weather map on 09 July 2017

3.1.2 Heavy rainfall during the period 03rd – 10th July 2017

These phenomena brought heavy rain at some areas in the middle parts of LMB, such as accumulated rainfalls recorded in this period were at Paksane (334.3 mm), Nakhon Phanom (247.5 mm) and Thakhek (279.6 mm) (see figure 3 -6)

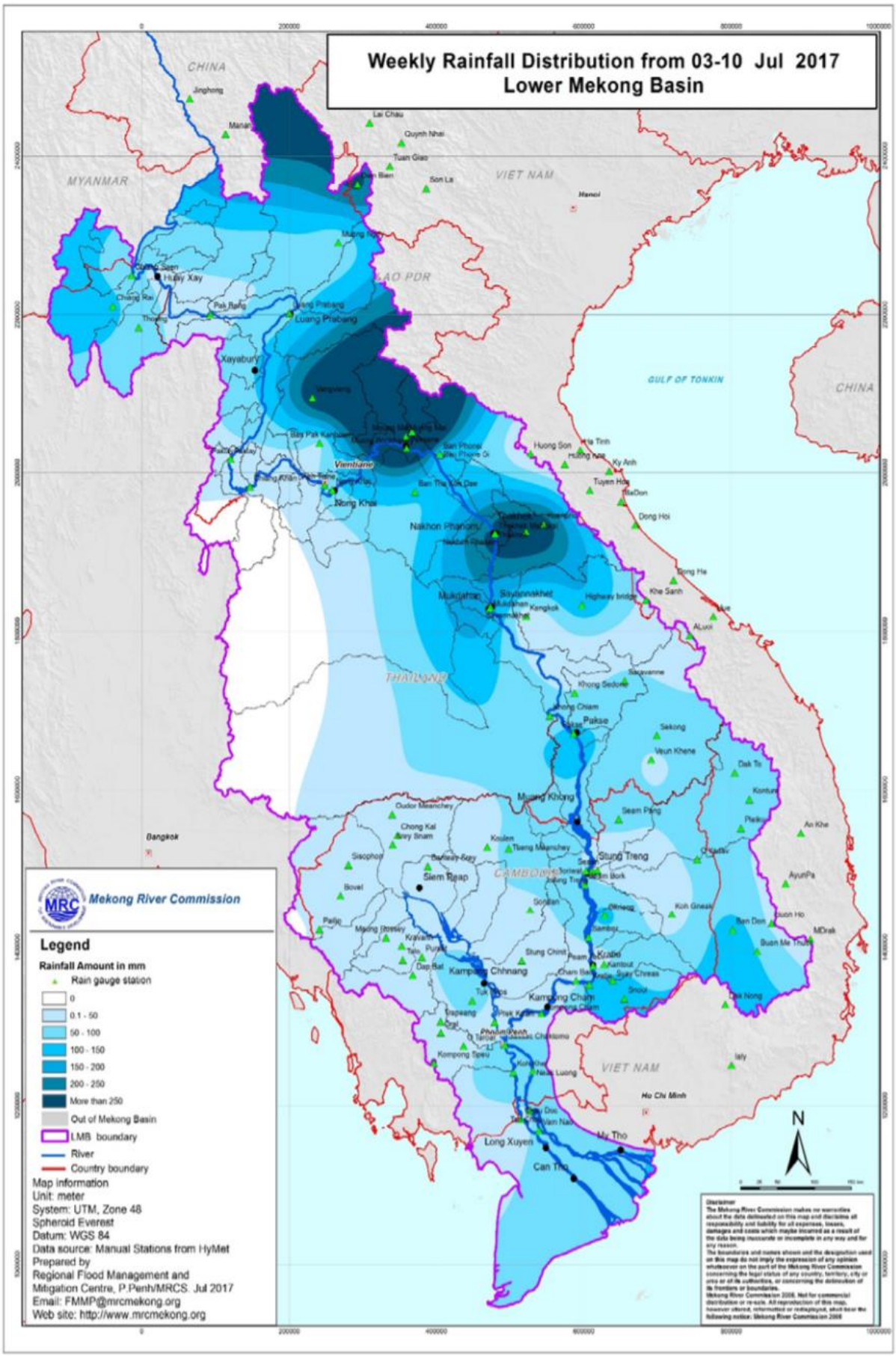


Figure 3-6 weekly rainfall distribution from 03 – 10 July 2017 in LMB

3.1.3 Flash flooding in the northern provinces of Lao PDR and Viet Nam.

On 09 July 2017 at 00:00 UTC (07:00 local time) the MRCFFG system detected that some areas covering areas in the northern provinces parts of Lao PDR, and Viet Nam for 01, 03 and 06 hour ahead. Figure 3-7 presents the 3 hourly FFG value at some areas of provinces of Lao PDR and Viet Nam.

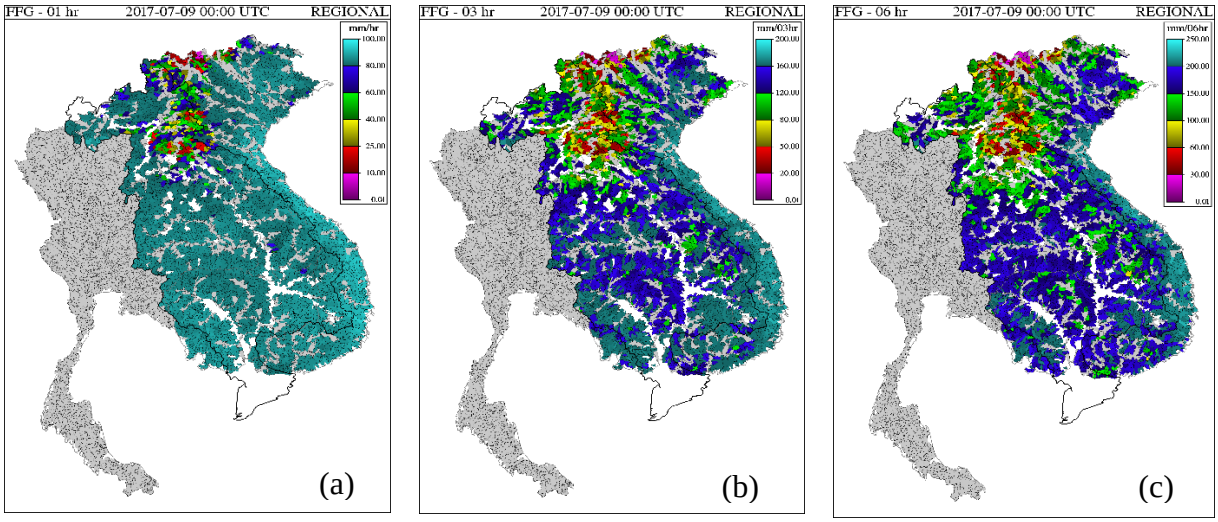


Figure 3-7: Flash flood rick areas detected by MRCFFGS on 09th July 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h.

The information on flash flood risk areas that was detected by the MRCFFG system on 9 July 2017 at 00:00 UTC was confirmed by the information published in the Lao PDR newspaper "Vientiane Times" and Viet Nam on 12 July 2017. Some flash flood risk areas that detected by the FFG system on 09 July 2017 at 00:00 UTC corresponded with the reported flash flood areas. Table 3.1-1 and 3.1-2 show the list of the flash flood risk areas detected by MRC FFG system on 09 July 2017 at 00:00 UTC. the Information from the "Vientiane Time" newspaper provided in the annex A of this report.

Table 3.1-1 Flash flood guidance detected by MRCFFG system in Lao PDR on 09 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG produ 09/07/2017 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
Attapeu	Phouvong	24.37	Attapeu	Phouvong	32.71	Attapeu	Phouvong	41.55
Xaysomboun Spe	Thathom	18.3	Xaysomboun Sp	Thathom	24.44	Xaysomboun S	Thathom	31.49
Xaysomboun Spe	Thathom	16.84	Saravane	Ta oi	33.27	Saravane	Ta oi	42.43
Xaysomboun Spe	Thathom	21.69	Savannakhet	Phine	33.26	Savannakhet	Phine	42.42
Xaysomboun Spe	Thathom	24.72	Xaysomboun Sp	Thathom	22.59	Xaysomboun S	Thathom	29.12
Bolikhamxay	Bolikhanh	23.04	Xaysomboun Sp	Thathom	29.27	Xaysomboun S	Thathom	37.16
Bolikhamxay	Viengthon	22.54	Xaysomboun Sp	Thathom	32.96	Xaysomboun S	Thathom	41.91
Bolikhamxay	Viengthon	24.3	Bolikhamxay	Bolikhanh	30.85	Bolikhamxay	Bolikhanh	39.25
Bolikhamxay	Viengthon	21.26	Bolikhamxay	Viengthon	30.27	Bolikhamxay	Viengthon	38.39
Bolikhamxay	Viengthon	18.6	Bolikhamxay	Viengthon	49.46	Bolikhamxay	Viengthon	41.37
Bolikhamxay	Viengthon	22.76	Bolikhamxay	Viengthon	49.03	Bolikhamxay	Viengthon	36.72
Bolikhamxay	Viengthon	24.12	Bolikhamxay	Viengthon	32.47	Bolikhamxay	Viengthon	31.79
Bolikhamxay	Viengthon	24.85	Bolikhamxay	Viengthon	28.53	Bolikhamxay	Viengthon	38.82
Bolikhamxay	Viengthon	24.53	Bolikhamxay	Viengthon	24.78	Bolikhamxay	Viengthon	40.94
Bolikhamxay	Viengthon	18.77	Bolikhamxay	Viengthon	30.39	Bolikhamxay	Viengthon	42.21
Bolikhamxay	Khamkheut	24.75	Bolikhamxay	Viengthon	32.33	Bolikhamxay	Viengthon	41.62
Bolikhamxay	Thaphabat	17.78	Bolikhamxay	Viengthon	33.14	Bolikhamxay	Viengthon	32.01
Xiengkhuang	Souy	24.94	Bolikhamxay	Viengthon	32.79	Bolikhamxay	Khamkheut	42.22
Xaysomboun Spe	Xaysombou	17.84	Bolikhamxay	Viengthon	24.98	Khammuane	Nakai	42.76
Xiengkhuang	Khoune	16	Bolikhamxay	Khamkheut	33.14	Bolikhamxay	Thaphabat	30.5
Xaysomboun Spe	Thathom	19.33	Khammuane	Nakai	33.61	Xiengkhuang	Souy	41.97
Xaysomboun Spe	Thathom	20.08	Bolikhamxay	Thaphabat	23.74	Xaysomboun S	Xaysombou	30.61
Xaysomboun Spe	Xaysombou	18.72	Xiengkhuang	Souy	33.17	Xiengkhuang	Khoune	28.69
Xaysomboun Spe	Xaysombou	23.85	Xaysomboun Sp	Xaysombou	23.84	Xaysomboun S	Thathom	32.72
Xaysomboun Spe	Thathom	24.17	Xiengkhuang	Khoune	22.22	Xaysomboun S	Thathom	34.59
Bolikhamxay	Bolikhanh	23.88	Xaysomboun Sp	Thathom	25.65	Xaysomboun S	Xaysombou	31.82
Xaysomboun Spe	Phoun	24.43	Xaysomboun Sp	Thathom	27.12	Xaysomboun S	Xaysombou	40.83
Vientiane	Vangvieng	22.48	Xaysomboun Sp	Xaysombou	24.89	Xaysomboun S	Thathom	41.15
Xaysomboun Spe	Phoun	23.82	Xaysomboun Sp	Xaysombou	31.88	Bolikhamxay	Bolikhanh	40.62
Xaysomboun Spe	Phoun	22.6	Xaysomboun Sp	Thathom	32.21	Xaysomboun S	Phoun	41.73
Xiengkhuang	Phookood	24.2	Bolikhamxay	Bolikhanh	31.82	Vientiane	Vangvieng	38.23
Xaysomboun Spe	Xaysombou	21.8	Xaysomboun Sp	Phoun	32.61	Xaysomboun S	Phoun	40.52
Xaysomboun Spe	Xaysombou	19.39	Vientiane	Vangvieng	30.02	Xaysomboun S	Phoun	38.62
Xaysomboun Spe	Xaysombou	18.28	Xaysomboun Sp	Phoun	31.91	Xiengkhuang	Phookood	41.36
Xaysomboun Spe	Xaysombou	22.51	Xaysomboun Sp	Phoun	30.31	Xaysomboun S	Xaysombou	37.46
Xaysomboun Spe	Xaysombou	23.73	Xiengkhuang	Phookood	32.32	Xaysomboun S	Xaysombou	32.82
Vientiane	Keo oudom	22.25	Xaysomboun Sp	Xaysombou	29.25	Xaysomboun S	Xaysombou	31.43
Vientiane	Vangvieng	23.3	Xaysomboun Sp	Xaysombou	25.73	Xaysomboun S	Xaysombou	38.38
Vientiane	Vangvieng	19.63	Xaysomboun Sp	Xaysombou	24.42	Xaysomboun S	Xaysombou	40.46
Vientiane	Vangvieng	21.83	Xaysomboun Sp	Xaysombou	30.23	Vientiane	Keo oudom	38.1
Vientiane	Met	18.58	Xaysomboun Sp	Xaysombou	31.87	Vientiane	Vangvieng	44.79
Vientiane	Kasy	19.18	Vientiane	Keo oudom	29.82	Vientiane	Vangvieng	39.71
Vientiane	Kasy	24.75	Vientiane	Vangvieng	35.45	Vientiane	Vangvieng	33.89
Vientiane	Kasy	21.8	Vientiane	Vangvieng	31.04	Vientiane	Vangvieng	37.37
Xayaboury	Xayabury	24.44	Vientiane	Vangvieng	26.42	Vientiane	Met	31.9
Luangprabang	Park Ou	23.34	Vientiane	Vangvieng	29.18	Vientiane	Kasy	32.68
Luangprabang	Chomphet	22.86	Vientiane	Met	24.79	Vientiane	Kasy	42.11
Oudomxay	Hoon	23.78	Vientiane	Kasy	25.51	Vientiane	Kasy	37.22
Oudomxay	Hoon	21.68	Vientiane	Kasy	33.01	Vientiane	Vangvieng	48.37

Table 3.1-2 Flash flood guidance detected by MRCFFG system in Lao PDR on 09 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products 09/07/2017 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
Kon Tum	Ngoc Hoi	23.58	Lai Chau	Dien Bien	33.27	Lai Chau	Dien Bien	42.22
Hoa Binh	Ky Son	23.3	Kon Tum	Ngoc Hoi	31.6	Kon Tum	Ngoc Hoi	40.44
Gia Lai	Ia Grai	23	Hoa Binh	Ky Son	31.21	Hoa Binh	Ky Son	39.8
Gia Lai	Ia Grai	23.42	Gia Lai	Ia Grai	30.87	Gia Lai	Ia Grai	39.69
Lai Chau	Dien Bien	23.94	Gia Lai	Ia Grai	31.43	Gia Lai	Ia Grai	40.04
Quang Nam	Dai Loc	19.32	Lai Chau	Dien Bien	31.96	Lai Chau	Dien Bien	40.67
Quang Nam	Que Son	15.84	Quang Nam	Dai Loc	25.69	Quang Nam	Dai Loc	32.95
Quang Ngai	Minh Long	24.4	Quang Nam	Que Son	21.92	Quang Nam	Que Son	28.34
Gia Lai	Kong Chro	24.59	Quang Ngai	Tra Bong	35.19	Quang Ngai	Tra Bong	44.73
Phu Yen	Tuy Hoa	22.66	Quang Ngai	Tra Bong	34.66	Quang Ngai	Tra Bong	44.17
Khanh Hoa	Van Ninh	16.56	Quang Ngai	Minh Long	32.44	Quang Ngai	Minh Long	41.49
Khanh Hoa	Ninh Hoa	16.98	Gia Lai	Kong Chro	32.84	Gia Lai	Kong Chro	41.66
Ninh Thuan	Ninh Son	22.73	Phu Yen	Tuy Hoa	29.33	Phu Yen	Tuy Hoa	36.36
Ninh Thuan	Ninh Hai	18.65	Khanh Hoa	Van Ninh	23.19	Khanh Hoa	Van Ninh	30.04
Binh Thuan	Tuy Phong	23.74	Khanh Hoa	Ninh Hoa	23.31	Khanh Hoa	Ninh Hoa	30.17
Binh Thuan	Ham Thuan Nam	24.14	Khanh Hoa	Ninh Hoa	44.9	Khanh Hoa	Ninh Hoa	57
Binh Thuan	Ham Thuan Nam	19.36	Khanh Hoa	Khanh Son	34.71	Khanh Hoa	Khanh Son	44.09
Gia Lai	Chu Pah	20.32	Khanh Hoa	Cam Ranh	37.59	Khanh Hoa	Cam Ranh	47.71
Kon Tum	Sa Thay	20.91	Ninh Thuan	Ninh Son	30.59	Ninh Thuan	Ninh Son	39.36
Dak Lak	Dak Nong	11.16	Ninh Thuan	Ninh Hai	26.4	Ninh Thuan	Ninh Hai	34.93
Cao Bang	Hoa An	21.87	Ninh Thuan	Ninh Phuoc	36.34	Ninh Thuan	Ninh Phuoc	46.19
Cao Bang	Hoa An	15.37	Binh Thuan	Tuy Phong	31.73	Binh Thuan	Tuy Phong	40.74
Cao Bang	Nguyen Binh	20.77	Binh Thuan	Ham Thuan Nam	32.09	Binh Thuan	Ham Thuan Nam	41.05
Bac Kan	Ngan Son	24.24	Binh Thuan	Ham Thuan Nam	36.48	Binh Thuan	Ham Thuan Nam	46.3
Lao Cai	Bat Xat	8.68	Binh Phuoc	Bu Dang	45.11	Binh Phuoc	Bu Dang	53.49
Lao Cai	Bat Xat	8.56	Lam Dong	Bao Lam	33.59	Lam Dong	Bao Lam	40.39
Lao Cai	Bat Xat	11.22	Lam Dong	Bao Lam	48.89	Lam Dong	Bao Lam	58.35
Lao Cai	Bat xat	19.07	Binh Thuan	Ham Thuan Nam	26.87	Binh Thuan	Ham Thuan Nam	34.46
Lao Cai	Bao Thang	19.53	Dong Nai	Xuan Loc	47.65	Gia Lai	Chu Pah	35.92
Lao Cai	Than Uyen	16.66	Gia Lai	Chu Pah	27.63	Kon Tum	Sa Thay	36.14
Lai Chau	Phong Tho	11.7	Kon Tum	Sa Thay	28.13	Dak Lak	Dak Nong	22.1
Lao Cai	Than Uyen	12.27	Dak Lak	Dak Nong	16.37	Lam Dong	Lac Duong	57.56
Son La	Quynh Nhai	17.98	Lam Dong	Lac Duong	49.57	Lam Dong	Lac Duong	58.86
Lai Chau	Sin Ho	12.84	Lam Dong	Lac Duong	47.67	Cao Bang	Hoa An	37.56
Lai Chau	Sin Ho	16.28	Lam Dong	Lac Duong	49.17	Cao Bang	Hoa An	29.19
Lai Chau	Sin Ho	19.21	Cao Bang	Hoa An	29.41	Cao Bang	Nguyen Binh	36.32
Lai Chau	Sin Ho	24.3	Cao Bang	Hoa An	22.16	Bac Kan	Ngan Son	41.03
Lai Chau	Sin Ho	16.86	Cao Bang	Nguyen Binh	28.49	Lao Cai	Bat Xat	16.75
Lai Chau	Sin Ho	10.92	Bac Kan	Ngan Son	32.34	Lao Cai	Bat Xat	17.02
Lai Chau	Phong Tho	13.93	Lao Cai	Bat Xat	12.6	Lao Cai	Bat Xat	19.8
Lai Chau	Phong Tho	10.66	Lao Cai	Bat Xat	12.58	Lao Cai	Bat xat	32.48
Lao Cai	Bat Xat	8.53	Lao Cai	Bat Xat	15.31	Lao Cai	Bao Thang	36.93
Lai Chau	Phong Tho	10.4	Lao Cai	Bat xat	25.36	Lao Cai	Bao Thang	46.64
Lai Chau	Muong Lay	10.52	Lao Cai	Bao Thang	28.04	Lao Cai	Than Uyen	28.8
Lai Chau	Muong Te	10.33	Lao Cai	Bao Thang	36.86	Lai Chau	Phong Tho	20.43
Lai Chau	Muong Te	14.69	Lao Cai	Than Uyen	22.34	Lao Cai	Than Uyen	21.45
Lai Chau	Muong Te	24.77	Lai Chau	Phong Tho	15.88	Son La	Quynh Nhai	30.75
Lai Chau	Muong Te	11.29	Lao Cai	Than Uyen	16.67	Lai Chau	Sin Ho	25.05

3.1.4 Conclusions

1. During the period 03rd – 10th July 2017, the southwest monsoon prevailing over the Andaman Sea and Thailand was strengthened during the second half of the period coupled with the low-pressure cell covered upper Vietnam during the first half of the period.
2. Heavy rain at some areas in the middle parts of LMB, such as accumulated rainfalls recorded from Hydmet Database appear at Lao PDR and Viet Nam.
3. Some flash flood risk areas, detected by the FFG system on 09th July 2017 at 00:00 UTC, corresponded with the reported flash flood areas.

3.2 Flash flooding in the northern provinces of Viet Nam, Lao PDR and Cambodia caused by tropical storm "TALAS" on 17th July 2017.

3.2.1 Weather condition during July 2016

"TALAS" was the first tropical cyclones of the year 2017 impacted to LMB. It was formed to a tropical disturbance over East Sea during 13 July 2017. The next day around 6:00 UTC, it developed as a weak tropical depression and started to move slowly towards the northwest. Several hours later, it intensified into Tropical Storm on 15 July. On 9:00 UTC of 16 July 2017, it was increased intensity into Severe Tropical Storm and around 18:00 UTC the same day (see figure 3.2-1). The circulation pressure after the storm had also caused heavy rains some areas from northern part to central northern parts of Viet Nam, and it was continued passed over Xienkhang, Xaysomboun and Bolikhamxay Procinces of Lao PDR on early morning of 17 July 2017.

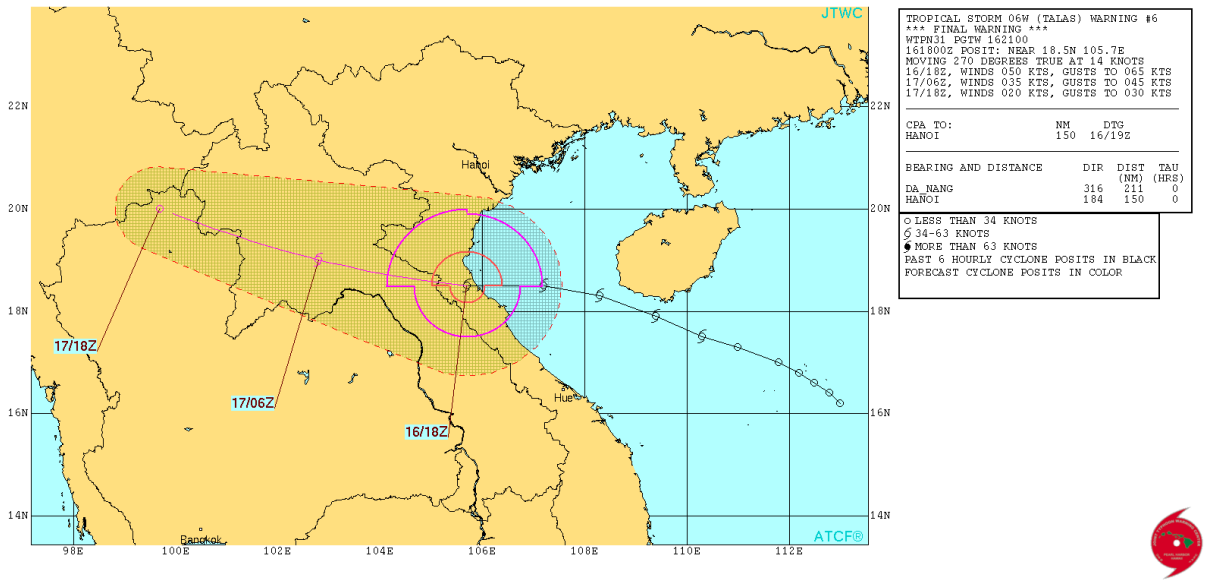


Figure 3.2-1: The center of Tropical Storm "Talas" was located approximately 278 km (172 miles) south of Hanoi, Vietnam- At 21:00 UTC 16 July 2017

(source: Joint Typhoon Warning Center -JTWC)

3.2.2 Heavy rainfall during the period 10th – 17th July 2017, caused by Tropical storm "TALAS"

During this period, there was rainfall happened in many parts of the LMB, most of heavy rainfalls happened in the middle reach of LMB due to influence for Tropical typhoon "TALAS". The maximum accumulated rainfalls were at Nakhon Phanom (203.9 mm.), Khong Chiam (257.4 mm.) and Pakse (202.7 mm.), see Figure 3.2-2 for ore details.

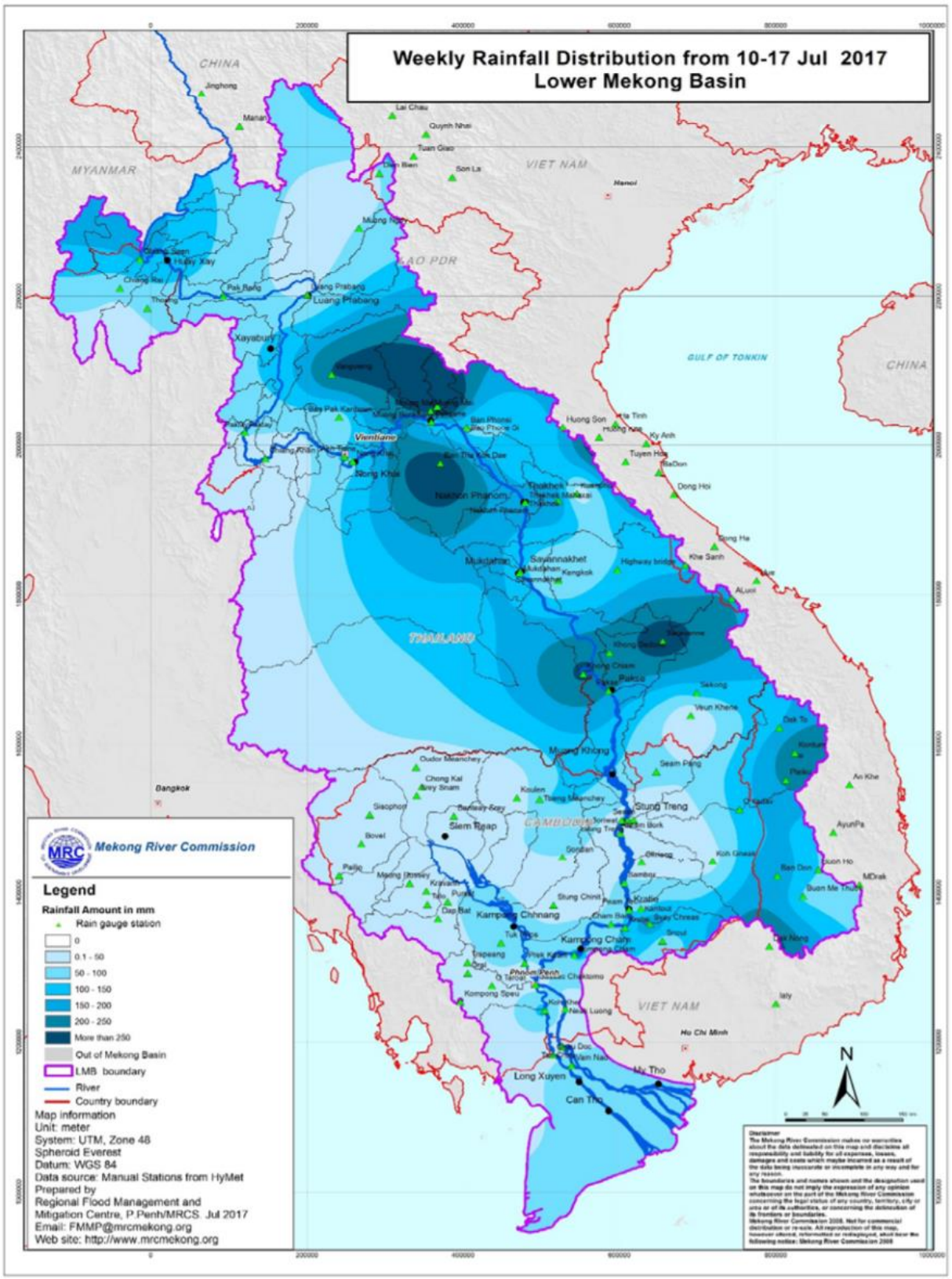


Figure 3.2-2Weekly rainfall distribution from 10th -17th July 2017 in the LMB.

3.2.3 Flash flooding in the northern provinces of Viet Nam Lao PDR, Viet Nam and Cambodia caused by tropical storm "TALAS" on 17 July 2017.

From 17 July 2017 at 00:00 UTC (07:00 AM local time) the MRCFFG System detected many districts of provinces part of Viet Nam, Cambodia and Lao PDR were at the risk of flash flood occurrence (see table 3.2-1, table 3.2-2, table 3.2.3 and figure 3.2.3 for more detail). According to the information published in newspaper, that the tropical storm "TALAS" cause a serious flash flood in some provinces of the Lao PDR, Viet Nam, and Cambodia province (see annex 2)

Table 3.2-1: Flash flood guidance detected by MRCFFG system in Lao PDR on 17 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG produ	17/07/2017 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
Attapeu	Phouvong	20.29	Attapeu	Phouvong	28.51	Attapeu	Phouvong	37.27
Saravane	Ta oi	20.49	Xaysomboun Sp	Thathom	42.99	Xaysomboun S	Thathom	52.88
Saravane	Ta oi	21.18	Saravane	Ta oi	28.81	Saravane	Ta oi	38.39
Savannakhet	Phine	17.18	Saravane	Ta oi	28.58	Saravane	Ta oi	37.18
Bolikhamxay	Viengthon	17.58	Savannakhet	Phine	25.11	Savannakhet	Phine	34.17
Bolikhamxay	Viengthon	16.42	Savannakhet	Atsaphang	46.41	Bolikhamxay	Bolikhanh	44.79
Bolikhamxay	Viengthon	21.64	Bolikhamxay	Bolikhanh	35.58	Bolikhamxay	Viengthon	33.51
Bolikhamxay	Viengthon	16.01	Bolikhamxay	Viengthon	25.29	Bolikhamxay	Viengthon	47.46
Bolikhamxay	Viengthon	9.69	Bolikhamxay	Viengthon	48.74	Bolikhamxay	Viengthon	59.56
Bolikhamxay	Khamkheut	24.31	Bolikhamxay	Viengthon	49.31	Bolikhamxay	Viengthon	33.3
Bolikhamxay	Khamkheut	25	Bolikhamxay	Viengthon	38.12	Bolikhamxay	Viengthon	39.52
Bolikhamxay	Khamkheut	20.26	Bolikhamxay	Viengthon	48.84	Bolikhamxay	Viengthon	32.76
Khammuane	Nakai	18.51	Bolikhamxay	Viengthon	24.56	Bolikhamxay	Viengthon	21.52
Bolikhamxay	Thaphabat	11.13	Bolikhamxay	Viengthon	30.12	Bolikhamxay	Khamkheut	42.52
Luangprabang	Nan	21.93	Bolikhamxay	Viengthon	24.03	Bolikhamxay	Khamkheut	44.99
Vientiane	Kasy	23.62	Bolikhamxay	Viengthon	15.14	Bolikhamxay	Khamkheut	38.08
Bolikhamxay	Pakkading	13.95	Bolikhamxay	Khamkheut	33	Khammuane	Nakai	36.25
Bolikhamxay	Pakkading	20.72	Bolikhamxay	Khamkheut	34.4	Bolikhamxay	Khamkheut	45.35
Khammuane	Hinboon	18.8	Bolikhamxay	Khamkheut	28.58	Bolikhamxay	Thaphabat	22.34
Khammuane	Bualapha	18.9	Khammuane	Nakai	26.99	Xaysomboun S	Xaysombou	58.72
Champasak	Pathoomph	20.39	Bolikhamxay	Khamkheut	34.79	Xiengkhuang	Khoune	39.85
Sekong	Kaleum	17.88	Bolikhamxay	Thaphabat	16.35	Xaysomboun S	Xaysombou	50.3
Xiengkhuang	Morkmay	19.19	Xaysomboun Sp	Xaysombou	48.71	Xaysomboun S	Thathom	51.4
Savannakhet	Sepone	22.03	Xiengkhuang	Khoune	32.63	Xaysomboun S	Xaysombou	54.77
Xiengkhuang	Morkmay	17.65	Xaysomboun Sp	Xaysombou	41.12	Xaysomboun S	Xaysombou	47.72
			Xaysomboun Sp	Thathom	41.33	Luangprabang	Nan	38.11
			Xaysomboun Sp	Xaysombou	44.91	Vientiane	Kasy	40.44
			Xaysomboun Sp	Xaysombou	38.42	Bolikhamxay	Pakkading	26.59
			Luangprabang	Nan	29.77	Bolikhamxay	Pakkading	39.02
			Vientiane	Kasy	31.67	Khammuane	Hinboon	35.27
			Bolikhamxay	Pakkading	19.79	Khammuane	Bualapha	37.45
			Bolikhamxay	Pakkading	29.52	Champasak	Pathoomph	37.64
			Khammuane	Hinboon	26.77	Champasak	Paksong	57.89
			Khammuane	Bualapha	27.67	Champasak	Paksong	49.34
			Champasak	Pathoomph	28.99	Sekong	Dakcheung	48.44
			Champasak	Paksong	48.45	Sekong	Kaleum	49.6
			Champasak	Paksong	40.32	Sekong	Kaleum	34.72

Table 3.2-2 Flash flood guidance detected by MRCFFG system in Lao PDR on 17 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	17/07/2017 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
Ha Tinh	Huong Son	18.47	Ha Tinh	Huong Son	26.58	Ha Tinh	Huong Son	35.83
Quang Tri	Huong Hoa	20.55	Kon Tum	Ngoc Hoi	34.95	Kon Tum	Ngoc Hoi	44.32
Lao Cai	Bat Xat	19.28	Ha Tinh	Huong Son	47.51	Ha Tinh	Huong Son	59.01
			Gia Lai	Ia Grai	34.67	Gia Lai	Ia Grai	44.09
			Gia Lai	Ia Grai	47.64	Gia Lai	Ia Grai	57.59
			Quang Tri	Huong Hoa	28.95	Quang Tri	Huong Hoa	38.43
			Quang Binh	Quang Ninh	37.92	Quang Binh	Quang Ninh	50.14
			Quang Binh	Quang Ninh	45.28	Quang Binh	Quang Ninh	57.98
			Quang Binh	Quang Ninh	42.23	Quang Binh	Quang Ninh	55.12
			Quang Tri	Da Krong	39.61	Quang Tri	Da Krong	50
			Binh Phuoc	Bu Dang	36.12	Binh Phuoc	Bu Dang	44.32
			Lam Dong	Bao Lam	45.09	Lam Dong	Bao Lam	53.33
			Binh Thuan	Ham Thuan Nam	45.97	Binh Thuan	Ham Thuan Nam	54.52
			Gia Lai	Chu Pah	45.45	Gia Lai	Chu Pah	55.35
			Kon Tum	Sa Thay	42.34	Kon Tum	Sa Thay	51.78
			Lao Cai	Bat Xat	24.33	Lao Cai	Bat Xat	29.79
			Lao Cai	Than Uyen	39.59	Lao Cai	Than Uyen	46.59
			Lao Cai	Bat Xat	33.4	Lao Cai	Bat Xat	39.85
			Lai Chau	Phong Tho	44.95	Lai Chau	Phong Tho	52.46
			Ha Tinh	Huong Khe	38.13	Ha Tinh	Huong Khe	49.07

Table 3.2-3: Flash flood guidance detected by MRCFFG system in Cambodia on 17 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	17/07/2017 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 Veaeng	15.01	Ratana Kiri	Ta Veaeng	21.99	Ratana Kiri	Ta Veaeng	29.53
Ratana Kiri	Ta Veaeng	15.94	Ratana Kiri	Ta Veaeng	23.29	Ratana Kiri	Ta Veaeng	31.38
Ratana Kiri	Veun Sai	19.12	Ratana Kiri	Andoung Mea	39.15	Ratana Kiri	Andoung Meas	48.35
			Ratana Kiri	Veun Sai	26.92	Ratana Kiri	Veun Sai	35.44

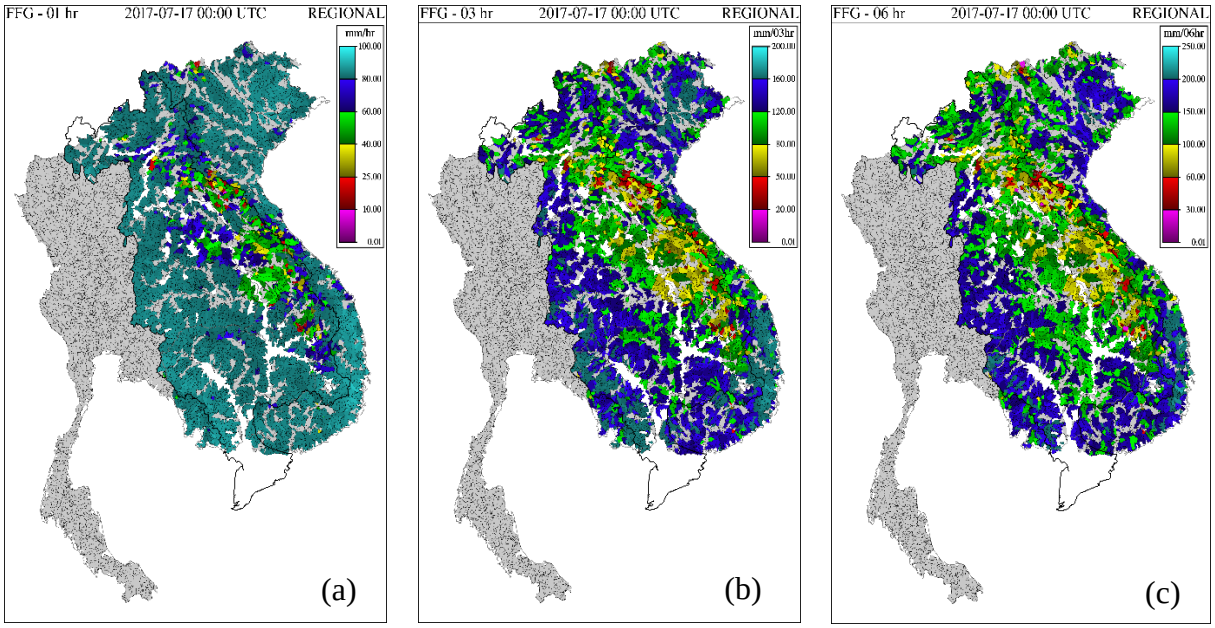


Figure 3.2-3: Flash flood rick areas detected by MRCFFGS on 17th July 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h

3.2.4 Conclusions

1. The tropical storm "TALAS" is the fourth storm of the year 2017, which was also the first storm that hit Viet Nam, and caused a serious damage to the northern provinces of Viet Nam and Lao PDR.
2. Many rainfall stations, located in the northern part of Viet Nam, recorded moderate rainfall during the period that TS "TALAS" hit the Mekong Region. Some of those rainfall stations recorded an amount of daily rainfall up to 70 and 100 mm.
3. MRCFFG System detected some districts of province of northern and central northern parts of Viet Nam, Lao PDR's provinces were at the risk of flash flood occurrences thought the checking the information in the newspaper as well as colleagues in Line Agencies from Member Countries (MCs).

3.3 Flash flooding in Lao DPR and Viet Nam on 20st – 25nd July 2017, caused by TD and tropical storm "SONCA".

3.3.1 Weather condition from 17th – 25th July 2017

During early period of the third week this month, the monsoon trough lying over Myanmar, Laos and Vietnam towards the active low pressure cell in upper South China Sea which later intensified into the tropical depression and the tropical storm "SONCA" on July 23 before making landfall over Dong Hoi, Vietnam in the afternoon of July 25 and weakening into a tropical depression passing Laos and moving further into Thailand (see figure 3.3-1, figure 3.3-2, and figure 3.3-3).

On July 21, both the Japan Meteorological Agency (JMA) and the Joint Typhoon Warning Center (JTWC) reported that Tropical Depression 08W had developed approximately 582 km (361 mi) to the south of Hong Kong. After moving westward for a couple of days, the system strengthened into a tropical storm by both agencies while nearing the island province of Hainan, receiving the name "SONCA". By July 24, "SONCA" reached its maximum intensity with a minimum pressure of 994 hPa. Early on July 25, the JTWC issued its final advisory as the system made landfall over in Quảng Trị Province (see figure 3.3.4)

All countries of Lower Mekong Basin was effected heavy rain and flash flood caused by this Tropical Storm; according to disaster damage report country, in Viet Nam at least six people were killed when the storm made landfall on July 25, all in the provinces of Ha Tinh and Quang Tri. In the northeast part of Thailand, Lao PDR and Cambodia a serious heavy rain and flash flood was occurred at that time at many provinces.

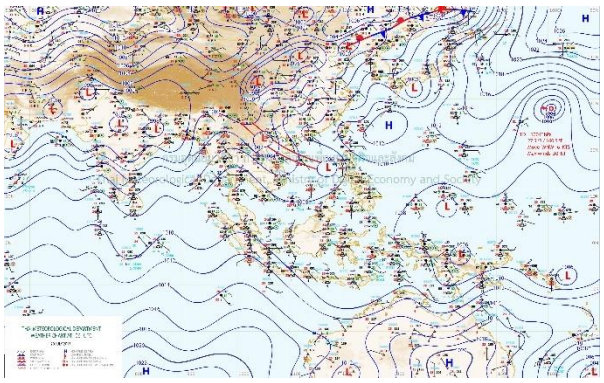


Figure 3.3-1: Weather Chart on 20 July 2017

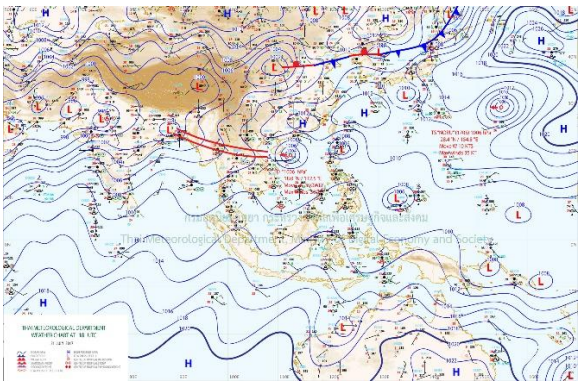


Figure 3.3-2: Weather Chart on 23 July 2017

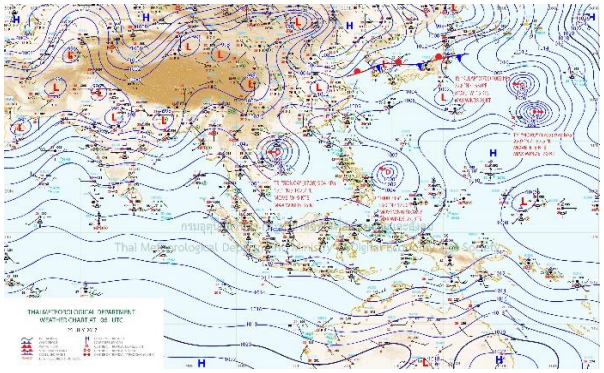


Figure 3.3-3: Weather Chart on 25 July.

Figure 3.3.4: Sonca's track (source: NCHMF)

3.3.2 Heavy rainfall during the period 17th – 24th July 2017, caused by Tropical Depression (TD) and Tropical Storm "SONCA"

Due to the influence of TS "SONCA" and Inter Tropical Convergence Zone (ITCZ), the period 17th – 24th July 2017, the moderate and heavy rain occurred from upper to middle – parts of LMB. The maximum accumulated rainfalls in period were recorded at Paksane (211.2 mm), Stung Treng (205 mm) and Koh Khel (210.5 mm.) (see figure 3.3 -5).

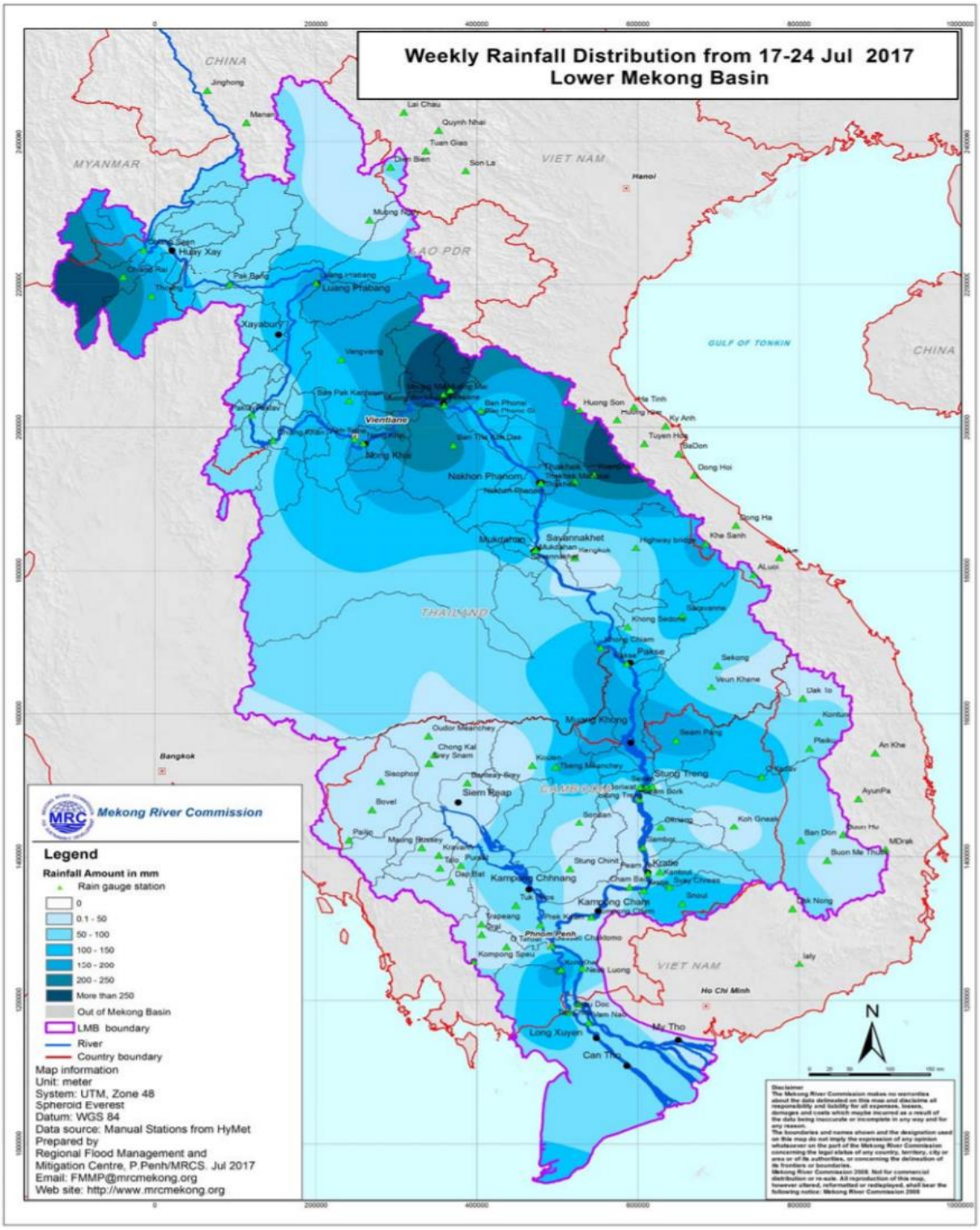


Figure 3.3-5: Weekly rainfall distribution from 17th – 24th July 2017 in the LMB.

3.3.3 Flash flooding in the northern provinces four countries of LMB, caused by Tropical Depression (TD) and Tropical Storm "SONCA"

During the period from July 20, 2017 to July 25, 2017, local heavy rains appeared due to the influence of two meteorological factors (ITCZ and the circulation after SONCA storm), on LMB there were several flash floods occurred. In fact, some flash floods have been detected by the MRCFFGS system, especially flash floods occurring on 25 July in all 04 countries of LMB (figure 3.3-9 and table 3.3-6, table 3.3-7, table 3.3-8, and table 3.3-9).

The flash flood event occurred on 20 and 21 July 2017 in some areas in Thailand caused by ITCZ, the MRCFFG system didn't detect. The figure 3.3-7 shown the flash flood rick areas detected by MRCFFGS on 20th July 2017 for the LMB, and figure 3.3-8 shown the flash flood rick areas detected by MRCFFGS on 20th July 2017 for the LMB. See table 3.3-1, table 3.3-2, table 3.3-3, table 3.3-4, table 3.3-50 for more detail flash flood guidance detected by MRCFFG system.

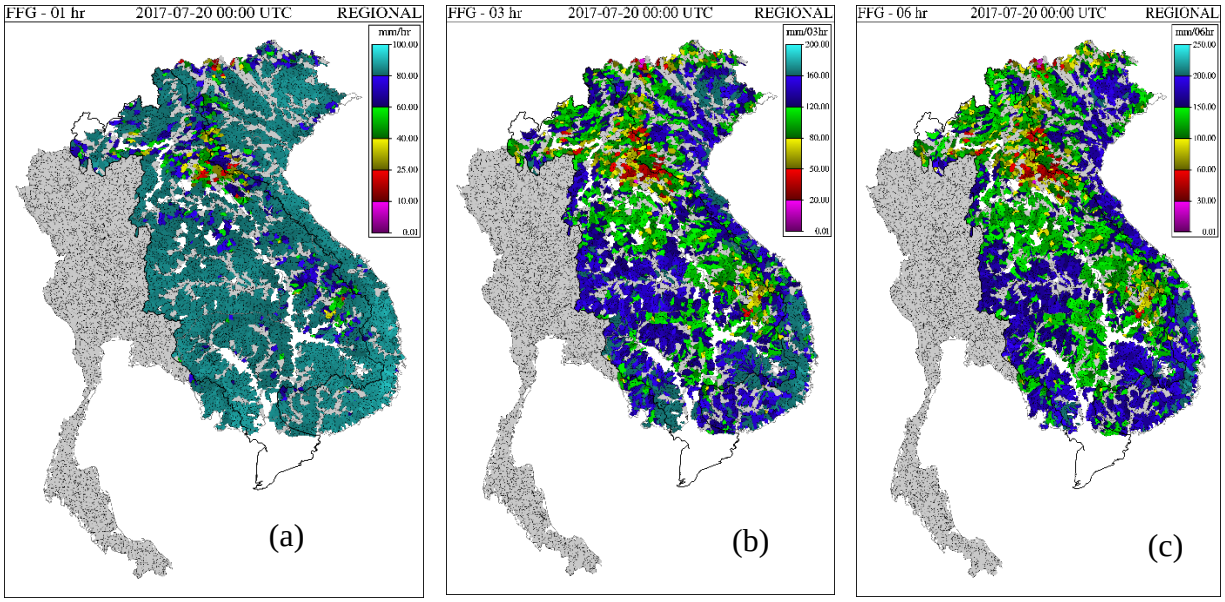


Figure 3.3-7: Flash flood rick areas detected by MRCFFGS on 20th July 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h

Table 3.3-1: Flash flood guidance detected by MRCFFG system in Viet Nam on 20 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	20/07/2017 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
Kon Tum	Ngoc Hoi	21.1	Kon Tum	Ngoc Hoi	29.11	Kon Tum	Ngoc Hoi	38.01
Lao Cai	Bat Xat	14.39	Hoa Binh	Ky Son	38.73	Hoa Binh	Ky Son	48.32
Lao Cai	Bao Thang	20.39	Binh Phuoc	Bu Dang	46.71	Binh Phuoc	Bu Dang	55.4
Lao Cai	Than Uyen	21.56	Cao Bang	Hoa An	48.38	Cao Bang	Hoa An	56.88
Lao Cai	Bat Xat	13.68	Lao Cai	Bat Xat	18.97	Lao Cai	Bat Xat	23.92
Lai Chau	Phong Tho	24.81	Lao Cai	Bat Xat	33.96	Lao Cai	Bat Xat	40.87
Lai Chau	Muong Te	19.63	Lao Cai	Bat Xat	38.42	Lao Cai	Bat Xat	45.31
			Lao Cai	Bao Thang	29.2	Lao Cai	Bao Thang	38.53
			Lao Cai	Bao Thang	40.15	Lao Cai	Bao Thang	50.94
			Lao Cai	Than Uyen	47.97	Lao Cai	Than Uyen	57.59
			Lao Cai	Than Uyen	26.96	Lao Cai	Than Uyen	32.88
			Lai Chau	Sin Ho	48.43	Lai Chau	Sin Ho	58.6
			Lai Chau	Phong Tho	37.06	Lai Chau	Phong Tho	44.45
			Lao Cai	Bat Xat	18.25	Lao Cai	Bat Xat	23.26
			Lai Chau	Phong Tho	30.8	Lai Chau	Phong Tho	37.23
			Lai Chau	Muong Te	26.11	Lai Chau	Muong Te	33.53
			Lao Cai	Bao Yen	47	Lao Cai	Bao Yen	56.67
			Hoa Binh	Ky Son	35.11	Hoa Binh	Ky Son	44.48
			Hoa Binh	Ky Son	35.86	Hoa Binh	Ky Son	45.5

Table 3.3-2: Flash flood risk areas detected by MRCFFG system in Lao PDR on 20 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG produ	20/07/2017 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
Xaysomboun Spe	Thathom	23.65	Attapeu	Phouvong	45.8	Attapeu	Phouvong	55.65
Xaysomboun Spe	Thathom	21.07	Xaysomboun Sp	Thathom	30.94	Xaysomboun S	Thathom	39.31
Bolikhamxay	Thaphabat	12.17	Xaysomboun Sp	Thathom	27.75	Xaysomboun S	Thathom	35.41
Xaysomboun Spe	Xaysombou	23.66	Xaysomboun Sp	Thathom	36.08	Xaysomboun S	Thathom	44.79
Xiengkhuang	Khoune	20.45	Xaysomboun Sp	Thathom	34.28	Xaysomboun S	Thathom	43.88
Xaysomboun Spe	Thathom	21.12	Bolikhamxay	Bolikhanh	35.45	Bolikhamxay	Bolikhanh	44.57
Xaysomboun Spe	Xaysombou	19.93	Bolikhamxay	Viengthon	39.03	Bolikhamxay	Viengthon	48.16
Xaysomboun Spe	Thathom	21.41	Bolikhamxay	Viengthon	47.77	Bolikhamxay	Viengthon	58.34
Bolikhamxay	Bolikhanh	19.1	Bolikhamxay	Viengthon	38.6	Bolikhamxay	Viengthon	48.22
Xaysomboun Spe	Xaysombou	23.13	Bolikhamxay	Viengthon	33.56	Bolikhamxay	Viengthon	42.26
Bolikhamxay	Pakkading	21.89	Bolikhamxay	Viengthon	42.76	Bolikhamxay	Viengthon	52.67
Xiengkhuang	Morkmay	22.3	Bolikhamxay	Viengthon	41.69	Bolikhamxay	Viengthon	51.59
Xiengkhuang	Morkmay	23.54	Bolikhamxay	Viengthon	37.24	Bolikhamxay	Viengthon	46.49
Xiengkhuang	Morkmay	24.55	Bolikhamxay	Khamkheut	41.97	Bolikhamxay	Khamkheut	52.01
			Bolikhamxay	Thaphabat	17.53	Bolikhamxay	Thaphabat	23.67
			Xiengkhuang	Souy	49.03	Xiengkhuang	Souy	59.62
			Xaysomboun Sp	Xaysombou	30.72	Xaysomboun S	Xaysombou	38.73
			Xiengkhuang	Khoune	27.03	Xiengkhuang	Khoune	33.95
			Xaysomboun Sp	Thathom	27.97	Xaysomboun S	Thathom	35.69
			Xaysomboun Sp	Thathom	35.99	Xaysomboun S	Thathom	44.54
			Xaysomboun Sp	Xaysombou	26.53	Xaysomboun S	Xaysombou	34
			Xaysomboun Sp	Xaysombou	37.6	Xaysomboun S	Xaysombou	47.36
			Xaysomboun Sp	Thathom	29.53	Xaysomboun S	Thathom	38.65
			Bolikhamxay	Bolikhanh	26.95	Bolikhamxay	Bolikhanh	35.79
			Xaysomboun Sp	Phoun	48.71	Xaysomboun S	Phoun	58.53
			Xiengkhuang	Phookood	42.05	Xiengkhuang	Phookood	52.12
			Xaysomboun Sp	Xaysombou	44.3	Xaysomboun S	Xaysombou	53.99
			Xaysomboun Sp	Xaysombou	38.84	Xaysomboun S	Xaysombou	47.75
			Xaysomboun Sp	Xaysombou	34.92	Xaysomboun S	Xaysombou	43.61
			Xaysomboun Sp	Xaysombou	36.64	Xaysomboun S	Xaysombou	45.53

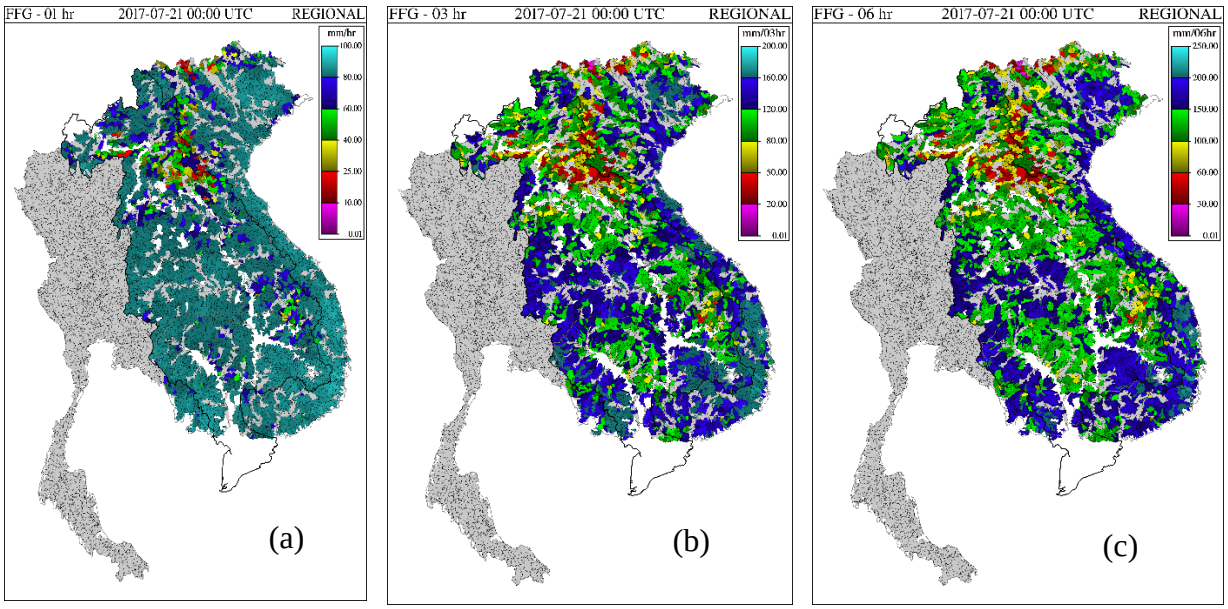


Figure 3.3-8: Flash flood rick areas detected by MRCFFGS on 21th July 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h

Table 3.3-3: Flash flood risk areas detected by MRCFFG system in Viet Nam on 21 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	21/07/2017 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
Lao Cai	Bat Xat	14.29	Kon Tum	Ngoc Hoi	49.23	Kon Tum	Ngoc Hoi	59.45
Lao Cai	Than Uyen	20.04	Nghe An	Tuong Duong	44.47	Nghe An	Tuong Duong	54.08
Lai Chau	Phong Tho	19.24	Hoa Binh	Ky Son	35.53	Hoa Binh	Ky Son	44.86
Lao Cai	Than Uyen	14.09	Lao Cai	Bat Xat	18.87	Cao Bang	Hoa An	58.59
Lai Chau	Phong Tho	20.42	Lao Cai	Bat Xat	41.31	Lao Cai	Bat Xat	23.8
Lai Chau	Phong Tho	19	Lao Cai	Bat Xat	37.59	Lao Cai	Bat Xat	48.88
Lao Cai	Bat Xat	15.08	Lao Cai	Bao Thang	37.02	Lao Cai	Bat Xat	44.41
Lai Chau	Phong Tho	24.94	Lao Cai	Bao Thang	39.96	Lao Cai	Bao Thang	46.88
Lao Cai	Bao Yen	24.07	Lao Cai	Than Uyen	26.35	Lao Cai	Bao Thang	50.66
Lao Cai	Bac Ha	24.92	Lai Chau	Phong Tho	24.33	Lao Cai	Than Uyen	33.54
Hoa Binh	Ky Son	23.6	Lao Cai	Than Uyen	18.79	Lai Chau	Phong Tho	29.92
			Lai Chau	Sin Ho	34.84	Lao Cai	Than Uyen	23.94
			Lai Chau	Sin Ho	49.79	Lai Chau	Sin Ho	43.52
			Lai Chau	Phong Tho	27.03	Lai Chau	Phong Tho	33.88
			Lai Chau	Phong Tho	25.4	Lai Chau	Phong Tho	32.67
			Lao Cai	Bat Xat	19.79	Lao Cai	Bat Xat	24.96
			Lai Chau	Phong Tho	30.94	Lai Chau	Phong Tho	37.39
			Lai Chau	Muong Te	37.02	Lai Chau	Muong Te	45.83
			Lai Chau	Muong Te	35.77	Lai Chau	Muong Te	44.28
			Son La	Mai Son	43.33	Son La	Mai Son	52.97
			Lao Cai	Bao Yen	32.15	Lao Cai	Bao Yen	40.82
			Ha Giang	Xin Man	34.4	Ha Giang	Xin Man	42.77
			Lao Cai	Bac Ha	32.34	Lao Cai	Bac Ha	40.85
			Lao Cai	Bao Yen	42.93	Lao Cai	Bao Yen	52.43
			Ha Giang	Vi Xuyen	47.79	Ha Giang	Vi Xuyen	57.52
			Ha Giang	Bac Me	47.62	Ha Giang	Bac Me	57.07
			Lao Cai	Bao Yen	42.07	Lao Cai	Bao Yen	50.99
			Bac Kan	TX. Bac Kan	46.88	Bac Kan	TX. Bac Kan	55.92
			Son La	Song Ma	47.15	Son La	Song Ma	57.75
			Son La	Song Ma	33.14	Son La	Song Ma	42.25

Table 3.3-4: Flash flood risk areas detected by MRCFFG system in Cambodia on 21 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	21/07/2017 00:00	UTC 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
Nan	King Amphoe Song Kha	23.89	Nan	King Amphoe Song K	31.79	Nan	King Amphoe S	40.4
			Udon Thani	Na Yung	36.4	Udon Thani	Na Yung	46.08
			Phayao	Chiang Kham	46.1	Phayao	Chiang Kham	56.53

Table 3.3-5: Flash flood risk areas detected by MRCFFG system in Lao PDR on 21 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	21/07/2017 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
Xaysomboun Special Region	Thathom	19.6	Attapeu	Phouvong	46.61	Attapeu	Phouvong	56.5
Xaysomboun Special Region	Thathom	20.04	Xaysomboun Special Region	Thathom	26.28	Xaysomboun Special Region	Thathom	33.99
Bolikhamxay	Bolikhanh	23.54	Xaysomboun Special Region	Thathom	26.56	Xaysomboun Special Region	Thathom	34.03
Bolikhamxay	Viengthon	21.41	Xaysomboun Special Region	Thathom	42.35	Xaysomboun Special Region	Thathom	51.43
Bolikhamxay	Viengthon	15.68	Xaysomboun Special Region	Thathom	36.47	Xaysomboun Special Region	Thathom	46.19
Bolikhamxay	Viengthon	21.89	Bolikhamxay	Bolikhanh	31.67	Bolikhamxay	Bolikhanh	40.49
Bolikhamxay	Viengthon	22.62	Bolikhamxay	Viengthon	34.47	Bolikhamxay	Viengthon	43.26
Bolikhamxay	Viengthon	20.06	Bolikhamxay	Viengthon	37.33	Bolikhamxay	Viengthon	47.17
Bolikhamxay	Thaphabat	21.05	Bolikhamxay	Viengthon	29.12	Bolikhamxay	Viengthon	37.91
Xiengkhuang	Khoune	22.4	Bolikhamxay	Viengthon	21.87	Bolikhamxay	Viengthon	29.01
Xaysomboun Special Region	Thathom	23.98	Bolikhamxay	Viengthon	39.74	Bolikhamxay	Viengthon	49.59
Xaysomboun Special Region	Xaysombou	22.59	Bolikhamxay	Viengthon	30.34	Bolikhamxay	Viengthon	39.35
Vientiane	Keo oudom	24.2	Bolikhamxay	Viengthon	31.07	Bolikhamxay	Viengthon	40.23
Xayaboury	Hongsa	24.69	Bolikhamxay	Viengthon	26.96	Bolikhamxay	Viengthon	34.89
Huaphanh	Viengthon	24.76	Bolikhamxay	Khamkheut	41.78	Bolikhamxay	Khamkheut	51.8
Huaphanh	Huameuang	19.15	Bolikhamxay	Thaphabat	27.65	Bolikhamxay	Thaphabat	35.16
Xiengkhuang	Phookood	23.28	Xiengkhuang	Souy	45.68	Xiengkhuang	Souy	55.99
Bolikhamxay	Pakkading	23.11	Xaysomboun Special Region	Xaysombou	32.57	Xaysomboun Special Region	Xaysombou	40.78
Xayaboury	Ngeun	22.98	Xiengkhuang	Khoune	29.06	Xiengkhuang	Khoune	36.07
Xayaboury	Hongsa	24.48	Xaysomboun Special Region	Thathom	31.15	Xaysomboun Special Region	Thathom	39.21
Bokeo	Pha Oudo	24.39	Xaysomboun Special Region	Thathom	44.18	Xaysomboun Special Region	Thathom	53.26
Bokeo	Pha Oudo	24.96	Xaysomboun Special Region	Xaysombou	33.45	Xaysomboun Special Region	Xaysombou	41.71
Xiengkhuang	Kham	20.41	Xaysomboun Special Region	Xaysombou	42.93	Xaysomboun Special Region	Xaysombou	53.03
Huaphanh	Huameuang	22.97	Xaysomboun Special Region	Thathom	35.74	Xaysomboun Special Region	Thathom	45.31
Xiengkhuang	Nonghed	24.42	Bolikhamxay	Bolikhanh	33.47	Bolikhamxay	Bolikhanh	42.8
Xiengkhuang	Morkmay	19.13	Xaysomboun Special Region	Phoun	43.83	Xaysomboun Special Region	Phoun	54.05
Xiengkhuang	Morkmay	20.24	Vientiane	Vangvieng	50	Vientiane	Vangvieng	59.96
Xiengkhuang	Morkmay	18.98	Xaysomboun Special Region	Phoun	39.75	Xaysomboun Special Region	Phoun	49.2
Xiengkhuang	Morkmay	20.43	Xaysomboun Special Region	Phoun	36.44	Xaysomboun Special Region	Phoun	45.44

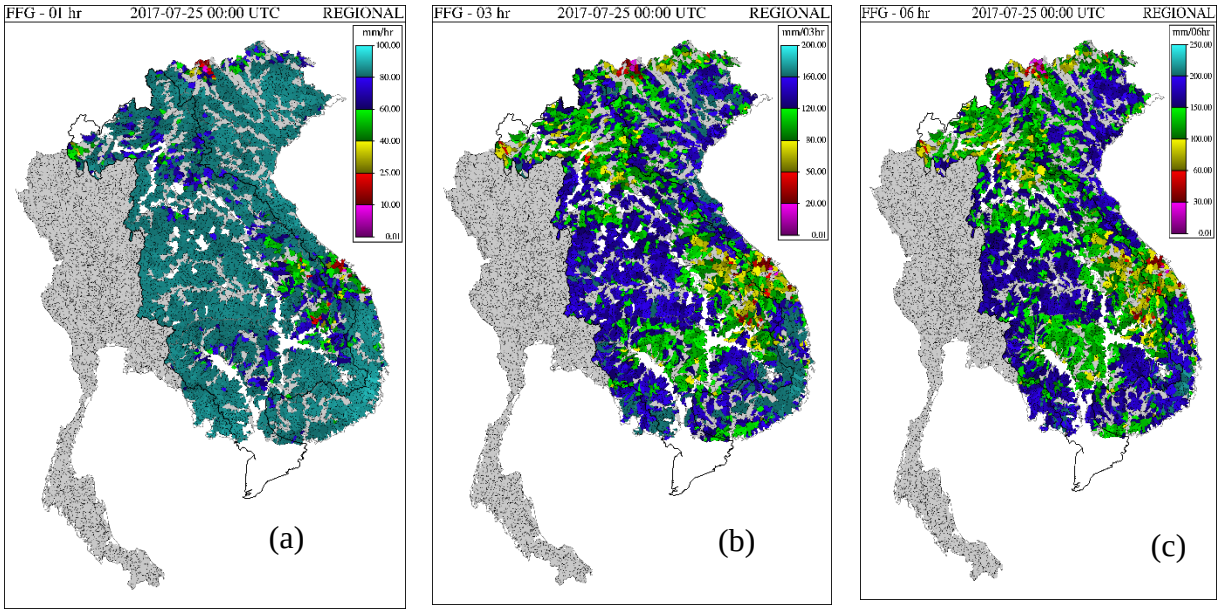


Figure 3.3-9: Flash flood rick areas detected by MRCFFGS on 20th July 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h

Table 3.3-6: Flash flood risk areas detected by MRCFFG system in Viet Nam on 25 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	25/07/2017 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
Kon Tum	Ngoc Hoi	22.69		Kon Tum	Ngoc Hoi	30.8		Kon Tum	Ngoc Hoi	39.77
Quang Nam	Hien	15.69		Gia Lai	Ia Grai	38.49		Gia Lai	Ia Grai	48.04
Quang Nam	Hien	14.53		Quang Nam	Hien	37.22		Quang Nam	Hien	46.96
Thua Thien Hue	Nam Dong	17.72		Quang Nam	Hien	24.35		Quang Nam	Hien	34.52
Da Nang	Hoa Vang	18.94		Quang Nam	Hien	21.67		Quang Nam	Hien	30.08
Da Nang	Hoa Vang	16.38		Thua Thien Hue	Nam Dong	26.99		Thua Thien Hue	Nam Dong	37.63
Quang Nam	Hien	18.23		Da Nang	Hoa Vang	28.87		Da Nang	Hoa Vang	40.33
Quang Nam	Dai Loc	9.38		Da Nang	Hoa Vang	24.58		Da Nang	Hoa Vang	33.96
Quang Nam	Dai Loc	15.66		Quang Nam	Hien	27.01		Quang Nam	Hien	36.74
Quang Nam	Que Son	12.88		Da Nang	Hoa vang	41.03		Da Nang	Hoa vang	52.24
Quang Ngai	Tra Bong	19.01		Quang Nam	Dai Loc	14.79		Quang Nam	Dai Loc	21.14
Quang Ngai	Tra Bong	20.82		Quang Nam	Dai Loc	23.58		Quang Nam	Dai Loc	32.55
Lao Cai	Bat Xat	13.39		Kon Tum	Dak To	46.62		Kon Tum	Dak To	56.24
Lao Cai	Bat Xat	23.81		Kon Tum	Dak Glei	46.64		Kon Tum	Dak Glei	56.83
Lai Chau	Phong Tho	16.89		Quang Nam	Que Son	49.64		Quang Nam	Nam Giang	58.35
Lao Cai	Than Uyen	20.47		Quang Nam	Nam Giang	47.1		Quang Nam	Que Son	26.16
Lai Chau	Phong Tho	16.74		Quang Nam	Que Son	19.25		Quang Ngai	Tra Bong	38.55
Lai Chau	Phong Tho	23.06		Quang Ngai	Tra Bong	28.04		Quang Ngai	Tra Bong	40.86
Lao Cai	Bat Xat	8.16		Quang Ngai	Tra Bong	30.06		Quang Ngai	Minh Long	45.98
Lai Chau	Phong Tho	9.7		Quang Ngai	Minh Long	35.9		Binh Phuoc	Bu Dang	56.72
				Binh Phuoc	Bu Dang	48.04		Dong Nai	Xuan Loc	59.95
				Dong Nai	Xuan Loc	46.58		Gia Lai	Chu Pah	55.71
				Gia Lai	Chu Pah	45.88		Cao Bang	Hoa An	57.91
				Cao Bang	Hoa An	49.4		Lao Cai	Bat Xat	22.68
				Lao Cai	Bat Xat	17.87		Lao Cai	Bat Xat	39.57
				Lao Cai	Bat Xat	32.82		Lao Cai	Bat Xat	35.35
				Lao Cai	Bat Xat	29.3		Lao Cai	Than Uyen	50.41
				Lao Cai	Than Uyen	41.5		Lai Chau	Phong Tho	27.03
				Lai Chau	Phong Tho	21.72		Lao Cai	Than Uyen	31.53
				Lao Cai	Than Uyen	25.74		Lai Chau	Sin Ho	53.3
				Lai Chau	Sin Ho	43.38		Lai Chau	Sin Ho	50.66
				Lai Chau	Sin Ho	40.95		Lai Chau	Sin Ho	43.99
				Lai Chau	Sin Ho	35.35		Lai Chau	Sin Ho	54.97
				Lai Chau	Sin Ho	45.11		Lai Chau	Sin Ho	50.96
				Lai Chau	Sin Ho	41.43		Lai Chau	Phong Tho	29.74
				Lai Chau	Phong Tho	23.13		Lai Chau	Phong Tho	37.67
				Lai Chau	Phong Tho	29.91		Lao Cai	Bat Xat	16.5
				Lao Cai	Bat Xat	12.15		Lai Chau	Phong Tho	19.37
				Lai Chau	Phong Tho	14.39		Lai Chau	Muong Lay	44.29
				Lai Chau	Muong Lay	35.53				

Table 3.3-7: Flash flood risk areas detected by MRCFFG system in Thailand on 25 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	25/07/2017 00:00	UTC 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 Ma	Fang	36.69		Chiang Mai	Fang	46.46
				Chiang Rai	Mae Suai	39.13		Chiang Rai	Mae Suai	48.87
				Chiang Rai	Mae Suai	47.18		Chiang Rai	Mae Suai	57.96

Table 3.3-8: Flash flood risk areas detected by MRCFFG system in Lao PDR on 25 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG produ	25/07/2017 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
Attapeu	Phouvong	24.03	Attapeu	Phouvong	32.46	Attapeu	Phouvong	41.43
Saravane	Ta oi	17.52	Saravane	Ta oi	25.22	Saravane	Ta oi	34.06
Sekong	Kaleum	20.26	Saravane	Ta oi	45.78	Saravane	Ta oi	56.06
			Savannakhet	Phine	34.77	Savannakhet	Phine	44.43
			Luangprabang	Nan	49.47	Luangprabang	Nan	58.96
			Sekong	Kaleum	28.5	Sekong	Kaleum	37.32
			Sekong	Dakcheung	37.31	Sekong	Dakcheung	45.98
			Attapeu	Sanxay	42.25	Attapeu	Sanxay	52.41

Table 3.3-9: Flash flood risk areas detected by MRCFFG system in Cambodia on 25 July 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	25/07/2017 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 Veaeng	19.63	Ratana Kiri	Ta Veaeng	26.95	Ratana Kiri	Ta Veaeng	34.84
Ratana Kiri	Ta Veaeng	21.72	Ratana Kiri	Ta Veaeng	29.49	Ratana Kiri	Ta Veaeng	38
Ratana Kiri	Veun Sai	20.85	Ratana Kiri	Andoung Mea	36.16	Ratana Kiri	Andoung Meas	44.99
			Ratana Kiri	Veun Sai	28.73	Ratana Kiri	Veun Sai	37.32

3.3.4 Conclusion

1. The ITCZ and the tropical storm "SONCA" is two main factors effected the flash flood in the Mekong regions. Especially, impact of TS "SONCA" made flash flood at some areas for whole MCs of LBM.
2. Many rainfall stations, located in the northern parts and central northern parts of Viet Nam, Central part of Lao PDR, Norther parts of Thailand and East part of Cambodia recorded moderate/heavy rainfall during the period.
3. Comparing flash flood information via newspaper, MRCFFG System detected some areas of province of northern and northern central parts of Viet Nam, Lao PDR's, northern parts of Thailand and northern part of Cambodia caused by TS "SONCA" (see annex 2 for more information). However, some flash flood events real occurred in some areas in Thailand caused ITCZ factors on 20 and 21 July 2017, the MRCFFGS didn't detect.

3.4 Flash flooding in norther part in Viet Nam on 03 August 2017, caused by ITCZ

3.4.1 Weather condition from 01th – 03th August 2017

On early 1st August 2017, an ITCZ appeared from upper (China) of north part of Viet Nam then moved to hit to northern part of Viet Nam on early 03 Aug 2017 (see figure 3.4-1). It made heavy locate rainfall in those areas, such as daily rainfall was recorded at Muong Te (141 mm/24h), Lai Chau (128 mm/24h), Quynh Nhai (92 mm/24h), Sin Ho (43 mm/24h).

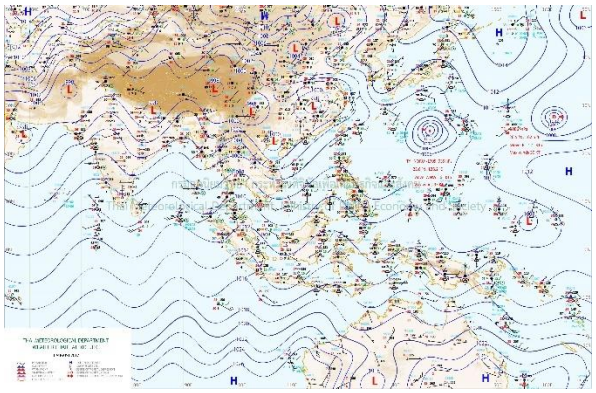


Figure 3.4-1 Weather chart on 01st August 2017

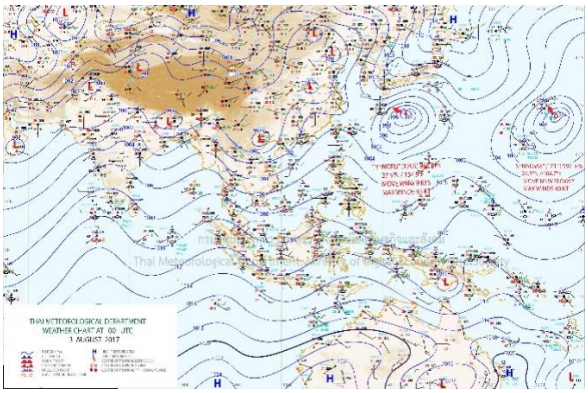


Figure 3.4-1 Weather chart on 03rd August 2017

3.4.2 Flash flooding in the northern provinces of Viet Nam, caused by ITCZ on 03 August 2017.

The MRCFFG system detected several areas in northern parts of Viet Nam would possibly occur flash flood event in those areas (see figure 3.4-3 and table 3.4-1)

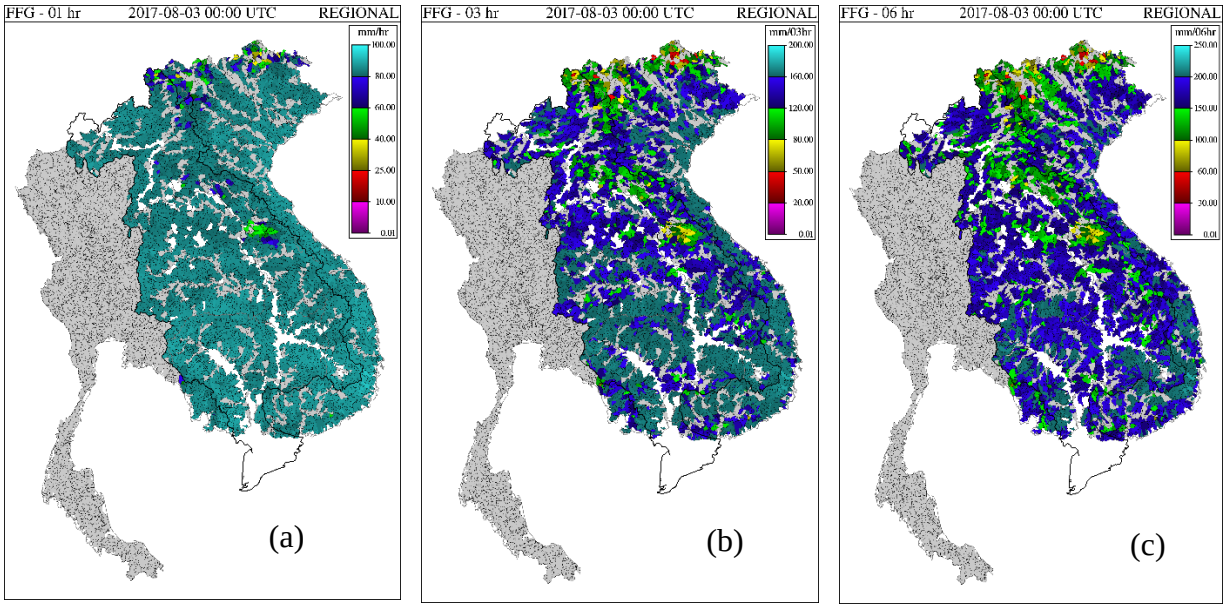


Figure 3.4-3: Flash flood rick areas detected by MRCFFGS on 03rd August 2017 (a) FFG 01h, (b) FFG 03h and (c) FFG 06h

Table 3.4.1: Flash flood risk areas detected by MRCFFG in Viet Nam on 03 August 2017 at 00UTC (07: 00 AM Local time)

Date of FFG products	03/08/2017 00:00	UTC time

1hour Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value

3hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG Value
Cao Bang	Hoa An	47.01
Lai Chau	Muong Te	45.12
Ha Giang	Xin Man	46.02
Tuyen Quang	Na Hang	48.56
Bac Kan	Ba Be	41.06
Ha Giang	Bac Me	33.78
Ha Giang	Bac Me	39.27
Cao Bang	Bao Lac	48.39
Bac Kan	Ba Be	45.86
Lai Chau	Dien Bien	49.63

6hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG Value
Cao Bang	Hoa An	55.43
Lai Chau	Muong Te	54.72
Ha Giang	Xin Man	55.62
Tuyen Quang	Na Hang	58.95
Bac Kan	Ba Be	50.34
Ha Giang	Bac Me	42.76
Ha Giang	Bac Me	48.04
Cao Bang	Bao Lac	58.79
Bac Kan	Ba Be	55.96
Bac Kan	TX. Bac Kan	59.54
Lai Chau	Dien Bien	59.31

3.4.3 Conclusion

1. The ITCZ is factor effected the flash flood in the northern part of Viet Nam.
2. The MRCFFGS detected this flash flood event on both time and space in Mu Cang Chai district of Lai Chau Province (see annex 4)

3.5 Flash flooding in the Lower Mekong Basin on 15 October 2017, caused by Tropical Depression.

3.5.1 Weather condition during the period 09th – 16th October 2017

Early on October 9, a tropical depression formed to the west of the Philippines and moved northwestward over South China Sea, on 10 October 2017, Tropical Depression made landfall in north central part of Vietnam and then continued moving through central part of Lao PDR on 11 October 2017 (see figure 3.5-1).

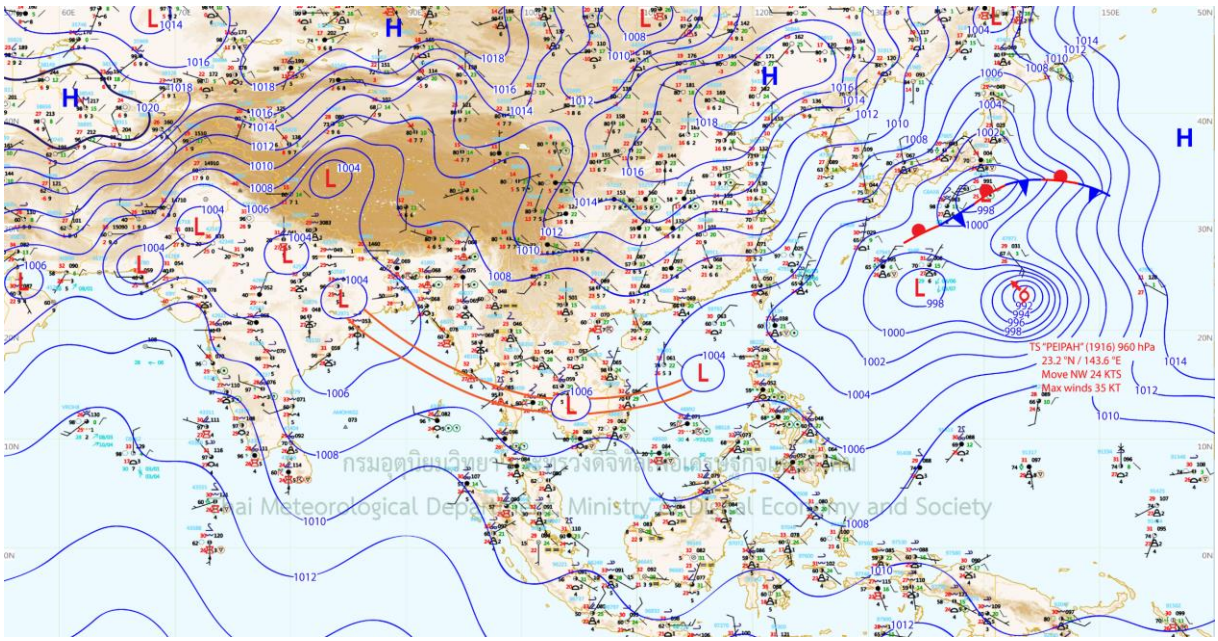


Figure 3.5-1: Weather chart on 16 October 2017

(Source: Thai Meteorological Department – TMD)

3.5.2 Heavy rainfall during the period 09th – 16th October 2017, caused by Tropical Depression

Although the flood season 2017 nearly completed; at this time which the rainfall in the Lower Mekong Basin will decrease significantly, but during the period 09th – 16th October 2017, the LBM was influenced by tropical Depression, it caused the heavy rain in some areas Laos PRD. heavy rainfalls were recorded in the middle and lower reaches of LMB; such as the maximum accumulated rainfalls were at Luang Prabang (119.8 mm.), Neak Luong (119.9 mm.) and Tan Chau (99.9 mm.) (see figure 3.5-2).

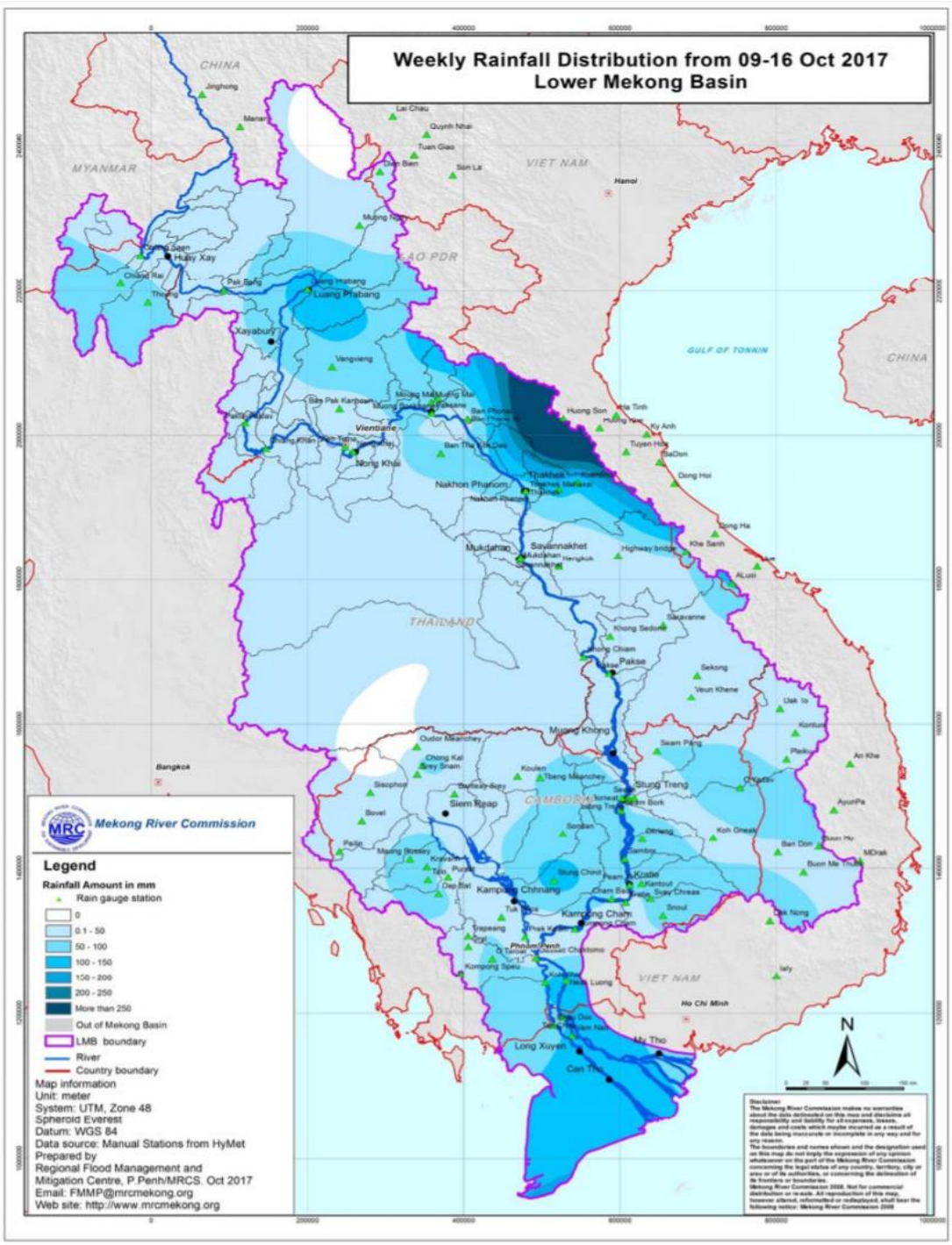
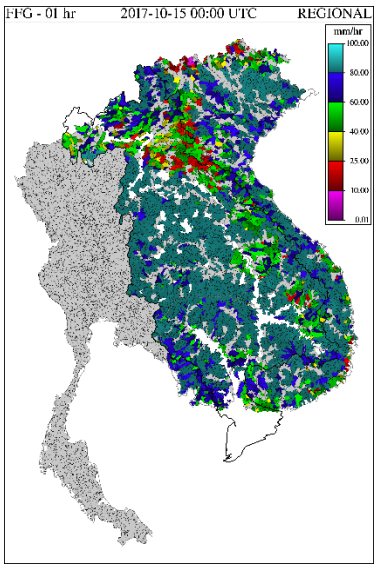
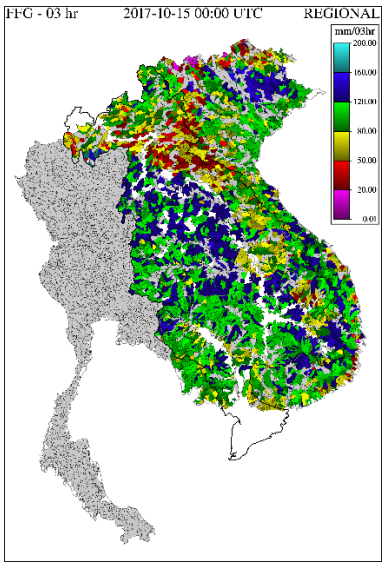
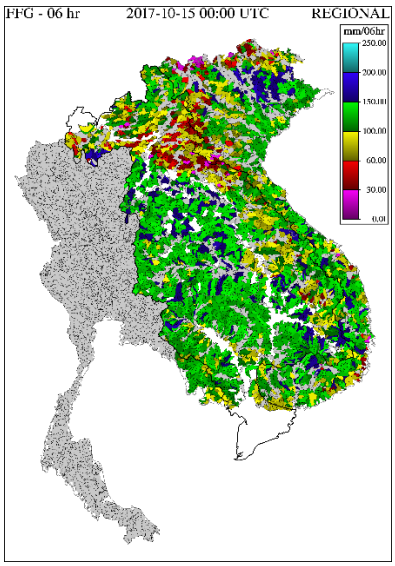


Figure 3.5-2: Weekly rainfall distribution from 17th – 24th July 2017 in the LMB.

3.5.3 Flash flooding in the LBM caused by tropical depression on 15th October 2017







Date of FFG products	15/10/2017 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
Hoa Binh	Ky Son	20.91	Kon Tum	Ngoc Hoi	42.22	Kon Tum	Ngoc Hoi	51.81
Gia Lai	Ia Grai	23.18	Nghe An	Tuong Duong	46.42	Nghe An	Tuong Duong	55.32
Gia Lai	Ia Grai	23	Hoa Binh	Ky Son	28.68	Hoa Binh	Ky Son	37.13
Quang Nam	Dai Loc	17.56	Gia Lai	Ia Grai	31.09	Gia Lai	Ia Grai	39.96
Quang Nam	Que Son	14.81	Gia Lai	Ia Grai	31.01	Gia Lai	Ia Grai	39.63
Quang Ngai	Minh Long	22.83	Quang Nam	Dai Loc	23.78	Quang Nam	Dai Loc	30.89
Gia Lai	Kong Chro	23.6	Quang Nam	Que Son	20.88	Quang Nam	Que Son	27.3
Khanh Hoa	Van Ninh	14.38	Quang Ngai	Tra Bong	34.14	Quang Ngai	Tra Bong	43.9
Khanh Hoa	Ninh Hoa	13.64	Quang Ngai	Tra Bong	34.03	Quang Ngai	Tra Bong	43.73
Khanh Hoa	Khanh Son	21.62	Quang Ngai	Minh Long	30.88	Quang Ngai	Minh Long	40
Khanh Hoa	Cam Ranh	24.28	Binh Dinh	Phu My	49.33	Gia Lai	Kong Chro	40.74
Ninh Thuan	Ninh Son	17.6	Phu Yen	Dong Xuan	49.06	Phu Yen	Tuy Hoa	55.43
Ninh Thuan	Ninh Hai	17.01	Gia Lai	Kong Chro	31.87	Khanh Hoa	Van Ninh	27.76
Binh Thuan	Ham Thuan Nam	16.4	Phu Yen	Tuy Hoa	47.21	Khanh Hoa	Ninh Hoa	26.73
Binh Thuan	Ham Thuan Nam	18.42	Khanh Hoa	Van Ninh	20.96	Khanh Hoa	Ninh Hoa	56.85
Lam Dong	Bao Lam	12.51	Khanh Hoa	Ninh Hoa	19.89	Khanh Hoa	Khanh Son	39.67
Binh Thuan	Ham Thuan Nam	17.25	Khanh Hoa	Ninh Hoa	44.59	Khanh Hoa	Cam Ranh	44.41
Gia Lai	Chu Pah	17.53	Khanh Hoa	Khanh Son	30.3	Ninh Thuan	Ninh Son	33.87
Kon Tum	Sa Thay	19.74	Khanh Hoa	Cam Ranh	33.63	Ninh Thuan	Ninh Hai	33.3
Dak Lak	Dak Nong	10.32	Ninh Thuan	Ninh Son	25.24	Ninh Thuan	Ninh Phuoc	47.08
Cao Bang	Hoa An	15.18	Ninh Thuan	Ninh Hai	24.75	Binh Thuan	Tuy Phong	46.07
Lao Cai	Bat Xat	8.44	Ninh Thuan	Ninh Phuoc	36.43	Binh Thuan	Ham Thuan Nam	32.1
Lao Cai	Bat Xat	8.36	Binh Thuan	Tuy Phong	36.51	Binh Thuan	Ham Thuan Nam	35.88
Lao Cai	Bat Xat	23.45	Binh Thuan	Ham Thuan Nam	23.74	Binh Phuoc	Bu Dang	53.92
Lao Cai	Bao Thang	19.16	Binh Thuan	Ham Thuan Nam	26.67	Lam Dong	Bao Lam	23.71

Date of FFG products	15/10/2017 00:00	UTC 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
			Nan	King Amphoe Song K	36.43	Nan	King Amphoe S	45.06
			Phayao	Chiang Kham	46.67	Phayao	Chiang Kham	57
			Chiang Rai	Chiang Saen	42.4	Chiang Rai	Chiang Saen	52.15
			Phayao	Chiang Kham	40.41	Phayao	Chiang Kham	49.89
			Lampang	Ngao	41.04	Lampang	Ngao	50.53
			Chiang Ma	Fang	48.5	Chiang Mai	Fang	58.5
			Chiang Rai	Mae Suai	43.35	Chiang Rai	Mae Suai	53.03
			Chiang Rai	King Amphoe Mae La	34.05	Chiang Rai	King Amphoe M	43.17
			Chiang Rai	Mae Suai	46.87	Chiang Rai	Mae Suai	57.26
			Chiang Ma	King Amphoe Chaipa	43.28	Chiang Mai	King Amphoe C	52.98
			Chiang Rai	Wiang Pa Pao	44.85	Chiang Rai	Wiang Pa Pao	54.74
			Chiang Rai	Wiang Pa Pao	39.75	Chiang Rai	Wiang Pa Pao	48.72

Date of FFG products	15/10/2017 00:00	UTC time						
1hour Flash Flood Guidance in Lao			**3hours Flash Flood Guidance in Lao**			**6hours Flash Flood Guidance in Lao**		
Provinces	Districts, Vilagies	FFG value	Provinces	Districts, Vilagies	FFG value	Provinces	Districts, Vilagies	FFG value
Attapeu	Phouvong	22.07	Attapeu	Phouvong	30.28	Attapeu	Phouvong	38.99
Xaysomboun Special Region	Thathom	16.05	Xaysomboun Special Region	Thathom	21.92	Xaysomboun Special Region	Thathom	28.68
Savannakhet	Phine	21.82	Saravane	Ta oi	36.41	Saravane	Ta oi	45.95
Xaysomboun Special Region	Thathom	14.64	Savannakhet	Phine	29.78	Savannakhet	Phine	38.72
Xaysomboun Special Region	Thathom	20.2	Xaysomboun Special Region	Thathom	20.13	Xaysomboun Special Region	Thathom	26.4
Bolikhamxay	Bolikhanh	20.7	Xaysomboun Special Region	Thathom	27.72	Xaysomboun Special Region	Thathom	35.57
Bolikhamxay	Viengthon	19.91	Xaysomboun Special Region	Thathom	34.08	Xaysomboun Special Region	Thathom	43.23
Bolikhamxay	Viengthon	22.01	Bolikhamxay	Bolikhanh	28.37	Bolikhamxay	Bolikhanh	36.64
Bolikhamxay	Viengthon	18.62	Bolikhamxay	Viengthon	27.5	Bolikhamxay	Viengthon	35.46
Bolikhamxay	Viengthon	15.57	Bolikhamxay	Viengthon	49.12	Bolikhamxay	Viengthon	38.88
Bolikhamxay	Viengthon	20.27	Bolikhamxay	Viengthon	48.67	Bolikhamxay	Viengthon	33.71
Bolikhamxay	Viengthon	20.89	Bolikhamxay	Viengthon	30.07	Bolikhamxay	Viengthon	28.01
Bolikhamxay	Viengthon	21.96	Bolikhamxay	Viengthon	25.69	Bolikhamxay	Viengthon	36.06
Bolikhamxay	Viengthon	21.83	Bolikhamxay	Viengthon	21.38	Bolikhamxay	Viengthon	37.3
Bolikhamxay	Viengthon	16.08	Bolikhamxay	Viengthon	27.76	Bolikhamxay	Viengthon	38.97
Bolikhamxay	Khamkheut	22.31	Bolikhamxay	Viengthon	28.9	Bolikhamxay	Viengthon	38.59
Khammuane	Nakai	23.82	Bolikhamxay	Viengthon	30.08	Bolikhamxay	Viengthon	28.66
Bolikhamxay	Thaphabat	16.03	Bolikhamxay	Viengthon	29.93	Bolikhamxay	Khamkheut	39.48
Xiengkhuang	Souy	23.6	Bolikhamxay	Viengthon	21.97	Bolikhamxay	Khamkheut	58.92
Xaysomboun Special Region	Xaysombou	16.57	Bolikhamxay	Khamkheut	30.55	Khammuane	Nakai	41.38
Xiengkhuang	Khoune	15.29	Bolikhamxay	Khamkheut	49.31	Bolikhamxay	Thaphabat	28.34
Xaysomboun Special Region	Thathom	18.25	Khammuane	Nakai	32.28	Xiengkhuang	Souy	40.64
Xaysomboun Special Region	Thathom	18.12	Bolikhamxay	Thaphabat	21.79	Xaysomboun Special Region	Xaysombou	29.1
Xaysomboun Special Region	Xaysombou	19.58	Xiengkhuang	Souy	31.82	Xiengkhuang	Khoune	28
Xaysomboun Special Region	Thathom	22.66	Xaysomboun Special Region	Xaysombou	22.45	Xaysomboun Special Region	Thathom	31.5
Bolikhamxay	Bolikhanh	23.89	Xiengkhuang	Khoune	21.51	Xaysomboun Special Region	Thathom	32.41
Xaysomboun Special Region	Phoun	21.27	Xaysomboun Special Region	Thathom	24.5	Xaysomboun Special Region	Xaysombou	33.02
Xiengkhuang	Phookood	23.7	Xaysomboun Special Region	Thathom	25.04	Xaysomboun Special Region	Xaysombou	47.11

Date of FFG products	15/10/2017 00:00	UTC time						
1hour Flash Flood Guidance in Cambodia			**3hours Flash Flood Guidance in Cambodia**			**6hours Flash Flood Guidance in Cambodia**		
Provinces	Districts, Vilagies	FFG value	Provinces	Districts, Vilag	FFG value	Provinces	Districts, Vilagie	FFG value
Ratana Kiri	Ta Veaeng	19.37	Ratana Kiri	Ta Veaeng	26.58	Ratana Kiri	Ta Veaeng	34.33
Ratana Kiri	Ta Veaeng	20.61	Ratana Kiri	Ta Veaeng	28.18	Ratana Kiri	Ta Veaeng	36.42
Ratana Kiri	Andoung Meas	21.6	Ratana Kiri	Andoung Mea	29.23	Ratana Kiri	Andoung Meas	37.38
Ratana Kiri	Veun Sai	22.16	Ratana Kiri	Veun Sai	30.05	Ratana Kiri	Veun Sai	38.64

3.5.4 Conclusion

4. Conclusion and Recommendations

The current report is seventh evaluation report of MRC Flash Flood Guidance (MRC-FFG) system after 8 years of operation. Although this evaluation report does not cover all of the flash flooding that occurred in 2017 flood season (from 01 June to 15 December 2016), it is based on the available flash flood information that was collected from newspaper of four riparian countries.

The other alternative evaluation method is to compare the flash flood risk areas detected by the MRCFFG system with changing water levels downstream of these areas. This method has been used in this report. However these do not fully reflect the flash flood characteristics, because the available water level and rainfall data in the operational database of the RFMMC are recorded two times per day at 07:00 AM and 07:00 PM, while the flash flood mostly occur within a 6 hourly period.

Notwithstanding this, it can be concluded that the MRC-FFG system during the severe weather condition in the region, such as tropical storms, tropical depressions or ITCZ, and low pressure, detected almost all flash flood risk areas in the Mekong region. There were only a few flash flood events that could not be detected by the system. Based on the experiences hitherto a number of recommendations are presented below, which are considered useful for further fine-tuning of MRC-FFG products during the 2017 flood season implementation:

1. Improve the Mean Aerial Precipitation (MAP) product by updating the bias correction factor for satellite rainfall (Hydroestimator) processing.
2. After updating the bias correction factor for satellite rainfall processing, the MRC- FFG operator should rerun the FFG system and check the results with the available flash flood information.
3. Update the GIS provincial administration database. The current GIS information (provincial administrative database, villages, districts and provincial name) was collected from national line agencies in 2003. It may be concluded that this information does not reflect the real condition, as some countries in the region recently revised provincial boundaries.
4. According to the information from the newspaper, flooding occurred also in many districts under flash flood risk level 2 (yellow color scale). It is recommended that the MRC-FFG operator should also provide the flash flood watch list for districts that are under the risk level 2 (yellow color scale).
5. The current MRC FFG system did not have a short time forecast rainfall which should be useful for the FFG operator to decide for the warning on the flash

flood for next 3 or 6 hours. The new improved MRC FFG system by HRC will be include the short time forecast rainfall for next 3-6-12-24 hours , this new version of FFG system plan to install in MRC/RFMMC in the next flood season . It is recommended that MRC is needed for close cooperation with HRC to accelerate the process of installation the new version of the MRC FFG system.

6. Strengthen the connection between the RFMMC and the National FFG operations for the region in order to receive additional information about areas where flash floods occurred. Such information will improve the present FFG evaluation report. Establish the connection between RFMMC staff (FFG operators) and the National Flood Expert, who working at the National line agencies under the FMMP's contract, for collection the flash flood information from each country.
7. Conduct Refreshment Training Courses of FFG system operation in combination with the Annual Flash Flood Gathering with the purpose: a) to improve the knowledge on FFG operation, b) to introduce the new tool for FFG operation, and c) to exchange the experiences between National Center's and the RFMMC operators.
8. The MRC-FFG operator should develop, in close cooperation with the GIS expert of Technical Division, an additional tool for the identification of Mekong sub-catchments, where flash floods occurred, as well as the location of hydrological stations in those sub-catchments, where rising water levels may have been recorded. If possible this tool should be connected "real time" with the FFG website.
9. Update the MRC-FFG information on the MRC webpage three times during daytime with 6 hourly intervals, at 07:00 AM, 01:00 PM and at 07:00 PM. During severe weather conditions such as tropical storms, tropical depressions, ITCZ etc. flash floods can occur at any time in any area of the LMB.

ANNEXES A - Newspapers

Annex 1 Flash flooding in the northern part of Lao PDR, caused by low pressure on 9 July 2017

Annex 2 Flash flooding in the northern part of Lao PDR, caused by low pressure on 9 July 2017

One dead, 5 missing as coal freighter overturned by storm Talas in central Vietnam

Tuesday, 07/18/2017, 11:41

A coal freighter docked at a beach in north-central Nghe An Province was overturned by storm Talas on July 16, leaving one dead and five still missing.

Vietnamese cargo ship VTB 26 was docked at Hon Ngu beach in Nghe An's Cua Lo District on Sunday evening to take shelter from storm Talas when it slipped its mooring and was overturned.

Tropical storm Talas, which had grown from a tropical depression in the East Vietnam Sea, hit the north-central region of Vietnam on Sunday evening, bringing about heavy rain and strong winds across the provinces of Nghe An and Thanh Hoa.

There were reportedly 13 people aboard the VTB 26 at the time of accident, including 12 crewmen and one employee of the coal company that had boarded the ship to escort the shipment.

As of 11:30 am on Monday, response teams had been able to rescue seven people and found one dead body suspected to be one of the crew members, while five others remain missing.

Dinh Viet Hong, deputy chairman of Nghe An, told *Tuoi Tre* (Youth) newspaper on Monday that the province had put together a command headed by the provincial Border Guards to carry out a search and rescue mission for the missing people.

According to Truong Duc Nghia, chief of office of the National Committee for Search and Rescue, the cargo ship VTB 26 had been transporting over 4,700 metric tons of coal from northern Quang Ninh Province to Cua Lo District before taking shelter from the storm.

Though distress signals were sent out by two other ships that spotted the VTB 26 slipping its mooring on Sunday evening, no rescue mission was immediately possible due to the fierce storm, said Vuong Binh Minh, director of the Port Authority of Nghe An.

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- Working together to secure a green nation
- Vietnam chosen as host of ASEAN People's Forum 2020
- Cases of hand-foot-mouth disease rise sharply in HCM City

Annex 3 Flash flooding in norther part in Viet Nam on 03 August 2017, caused by ITCZ

Vietnam – at Least 12 Killed in Flash Floods and Landslides in North

4 AUGUST, 2017 BY RICHARD DAVIES IN ASIA, NEWS

Flash floods and landslides triggered by heavy rains have killed at least 12 people in northern Vietnam according to reports by Vietnam's Central Steering Committee for Natural Disaster Prevention and Control (CCNDPC).

Rain has been falling over the last few days in Vietnam's northern mountainous provinces. The rain was particularly heavy from 02 to 03 August, where several locations recorded more than 100 mm in 24 hours.

Flash flooding occurred in Mu Chang Chai district in Yen Bai Province and Muong La district, Son La Province. Landslides have also been reported in these areas, as well as in Nam-Ho Dien Bien district in Lai Chau Province.

Son La Province

According to a CCNDPC report of 04 August, flash floods and landslides in Muong La district of Son La Province have killed 10 people, with 6 others missing and 4 injured.

The floods occurred after the Da River (Black River) and smaller streams in the district overflowed.

The total number of houses damaged was 258 houses, of which 179 houses were swept away or completely destroyed.

Roads in the district have been blocked, isolating several communities. A 3 km long stretch of a provincial road was washed away.

More than 2,500 people, including military and police teams, have been mobilised for search and rescue operations in the affected areas.

Yen Bai Province

CCNDPC reported on 03 August that 2 people had died in Mu Chang Chai district in Yen Bai, and a further 12 people were missing and 9 injured.

Flash floods washed away 29 houses and 25 were damaged or destroyed by landslides.

Lai Chau Province

CCNDPC say that at least person was killed, 3 injured and 2 are missing after landslides in Lai Chau Province.

Rainfall

Vietnam's northern mountainous provinces have seen heavy rain since 01 August. Figures below from reports by CCNDPC for 24 hour rainfall totals, 02 to 03 August 2017.

Lai Chau Province

Muong Te – 135mm

Nam Bum – 121mm

Son La Province

Ta Bom 172mm

Muong La – 118 mm

Xie Yang – 159 mm

Yen Bai Province

Mu Cang Chai 78mm

Khau Phia – 145 mm

Ban An – 83 mm

Prompt actions requested to deal with flood aftermath

Saturday, 2017-08-05 12:02:36 A Font Size: − | + Print

Hua Nam village, Nam Pham commune, Muong La district (Son La province) suffers heavy losses due to floods. (Credit: NDO)

A Font Size: − | +

NDO/VNA – Prime Minister Nguyen Xuan Phuc has ordered the authorities of the northern mountainous provinces, along with the relevant agencies and ministries, to augment their efforts in response to the torrential rains and floods that have wreaked havoc in the region over the last few days.

>>> Deputy PM urges for readiness in response to natural disasters

Widespread heavy rains have been reported across the mountainous and midland provinces in northern Vietnam. Flash floods and landslides in a number of areas have caused heavy human and property losses, especially in the Muong La district of Son La province and Mu Cang Chai district of Yen Bai province.

In his written order, the PM requested that the provincial People's Committees, particularly of Yen Bai and Son La, continue capitalising on local forces to search for missing people and address the flood consequences, evacuate residents from flood and landslide prone areas, whilst ensuring food supply for locals.

The National Committee for Search and Rescue, the Ministry of Defence and the Ministry of Public Security were told to deploy their local forces to assist in the search and rescue activities and help localities overcome flood consequences.

Annex 4 Flash flooding in the Lao PRD, caused by Tropical storm “SONCA” on 25 July 2017

31 Jul 2017

Lao PDR, Flooding in several Provinces

REPORT from ASEAN Coordinating Centre for Humanitarian Assistance

Published on 25 Jul 2017 — View Original

Description

The high rainfall intensity, enhanced by the Tropical Storm (TS) "Sonca", has triggered flooding in Province of Saravan, Champassak, Xekong, Xayaboury, Borikhamxay. Savannakhet and Attapeu.

In Xayaboury Province, two people were died and one person was reportedly injured after flash flood hit Kaenthao District. About 89 houses were affected by the incident.

Meanwhile in Borikhamxay Province, the flood has severely affected 43 villages in Khamkeuth District. About 900 families were reportedly affected and one person was died because of the flood. The flood also submerged at least 559 ha of crops and rice fields.

The TS "Sonca" which brought heavy rain since 25 July, has also triggered flooding in Champassak Province where 628 families in 14 villages of Pakxe District had been affected so as 13,5 ha of rice field.The local authority has evacuated 47 families to temporary shelter.

In Savannakhet, 245 families in eight villages of Xayphouthong District and 451 ha of rice fields were reportedly affected.

Meanwhile in Xekong Province, more than 10 families were affected in Lamam District.

Further, 30 villages and 1,511 ha of rice field in Vapy District, Saravan Province were flooded.

The flood also inundated hectares of agriculture areas in Sanamxay District, Attapeu Province.

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Lao PDR, Flooding in several Provinces

VERIFIED

01:00 Jul 25 2017 Bolikhamsai, Laos

Flood Storm

Description

The high rainfall intensity, enhanced by the Tropical Storm (TS) "Sonca", has triggered flooding in Province of Saravan, Champassak, Xekong, Xayaboury, Borikhamxay. Savannakhet and Attapeu.

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Further, 30 villages and 1,511 ha of rice field in Vapy District, Saravan Province were flooded.

The flood also inundated hectares of agriculture areas in Sanamxay District, Attapeu Province.

Additional Data

Country: Laos

Affected Area / Region: Saravan, Champassak, Xekong, Xayaboury, Borikhamxay. Savannakhet and Attapeu.

Casualties

Death: 3

Affected Families: 1872

Displaced Persons: 188

Damages

Annex 4 Flash flooding in the Viet Nam, caused by Tropical storm "SONCA" on 25 July 2017

Viet Nam News > Society

Storm Sonca to cause heavy rains in north and north central VN

Update: July, 24/2017 - 17:40

The latest image of Storm Sonca (or Storm No 4). — Source: The National Hydro-meteorological Forecast Centre

Viet Nam News HÀ NỘI — Tropical Storm Sonca, the fourth to hit Việt Nam this year, is forecast to make landfall in central and northcentral Việt Nam on Tuesday night and early Wednesday morning, according to the National Hydro-meteorological Forecast Centre.

According to the centre, the storm has hardly moved in the past 24 hours. At 4am on Monday, the typhoon location was about 150km southeast of Hainan (China).

The strongest winds near the typhoon centre reach the speed of 60km-75km per hour.

In the next 24 to 48 hours, the storm is forecast to make landfall from Thanh Hóa to Quảng Bình provinces before weakening into a tropical depression.

From tomorrow, coastal areas from Thanh Hóa to Quảng Binh will have high waves of up to 2-3m and rough sea. These

SOCIETY

Last update 10:15 | 27/07/2017

Tropical storm Sonca causes damage across central region

Tropical storm Sonca, the fourth to strike the East Sea and third to hit Vietnam this year, has led to floods and extensive damage to agriculture, infrastructure and houses in central region.

After heavy rains hit central provinces from Thanh Hoa to Thua Thien-Hue on July 25, around 2,878 hectares of paddies in Thua Thien – Hue and Quang Tri were submerged.

It also caused a whirlwind in Ha Tinh, which injured two people and blew away roofs of 64 houses. The local damage has amounted to about 960 million VND (42,230 USD).

Relevant authorities have visited affected families and mobilised resources to help alleviate the storm impacts, particularly in search and rescue missions and fixing damaged facilities.

Last week, tropical storm Talas, the second of the season, killed at least eight people and damaged buildings and roads across northern and central regions. Weather forecasters have predicted a particularly stormy typhoon season this year, with 13-15 typhoons and tropical depressions expected to develop over the East Sea.

Floods kills 2 in northern Laos

Source: Xinhua | 2017-08-07 00:24:44 | Editor: Song Lifang

VIENTIANE, Aug. 6 (Xinhua) -- Two villagers were reportedly killed by flash flooding in northern Laos' Oudomxay province and many households severely impacted as heavy rain lashed multiple districts over the weekend, a senior provincial official said Sunday.

A heavy downpour from Friday midnight to Saturday morning caused a flash flood, paralyzing transport in Muang Xay, capital of the province, some 320 km north of Lao capital Vientiane.

Other districts affected by the floods included Nga and La districts, Director of Provincial Labor and Social Welfare Department Somfong Sengchanthala told Vientiane Times on Sunday.

"Xay district was most severely affected. It was the heaviest impact by such a flood in the nine years since 2009," Somfong said.

Soldiers, rescue teams and authorities from various sectors are deployed for relief operations, including cleaning up after the destruction and repairing public facilities.

"Almost all public facilities in Xay district, the electricity, roads and other facilities, have largely returned to their normal modes of operation," Somfong said on Sunday. "It was a flash flood impacting because of the mountainous terrain. The flood just lasted for a short period."

The flash flood reportedly killed two people, the director said.

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 raingauge 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)
.	.	.	.	.
PFFT	Persistence Flash Flood Threat	Text & Images	00, 06, 12 & 18 UTC	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.

				For example, the 6-hr PFFT at 12:00 UTC = 06-hr MAP from 12:00 UTC - 06-hr FFG from 12:00 UTC
				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 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
				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.
				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)

Bulletin of Flash Flood Guidance On 21 July 2017 at 00:00 UTC (07:00AM Local time)

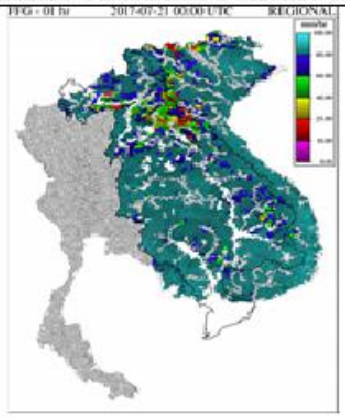


Figure 1: 01 hourly of Flash Flood Guidance (FFG) values on 21 July 2017 at 00:00 UTC (07:00 local time).
01 hourly shows high-risk flash flood occurrence at Laos, Thailand and Vietnam.

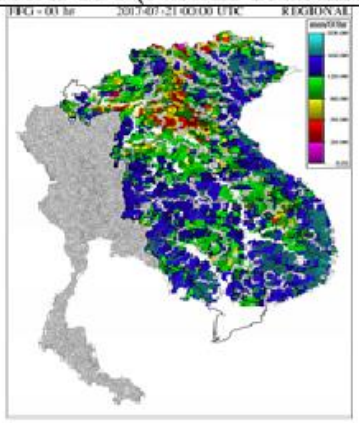


Figure 2: 03 hourly Flash Flood Guidance (FFG) on 21 July 2017 at 00:00 UTC (07:00 local time).
03 hourly shows high-risk flash flood occurrence at Laos, Thailand, Cambodia and Vietnam.

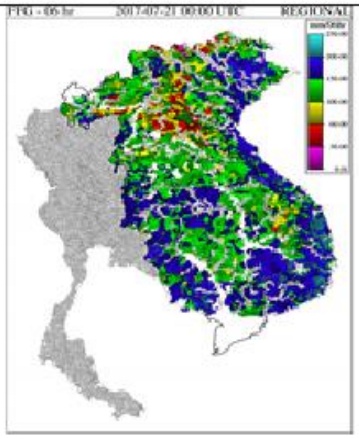


Figure 3: 06 hourly Flash Flood Guidance 21 July 2017 at 00:00 UTC (07:00 local time).

06 hourly shows high-risk flash flood occurrence at Laos, Thailand, Cambodia and Vietnam.

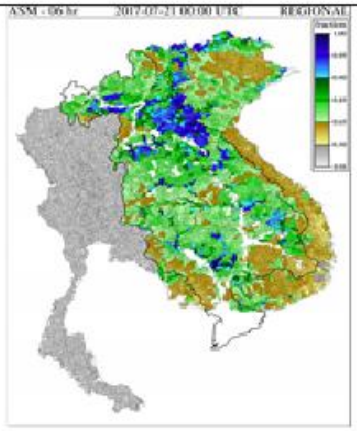


Figure 4: 06 hourly Average Soil Moisture (ASM) condition (upper soil zone) up to 21 July 2017 at 00:00 UTC (07:00 local time).
06 hourly ASM shows that the soil moistures at some areas of Lower Mekong Basin.

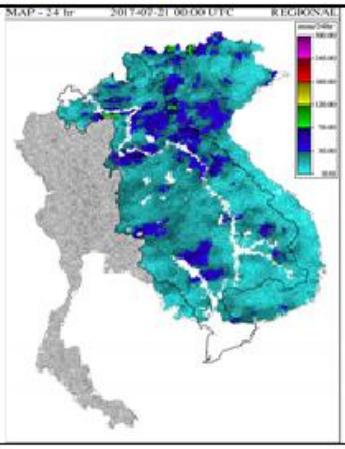


Figure 5: 24 hourly Mean Areal Precipitation (MAP) from 00:00 UTC on 20 June 2017 to 00:00 UTC (07:00 local time) on 21 July 2017.

24 hourly MAP shows that there is heavy rain occurred at some areas in Lower Mekong Basin and north of Vietnam.

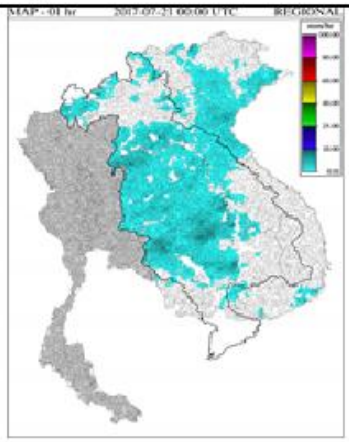


Figure 6: The last 01 hour of Mean Areal Precipitation (MAP) at 00:00 UTC (07:00 local time) on 21 July 2017.

01 hourly MAP shows that there is heavy rain occurred in Lower Mekong Basin.

Annex B3: Template of FFG bulletin (Excel format for 04 countries)

Date of FFG products	21/07/2017 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
Lao Cai	Bat Xat	14.29	Kon Tum	Ngoc Hoi	49.23	Kon Tum	Ngoc Hoi	59.45
Lao Cai	Than Uyen	20.04	Nghe An	Tuong Duong	44.47	Nghe An	Tuong Duong	54.08
Lai Chau	Phong Tho	19.24	Hoa Binh	Ky Son	35.53	Hoa Binh	Ky Son	44.86
Lao Cai	Than Uyen	14.09	Lao Cai	Bat Xat	18.87	Cao Bang	Hoa An	58.59
Lai Chau	Phong Tho	20.42	Lao Cai	Bat Xat	41.31	Lao Cai	Bat Xat	23.8
Lai Chau	Phong Tho	19	Lao Cai	Bat Xat	37.59	Lao Cai	Bat Xat	48.88
Lao Cai	Bat Xat	15.08	Lao Cai	Bao Thang	37.02	Lao Cai	Bat Xat	44.41
Lai Chau	Phong Tho	24.94	Lao Cai	Bao Thang	39.96	Lao Cai	Bao Thang	46.88
Lao Cai	Bao Yen	24.07	Lao Cai	Than Uyen	26.35	Lao Cai	Bao Thang	50.66
Lao Cai	Bac Ha	24.92	Lai Chau	Phong Tho	24.33	Lao Cai	Than Uyen	33.54
Hoa Binh	Ky Son	23.6	Lao Cai	Than Uyen	18.79	Lai Chau	Phong Tho	29.92
			Lai Chau	Sin Ho	34.84	Lao Cai	Than Uyen	23.94
			Lai Chau	Sin Ho	49.79	Lai Chau	Sin Ho	43.52
			Lai Chau	Phong Tho	27.03	Lai Chau	Phong Tho	33.88
			Lai Chau	Phong Tho	25.4	Lai Chau	Phong Tho	32.67
			Lao Cai	Bat Xat	19.79	Lao Cai	Bat Xat	24.96
			Lai Chau	Phong Tho	30.94	Lai Chau	Phong Tho	37.39
			Lai Chau	Muong Te	37.02	Lai Chau	Muong Te	45.83
			Lai Chau	Muong Te	35.77	Lai Chau	Muong Te	44.28
			Son La	Mai Son	43.33	Son La	Mai Son	52.97
			Lao Cai	Bao Yen	32.15	Lao Cai	Bao Yen	40.82
			Ha Giang	Xin Man	34.4	Ha Giang	Xin Man	42.77
			Lao Cai	Bac Ha	32.34	Lao Cai	Bac Ha	40.85
			Lao Cai	Bao Yen	42.93	Lao Cai	Bao Yen	52.43
			Ha Giang	Vi Xuyen	47.79	Ha Giang	Vi Xuyen	57.52
			Ha Giang	Bac Me	47.62	Ha Giang	Bac Me	57.07
			Lao Cai	Bao Yen	42.07	Lao Cai	Bao Yen	50.99
			Bac Kan	TX. Bac Kan	46.88	Bac Kan	TX. Bac Kan	55.92
			Son La	Song Ma	47.15	Son La	Song Ma	57.75
			Son La	Song Ma	33.14	Son La	Song Ma	42.25
			Son La	Song Ma	46.6	Son La	Song Ma	56.86
			Son La	Song Ma	41.06	Son La	Song Ma	50.46
			Son La	Song Ma	35.38	Son La	Song Ma	44.29
			Son La	Song Ma	33.64	Son La	Song Ma	42.41
			Hoa Binh	Ky Son	31.23	Hoa Binh	Ky Son	40.01
			Hoa Binh	Ky Son	33.79	Hoa Binh	Ky Son	43.23

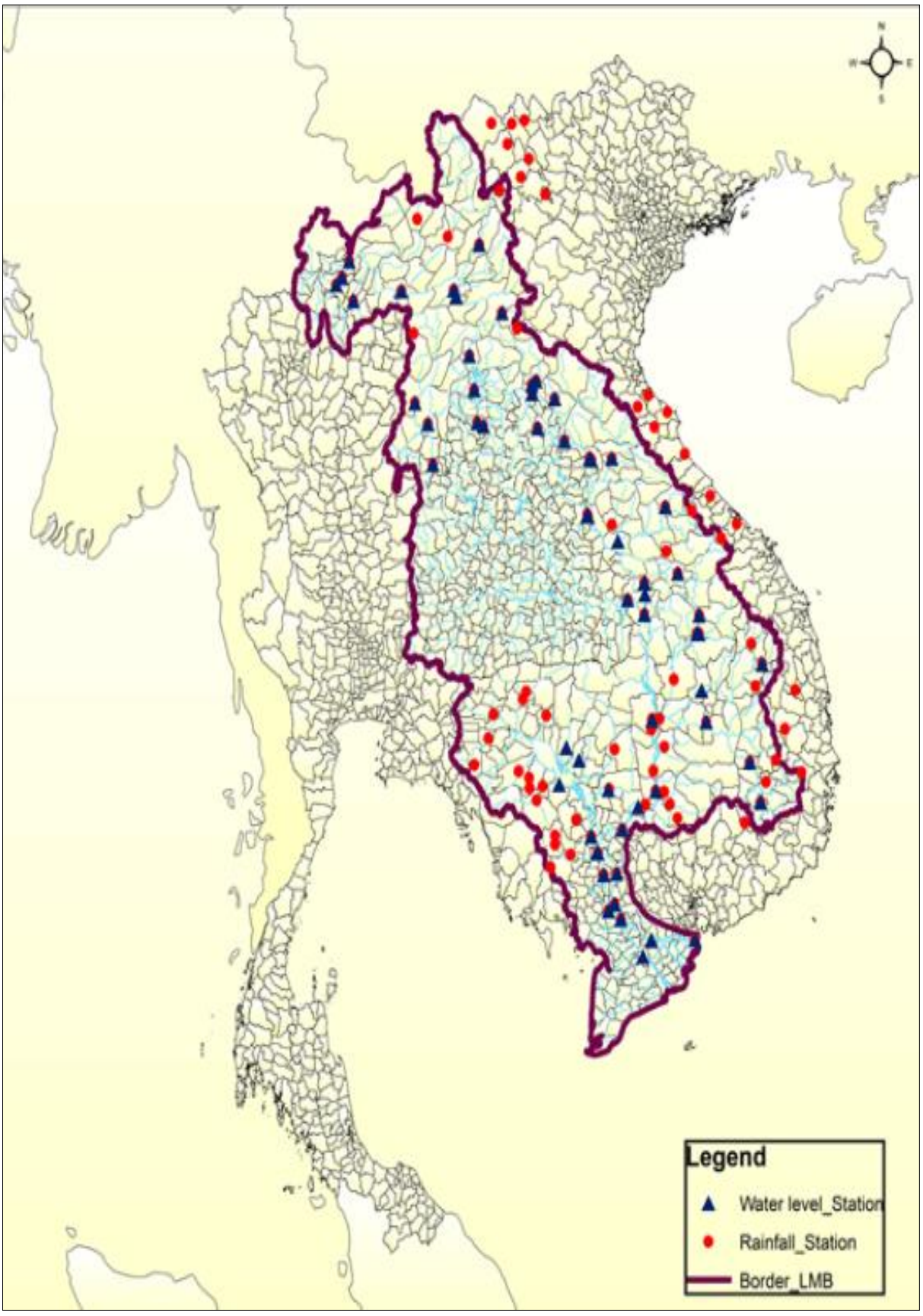
Date of FFG products	21/07/2017 00:00	UTC time						
1hour Flash Flood Guidance in Thailand			**3hours Flash Flood Guidance in Thailand**			**6hours Flash Flood Guidance in Thailand**		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Nan	King Amphoe Song Kha	23.89	Nan	King Amphoe Song K	31.79	Nan	King Amphoe S	40.4
			Udon Thani	Na Yung	36.4	Udon Thani	Na Yung	46.08
			Phayao	Chiang Kham	46.1	Phayao	Chiang Kham	56.53

Date of FFG products	21/07/2017 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
Xaysomboun Special Region	Thathom	19.6	Attapeu	Phouvong	46.61	Attapeu	Phouvong	56.5
Xaysomboun Special Region	Thathom	20.04	Xaysomboun Special Region	Thathom	26.28	Xaysomboun Special Region	Thathom	33.99
Bolikhamxay	Bolikhanh	23.54	Xaysomboun Special Region	Thathom	26.56	Xaysomboun Special Region	Thathom	34.03
Bolikhamxay	Viengthon	21.41	Xaysomboun Special Region	Thathom	42.35	Xaysomboun Special Region	Thathom	51.43
Bolikhamxay	Viengthon	15.68	Xaysomboun Special Region	Thathom	36.47	Xaysomboun Special Region	Thathom	46.19
Bolikhamxay	Viengthon	21.89	Bolikhamxay	Bolikhanh	31.67	Bolikhamxay	Boliikhanh	40.49
Bolikhamxay	Viengthon	22.62	Bolikhamxay	Viengthon	34.47	Bolikhamxay	Viengthon	43.26
Bolikhamxay	Viengthon	20.06	Bolikhamxay	Viengthon	37.33	Bolikhamxay	Viengthon	47.17
Bolikhamxay	Thaphabat	21.05	Bolikhamxay	Viengthon	29.12	Bolikhamxay	Viengthon	37.91
Xiengkhuang	Khoune	22.4	Bolikhamxay	Viengthon	21.87	Bolikhamxay	Viengthon	29.01
Xaysomboun Special Region	Thathom	23.98	Bolikhamxay	Viengthon	39.74	Bolikhamxay	Viengthon	49.59
Xaysomboun Special Region	Xaysombou	22.59	Bolikhamxay	Viengthon	30.34	Bolikhamxay	Viengthon	39.35
Vientiane	Keo oudom	24.2	Bolikhamxay	Viengthon	31.07	Bolikhamxay	Viengthon	40.23
Xayaboury	Hongsa	24.69	Bolikhamxay	Viengthon	26.96	Bolikhamxay	Viengthon	34.89
Huaphanh	Viengthon	24.76	Bolikhamxay	Khamkheut	41.78	Bolikhamxay	Khamkheut	51.8
Huaphanh	Huameuang	19.15	Bolikhamxay	Thaphabat	27.65	Bolikhamxay	Thaphabat	35.16
Xiengkhuang	Phookood	23.28	Xiengkhuang	Souy	45.68	Xiengkhuang	Souy	55.99
Bolikhamxay	Pakkading	23.11	Xaysomboun Special Region	Xaysombou	32.57	Xaysomboun Special Region	Xaysombou	40.78
Xayaboury	Ngeun	22.98	Xiengkhuang	Khoune	29.06	Xiengkhuang	Khoune	36.07
Xayaboury	Hongsa	24.48	Xaysomboun Special Region	Thathom	31.15	Xaysomboun Special Region	Thathom	39.21
Bokeo	Pha Oudo	24.39	Xaysomboun Special Region	Thathom	44.18	Xaysomboun Special Region	Thathom	53.26
Bokeo	Pha Oudo	24.96	Xaysomboun Special Region	Xaysombou	33.45	Xaysomboun Special Region	Xaysombou	41.71
Xiengkhuang	Kham	20.41	Xaysomboun Special Region	Xaysombou	42.93	Xaysomboun Special Region	Xaysombou	53.03
Huaphanh	Huameuang	22.97	Xaysomboun Special Region	Thathom	35.74	Xaysomboun Special Region	Thathom	45.31
Xiengkhuang	Nonghed	24.42	Bolikhamxay	Bolikhanh	33.47	Bolikhamxay	Bolikhanh	42.8
Xiengkhuang	Morkmay	19.13	Xaysomboun Special Region	Phoun	43.83	Xaysomboun Special Region	Phoun	54.05
Xiengkhuang	Morkmay	20.24	Vientiane	Vangvieng	50	Vientiane	Vangvieng	59.96
Xiengkhuang	Morkmay	18.98	Xaysomboun Special Region	Phoun	39.75	Xaysomboun Special Region	Phoun	49.2
Xiengkhuang	Morkmay	20.43	Xaysomboun Special Region	Phoun	36.44	Xaysomboun Special Region	Phoun	45.44
			Xiengkhuang	Phookood	40.86	Xiengkhuang	Phookood	50.82
			Xaysomboun Special Region	Xaysombou	38.38	Xaysomboun Special Region	Xaysombou	47.62
			Xaysomboun Special Region	Xaysombou	33.56	Xaysomboun Special Region	Xaysombou	41.89
			Xaysomboun Special Region	Xaysombou	29.58	Xaysomboun Special Region	Xaysombou	37.58
			Xaysomboun Special Region	Xaysombou	38.07	Xaysomboun Special Region	Xaysombou	47.05
			Xaysomboun Special Region	Xaysombou	39.04	Xaysomboun Special Region	Xaysombou	48.36
			Vientiane	Keo oudom	32.11	Vientiane	Keo oudom	40.8
			Vientiane	Vangvieng	33.56	Vientiane	Vangvieng	41.89
			Vientiane	Kasy	45.26	Vientiane	Kasy	54.73
			Xayaboury	Hongsa	32.59	Xayaboury	Hongsa	41.58
			Luangprabang	Ngoi	49.55	Luangprabang	Ngoi	59.67
			Huaphanh	Viengthon	44.8	Huaphanh	Viengthon	54.23
			Huaphanh	Viengthon	39.62	Huaphanh	Viengthon	48.82
			Luangprabang	Phonxay	38.32	Luangprabang	Phonxay	47.67
			Luangprabang	Phonxay	44.53	Luangprabang	Phonxay	55.05
			Luangprabang	Nan	35.32	Luangprabang	Nan	44
			Huaphanh	Viengthon	34.66	Huaphanh	Viengthon	43.6
			Huaphanh	Viengthon	33.76	Huaphanh	Viengthon	43.44
			Huaphanh	Huameuang	26.71	Huaphanh	Huameuang	35.2
			Xiengkhuang	Phookood	38.99	Xiengkhuang	Phookood	49.04
			Xiengkhuang	Phookood	30.51	Xiengkhuang	Phookood	38.71
			Xiengkhuang	Phookood	35.63	Xiengkhuang	Phookood	45.22
			Xiengkhuang	Phookood	41.61	Xiengkhuang	Phookood	51.69
			Luangprabang	Phoukhoun	38.01	Luangprabang	Phoukhoun	47.05
			Luangprabang	Phoukhoun	41.68	Luangprabang	Phoukhoun	51.65
			Vientiane	Kasy	33.66	Vientiane	Kasy	42.54
			Bolikhamxay	Pakkading	30.31	Bolikhamxay	Pakkading	38.56
			Bolikhamxay	Pakkading	39.73	Bolikhamxay	Pakkading	49.88
			Khammuane	Hinboon	48.53	Khammuane	Hinboon	58.46
			Champasak	Pathoomph	39.23	Champasak	Pathoomph	48.35
			Xayaboury	Ngeun	30.7	Xayaboury	Ngeun	39.39
			Xayaboury	Hongsa	32.75	Xayaboury	Hongsa	41.89
			Xayaboury	Xienghon	34.6	Xayaboury	Xienghon	44.21
			Xayaboury	Khop	44.6	Xayaboury	Khop	54.81
			Bokeo	Pha Oudo	32.48	Bokeo	Pha Oudo	41.48
			Bokeo	Pha Oudo	33.48	Bokeo	Pha Oudo	42.74
			Bokeo	Pha Oudo	35.58	Bokeo	Pha Oudo	44.65
			Oudomxay	Pakbeng	49.64	Oudomxay	Pakbeng	59.89
			Huaphanh	Viengthon	40.65	Huaphanh	Viengthon	50.53
			Huaphanh	Viengthon	42.73	Huaphanh	Viengthon	52.24
			Huaphanh	Viengthon	47.45	Huaphanh	Viengthon	57.55
			Huaphanh	Huameuang	35.9	Huaphanh	Huameuang	44.94
			Xiengkhuang	Kham	43.94	Xiengkhuang	Kham	54.4
			Xiengkhuang	Kham	27.81	Xiengkhuang	Kham	36.07
			Huaphanh	Huameuang	35.37	Huaphanh	Huameuang	44.28
			Huaphanh	Huameuang	30.65	Huaphanh	Huameuang	39.17
			Xiengkhuang	Kham	35.06	Xiengkhuang	Kham	44.12
			Xiengkhuang	Nonghed	47.09	Xiengkhuang	Nonghed	57.87
			Xiengkhuang	Pek	43.9	Xiengkhuang	Pek	54.43
			Xiengkhuang	Pek	48.45	Xiengkhuang	Pek	58.93
			Xiengkhuang	Nonghed	32.86	Xiengkhuang	Nonghed	42.11
			Xiengkhuang	Morkmay	25.56	Xiengkhuang	Morkmay	32.96
			Xiengkhuang	Morkmay	27.89	Xiengkhuang	Morkmay	36.04
			Huaphanh	Viengthon	35.48	Huaphanh	Viengthon	44.75
			Xiengkhuang	Morkmay	25.45	Xiengkhuang	Morkmay	32.79
			Xiengkhuang	Morkmay	27.28	Xiengkhuang	Morkmay	34.98

Date of FFG products	21/07/2017 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 Veaeng	42.05	Ratana Kiri	Ta Veaeng	51.07
			Ratana Kiri	Ta Veaeng	44.87	Ratana Kiri	Ta Veaeng	54.48
			Ratana Kiri	Veun Sai	44.55	Ratana Kiri	Veun Sai	54.25

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%A9t-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 waring 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