

## **Mekong River Commission**

**Technical Support Division** 

## **Evaluation Report on Flash Flood Guidance System for**

Flood Season 2016

(1<sup>st</sup> June – 31<sup>st</sup> December 2016)

Draft





Prepared by Regional Flood Management and Mitigation Center January 2017



## Certification of Approval of Internal FMMP Technical Document

Evaluation Report on Flash Flood Guidance System for Flood Season 2016  $(1^{st}$  June –  $31^{st}$  December 2015)

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### 1. Background Information

To respond to regional and national needs and in order to address the problems of flash floods in each MRC Member Country of the Mekong River Commission (MRC), the MRC and the Hydrological Research Centre (HRC) in San Diego, California, USA, with the financial support from the Office of US Foreign Disaster Assistance (OFDA) of the US Agency for International Development (USAID) have jointly implemented flash-flood mitigation in Cambodia, Lao PDR, Thailand and Viet Nam under the MRC Flood Management and Mitigation Programme (FMMP).

In late 2009 the computational and dissemination servers for the MRC-FFG system were installed at MRC's 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. A five-day MRC-FFG system in-depth regional training course, combined with hands-on operation, and a three-day national training course were successfully organised in 2010. Presently the MRC-FFG system is put in an operational testing mode in order to fine-tuning as well as to gain further experience.

During the 2010 flood season the Flash Flood Guidance System (FFG SYSTEM) has been operating successfully. Reference is made to the records of tropical storms and records of tropical depressions.

During the 2013 flood season the flood forecasting team of RFMMC continued operating the Flash Flood Guidance System; the information received from FFG System was processed, updated and posted in the MRC flood forecasting webpage in parallel with the river flood forecast. During the severe weather condition in the 2013 flood season, such as tropical storm "BEBINCAN", "RUMBIA", "JEBI", "MANGKHUT", "WUTIP" and the Inter Tropical Conversion Zone (ITCZ), the MRC-FFG system did detect very clearly the flash flood risk areas in some villages and districts of the four MRC Member Countries. During the 2014 flood season the flood forecasting team of RFMMC continued operating the Flash Flood Guidance System. The MRC-FFG system detected very clearly the flash flood risk areas in some villages and districts of the LMB during the severe weather condition of flood season 2014 such as Tropical storm "RAMMASUN", "KALMAEGI", "SINLAKU", "HAGUPIT" and several ITCZ and low pressure. During the flood season 2015 the MRC FFG system was continued to operated and it was successful detected several flash flood even during the severe weather condition such as tropical storms "KIJURA", "VAM CO", several ITCZ, and Low Pressure. In March 2012 the first evaluation report on MRC-FFG system has been produced, to evaluate the performance of FFG system for period from May until 31 October 2011.

The present evaluation report is a seventh evaluation report of MRC-FFG system, it produced to evaluate the performance of FFG System for the detection of the risk areas of potential flash floods in villages and districts in Cambodia, Lao PDR, Thailand and Viet Nam during the flood season from 01 June until 15 December 2016.

### 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. 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.

The second concept evaluates the FFG System through the recorded water levels that are available in the operational database of RFMMC. 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. The annex 2B 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

There were 40 tropical storms and tropical depression which developed over the Pacific Ocean or over the East Sea (also South China Sea) during 2016 (data up to 15 December 2016); four to five of them caused serious flash floods, affected the 4 MRC Member Countries of Lower Mekong Basin. Figure 3-1 presents the track of the tropical storm during the year 2016. List of the tropical storm and depression happened in the North-West Pacific for flood season 2016 is provided in the annex 1B of this report.

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. Figure 3-2 presents an example of weather chart during the ITCZ occurrence in Mekong region. The next paragraphs describe examples of flash floods, which occurred at some tributaries during the severe weather condition of the 2016 flood season.

At least 12 flash floods has been occurred at the Mekong region during the flood season 2016, especially for the areas of the Viet Nam and Lao PDR. August 2016 was a month where the flash flood has been seriously occurred in the LMB region. Figure 3-3 present the calendar date recorded the flash flood occurred in the LMB region.



Figure 3-1 The tropical Storm Track during the year 2016, Source: UNISYS.



Source: Thai Meteorological Department





Figure 3-3 Calendar date of flash flood recorded in the LMB

# 3.1 Flash flooding in the northern part of Lao PDR, caused by low pressure during 23 July 2016

### 3.1.1 Weather condition during the third week of July

The whole third week of July, from 21 to 23, the Lower Mekong Basin was covered by low pressure, which laid across upper Thailand to northern part of Viet Nam via the central and northern parts of Lao PDR. During this period, some areas of central and northern parts of Lao PDR, eastern part of Thailand, central and northern parts of Viet Nam, were covered by the heavy rain. Figure 3.1-1 and Figure 3.1-2 present the weather chart of Mekong region during the third week of July 2016. Figure 3.1-3 present the Infrared Image, MTSAT IR, at 23.00 UTC on July 21, 2016.





Source: TMD Figure 3.1-1

-1 Weather chart issued at 18:00 UTC on 21 July 2016.

Source: TMD Figure 3.1-2 W

Weather chart issued at 18:00 UTC on 23 June 2016.



Source: Japan Meteorological Agency Figure 3.1-3 Infrared Image, MTSAT IR, at 23.00 UTC on July 21, 2016

### 3.1.2 Heavy rainfall during the period 21-24 July 2014

From 20 to 24 July 2016 the Central and Northern Provinces of Lao PDR were covered by a low pressure cell, which caused heavy rainfall. Within 24 hours, the accumulated rainfall at some hydrological stations, located in the Bolikhamxay and Xiengkhuan Provinces raised up to 100 mm. Figure 3.1-4 to Figure 3.1-7 show accumulated rainfall of hydro-meteorological stations located in Bolikhamxay and Xiengkhuang provinces from 20 to 24 July 2016. Figure 3.1-8 to Figure 3.1-9 present the 24 hours accumulated rainfall from Hydroestimator (satellite rainfall estimated).







Figure 3.1-6 Accumulated rainfall at Phiengluang Station.

Figure 3.1-5 Accumulated rainfall at Moung Mai Station.



Figure 3.1-7 Accumulated rainfall at Chiang Saen Station.



### 3.1.3 Flash flooding in the Central and Southern Provinces of Lao PDR

On 22 July 2016 at 00:00 UTC (07:00 local time) the MRC-FFG system detected that some areas covering villages in the Northern Provinces of Lao PDR, such as Bokeo and Xayaboury Provinces, were at risk of flash flood occurrence. Figure 3.1-10 presents the 3 hourly FFG value at some areas of Central Provinces of Lao PDR.

The information on flash flood risk areas that was detected by the MRC-FFG system on 22 July 2016 at 00:00 UTC was confirmed by the information published in the Lao PDR newspaper "Vientiane Times" on 26 July 2016, which informed that on evening of 23 July 2016 flash flood has been occurred in some areas in Xayaboury Province. Some flash flood risk areas that detected by the FFG system on 22 July 2016 at 00:00 UTC corresponded with the reported flash flood areas. Table 3.1-1 show the list of the flash flood risk villages detected by MRC FFG system on 22 July 2016 at 00:00 UTC the Information from the "Vientiane Time" newspaper provided in the annex A of this report.



Figure 3.1-10 Flash flood risk areas detected by MRC-RFMMC-FFG system on 22 July 2016.

Table 3.1-1	Flash flood risk	village de	tected by MRC	-FFG system	on 22 July 20	16 at 00UTC
		0	2		<i>.</i>	

Date of FFG produ	22/07/	2016 00:00	UTC time				
1hou	1hour Flash Flood Guidance in Lao 3hour Flash Flood Guidan			uidance in Lao			
Provinces	Districts	Villages	FFG Value	Provinces	Districts	Villages	FFG Value
No Risk Areas	to Flash Fl	Occurence		Bokeo	Pha Oudo	KANG	44.96
				Bokeo	Pha Oudo	MOKPORN	44.96
				Bokeo	Pha Oudo	MOKSOUK	44.96
				Bokeo	Pha Oudo	MOKKHA KANG	44.96
				Bokeo	Pha Oudo	SIBOUNHEUAN	44.96
				Bokeo	Pha Oudo	PHA OU DOM	44.96
				Bokeo	Pha Oudo	THINKEO NEUA	44.96
				Xayaboury	Xienghon	MOK SA KIEN	45.09
				Xayaboury	Xienghon	HONG KHOU	45.09
				Xayaboury	Xienghon	KEW KENE	45.09
				Xayaboury	Xienghon	NGEW	45.09
				Xayaboury	Xienghon	NAM BENG	45.09
				Xayaboury	Xienghon	LAO OU	45.09
				Xayaboury	Xienghon	LAO SA NO	45.09

## **3.1.4** Impacts of low pressure weather to the water levels in some tributaries of the Mekong River Basin

Heavy rainfall occurred at some Mekong sub-catchments located in central and northern parts of Lao PDR during the low pressure period, which led to a quick increase of water level at some tributaries of Nam San, Nam Ngiep sub-catchments on 22 - 24 July 2016. And also water level at some stations located in the mainstream of the Mekong at the northern part of Lao PDR has been remarkably increased. For example, in the hydrological station Pak Ben, the water level increased from 8.12 m at 7:00 AM on 25 July to 12.15 m at 7:00 PM of 25 July 2016, while at the hydrological station Paklay in the Mekong mainstream the water level started to increase from 4.85 m at 07:00 PM on 24 July 2016. Figure 3.1-11 to Figure 3.1-12 present the hydrograph at some hydrological stations of the Mekong tributaries.



Figure 3.1-11 Hydrograph at hydrological stations of Mekong tributaries in Lao PDR during the low pressure period from 22 to 25 July 2016.



Figure 3.1-12 Hydrograph at hydrological stations of Mekong mainstream in Lao PDR during the low pressure period from 22 to 25 July 2016.

#### 3.1.5 Conclusions

- 1. During the third week of July from 21 to 24 July 2016, the Lower Mekong Basin was covered by low pressure, which laid across upper Thailand to the northern part of Viet Nam via the northern part of Lao PDR. During this period some areas of northern part of Lao PDR, and northern part of Viet Nam have been covered by heavy rainfall.
- 2. The daily rainfall at some hydro-meteorological stations located in the Bolikhamxay and Xayaboury Provinces of Lao PDR increased to levels of 100 mm.
- 3. Water levels at some hydrological stations of tributaries of the Nam Sane, Nam Ngiep sub-catchments increased about 3-4 m on the 23 to 25 July 2016.
- 4. On 22 July 2016 at 00:00 UTC (07:00 local time) the MRC-FFG system detected that some areas villages of the Northern Provinces of Lao PDR, such as Bokeo, Xayaboury provinces of Lao PDR, were at the risk of flash flood occurrence. The information on flash flood risk areas, detected by MRC-FFG system on 22 July 2016 at 00:00 UTC, was confirmed by the information published in the Lao PDR newspaper "Vientiane Times" on 26 July 2016. Some flash flood risk areas, detected by the FFG system on 22 July 2016 at 00:00 UTC, corresponded with the reported flash flood areas.

# 3.2 Flash flooding in the Northern Provinces of Viet Nam, caused by tropical storm "MIRINAE"

### 3.2.1 Weather condition during the third week of July 2016

"MIRINAE" formed as a tropical depression over the central part of the South China Sea about 300 km east of Xisha on the night of 25 July. Moving west-northwestwards, it intensified into a tropical storm the next morning. "MIRINAE" made landfall over the east coast of Hainan Island on the night of 26 July and weakened slightly while crossing Hainan Island. After entering Beibu Wan, "MIRINAE" re-organized and reintensified the next morning, becoming a severe tropical storm on the evening of 27 July and reaching peak intensity with an estimated sustained wind of 90 km/h near its centre. "MIRINAE" made landfall over the coast of northern Vietnam that night and weakened gradually. Tropical storm "MIRINAE" is the first tropical storm hit the Vietnam this year It finally dissipated over northern Vietnam on the evening of 28 July.

Figure 3.2-1 presents the position of tropical depression at the Pacific Ocean. The storm then moved in westerly direction.



Figure 3.2-1 Track of the tropical storm "MIRINAE". Source : ECHO

#### 3.2.2 Rainfall during the period of tropical storm "MIRINAE"

During the period from 25 to 28 July 2014, when typhoon storm "MIRINAE" was active in the region, heavy rainfalls occurred at some areas in the northern part of Viet Nam, Figure 3.2-2 to Figure 3.2-3 present the daily accumulated rainfall at some stations located at the Northern Provinces of Viet Nam, where the daily rainfall during this period almost reached 50 to 70 mm per day. Figure 3.2-4 to Figure 3.2-5 present the 24 hours accumulated rainfall from Hydroestimator (satellite rainfall estimated)



Figure 3.2-2 Daily accumulated rainfall (in mm) at Mai Chau Station.

Figure 3.2-3 Daily accumulated rainfall (in mm) at Quang Nhai Station.



Figure 3.2-4 24 hourly satellite rainfall estimate from 00:00 UTC on 27 July to 00:00 UTC on 28 July 2016.



Figure 3.2-5 24 hourly satellite rainfall estimate from 00:00 UTC on 28 July to 00:00 UTC on 29 July 2016.

## 3.2.3 Flash flooding in the Northern Provinces of Viet Nam, caused by tropical storm "MIRINAE"

From 28 July 2016 at 00:00 UTC (07:00 AM of 28 July 2016 local time) the MRC-FFG System detected only two districts of the Nghe An Province in the northern part of Viet Nam were at the risk of flash flood occurrence. But according to the information published in newspaper, that the tropical storm "MIRINAE" cause a serious flash flood in some provinces in the coastal areas of the northern part of Viet Nam, such as Nam Dinh, Ninh Binh, Thai Binh, on morning of 28 July 2016, That mean the MRC FFG system did not well to detect the flash flood during the tropical storm "MIRINAE" fist storm of the LMB region. The primary investigation of this problem we found that calculation of soil moisture model of the MRC FFG system during the tropical storm "MIRINAE" was not correct. Figure 3.2-6 presents the 3 hour flash flood risk areas at some districts of the Northern Provinces of Viet Nam. Figure 3.2-7 and Figure 3.2-8 presents map of Average soil moisture condition calculated by the MRC FFG system on 27 July 2016 at 18:00 UTC and on 28 July 2016 at 00:00 UTC, where show the soil condition in the northern part of Viet Nam calculated by Model simulation was very dry.



Figure 3.2-6 Flash flood risk areas detected by MRC-RFMMC-FFG (3 hour FFG) system on 28 July 2016.



Figure 3.2-7 6 hour Average soil Moisture condition (ASM) of Model calculation of MRC FFG system on 27 July 2016 at 18:00 UTC



### 3.2.4 Conclusions

- 1. The tropical storm "MIRINAE" is the fourth storm of the year 2016, which was also the first storm that hit Viet Nam, and caused a serious damage to the Northern Provinces of Viet Nam.
- 2. Many rainfall stations, located in the northern part of Viet Nam, recorded moderate rainfall during the period that TS "MIRINAE" hit the Mekong Region. Some of those rainfall stations recorded an amount of daily rainfall up to 70 and 100 mm.
- 3. On 28 July 2016 at 00:00 UTC the MRC-FFG System detected two districts in Nghe An Province of northern part of Viet Nam were at the risk of flash flood occurrences, but the flash flood has been occurrence in other provinces of the coastal areas of the northern part of Viet Nam when the tropical storm "MIRINAE" landed, The primary investigation show that the miss detection of MRC FFG system was cause by insufficient of the Soil moisture estimation by model.
- 4. It is suggested that the model parameter for calculation of soil moisture condition should be review, and recalibrated.

# 3.3 Flash flooding in the Northern Provinces of Viet Nam, caused by tropical storm "NIDA"

### 3.3.1 Weather condition during the first week of August 2016

During July 28, a tropical depression developed about 1,020 km (635 mi) to the eastsoutheast of Manila in the Philippines. Over the next day as the system moved northnorthwestwards under the influence of a subtropical ridge of high pressure, deep convection started wrapping into the system's low level circulation center. On July 31, NIDA made landfall over the area between Baggao and Gattaran of the Cagayan Province in the Philippines at 13:20 <u>PST</u> (05:20 <u>UTC</u>) as a severe tropical storm. At 03:35 CST on August 2 (19:35 UTC on August 1), NIDA made landfall over Dapeng Peninsula of Shenzhen, Guangdong, China as a severe tropical storm. Then the NIDA system was transform to the tropical depression on 3 August 2016 at border of Guangxi and Guizhou Province of China. Figure 3.3-1 presents the position of tropical storm "NIDA" at the Pacific Ocean. The storm then moved in westerly direction to China.



Figure 3.3-1 Track of the tropical storm "NIDA". Source: ECHO

### 3.3.2 Rainfall during the period of tropical storm "NIDA"

During the period from 03 to 05 August 2016, when typhoon storm "NIDA" was active and transformed to the tropical depression cell at the southern part of China, heavy rainfalls occurred at some areas in the northern part of Viet Nam, Figure 3.3-2 to Figure 3.3-5 present the daily accumulated rainfall at some stations located at the Northern Provinces of Viet Nam, where the daily rainfall during this period almost reached 60 to 100 mm per day. Figure 3.3-6 and Figure 3.3-7 present the 24 hours accumulated rainfall from Hydroestimator (satellite rainfall estimated).



Figure 3.3-2 Daily accumulated rainfall (in mm) at Moung Te Station in Lai Chau Province.



Figure 3.3-3 Daily accumulated rainfall (in mm) at Sin Ho Station in Lai Chau Province.



Figure 3.3-4 Daily accumulated rainfall (in mm) at Quynh Nhai Station in Son La Province.



Figure 3.3-5 Daily accumulated rainfall (in mm) at Tam Duong Station Hao Binh Province



## **3.3.3** Flash flooding in the Northern Provinces of Viet Nam, caused by tropical storm "NIDA"

From 03 August 2016 at 06:00 UTC (01:00 PM of 03 August 2016 local time) the MRC-FFG System detected many districts of the Lao Cai, Bac Kan, Lai Chau Provinces in the northern part of Viet Nam were at the risk of flash flood occurrence. Figure 3.3-8 present the 3 hour flash flood risk areas at some districts of Northern Provinces of Viet Nam detected on 03 August 2016 at 06:00 UTC. This area was extend to other provinces on 04 August 2016 at 00:00 UTC, the Figure 3.3-9 present the location of 3 hours flash flood risk areas on 04 August 2016 at 00:00 UTC. The information on flash flood areas detected by MRC FFG system on 03 August and 04 August 2016 was confirmed by Viet Nam newspaper on "Viet Nam New "on Saturday 06 August 2016. This information also provided in the annex A of this report.



Figure 3.3-8 Flash flood risk areas detected by MRC-RFMMC-FFG (3 hour FFG) system on 03 August 2016 at 06:00 UTC.





Table 3.3-1List of Flash flood risk areas detected by MRC- FFG on 03 August 2016 at 06:00UTC

Date of FFG products	3 03/08/2016 06:00 UTC time					
1hour Flash Flood Guidance in Vietnam				<b>3hours Flash Flood Guidance in Vietnam</b>		
Provinces	Districts	FFG value		Provinces	Districts	FFG Value
Lao Cai	Bat Xat	13.39		Lao Cai	Bat Xat	36.09
Bac Kan	TX. Bac Kan	14.89		Lao Cai	Sa Pa	49.04
Bac Kan	Bach Thong	14.89		Lao Cai	Than Uyen	49.04
Lai Chau	Phong Tho	13.39		Bac Kan	TX. Bac Kan	21.36
				Bac Kan	Bach Thong	21.36
				Lai Chau	Phong Tho	37.06
				Dak Lak	Dak R'Lap	47.03
				Dak Lak	Dak Nong	47.03
				Lam Dong	Bao Lam	47.03
Date of FFG products	04/08/2016 00:00	UTC time				
----------------------	-----------------------	-----------	--	--------------	-----------	
1hour Flash	Flood Guidance in Vie	etnam	3hours Flash Flood Guidance in Vietnam			
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	
Ha Giang	Xin Man	21.03	Ha Giang	Meo Vac	39.08	
Cao Bang	Bao Lac	23.17	Ha Giang	Yen Minh	41.55	
Cao Bang	Nguyen Binh	23.17	Ha Giang	Quan Ba	33.86	
Lao Cai	Bat Xat	12.80	Ha Giang	Bac Me	41.55	
Lao Cai	Bac Ha	21.03	Ha Giang	Hoang Su Phi	43.79	
Lao Cai	Sa Pa	16.03	Ha Giang	Vi Xuyen	43.98	
Lao Cai	Than Uyen	16.03	Ha Giang	Xin Man	39.87	
Bac Kan	Ba Be	23.17	Ha Giang	Bac Quang	47.66	
Lai Chau	Phong Tho	15.04	Cao Bang	Bao Lac	39.63	
Dak Lak	Dak Nong	13.70	Cao Bang	Nguyen Binh	31.10	
			Lao Cai	Bat Xat	22.33	
			Lao Cai	Bac Ha	37.87	
			Lao Cai	Sa Pa	33.98	
			Lao Cai	Bao Yen	47.66	
			Lao Cai	Than Uyen	20.89	
			Bac Kan	TX. Bac Kan	36.79	
			Bac Kan	Ba Be	40.49	
			Bac Kan	Bach Thong	36.79	
			Tuyen Quang	Na Hang	49.87	
			Lai Chau	Phong Tho	25.54	
			Dak Lak	Dak R'Lap	49.82	
			Dak Lak	Dak Nong	34.54	
			Lam Dong	Bao Lam	42.87	

Table 3.3-2List of Flash flood risk areas detected by MRC- FFG on 06 August 2016 at 00:00UTC

#### 3.3.4 Conclusions

- 1. The tropical storm "NIDA" is the fifth storm of the year 2016, which has been hit the southern part of China (out site of the LMB region), but it still effected to some areas in the Northern Provinces of Viet Nam.
- 2. Many rainfall stations, located in the northern part of Viet Nam, recorded moderate to heavy rainfall during the period that TS "NIDA" hit the southern part of China and transformed to the tropical depression cell. Some of those rainfall stations recorded an amount of daily rainfall up to 60 and 100 mm.
- 3. On 03 August 2016 at 06:00 UTC the MRC-FFG System detected many districts in some provinces of northern part of Viet Nam were at the risk of flash flood occurrences
- 4. Information from the newspaper indicated that flash flood was occurred on 05 August 2016 at the same district that has been detected by the MRC FFG system on 03 August 2016 at 06:00 UTC (13:00 local time), and also on 04 August 2016 at 00:00 UTC (see information on annex A).

### 3.4 Flash flooding in Bokeo Province in Lao PDR, Northern Provinces of Viet Nam, caused by ITCZ on 12-15 August 2016

#### 3.4.1 Weather situation on the second week of August 2016

During August 10 to August 15, the Inter Tropical Convergence Zone (ITCZ) continue lying across Myanmar, the upper North of Thailand and the North of Viet Nam while the Westerly wind prevails over Andaman Sea, the Gulf of Thailand, South of Thailand and South of Indochina Peninsular. More rain and heavy rain was occurred in Myanmar, the upper South, the East, the Central and the Northeast of Thailand, the Southwest Coastal areas of Cambodia, the Lower Mekong Basin, the upper South and the Central and the North of Lao PDR, the North of Viet Nam during 10 to 15 August 2016. Figure 3.4-1 and Figure 3.4-2 present the weather chart of the LMB region where ITCZ was cover this region for the hold second week of August.



Figure 3.4-1 Weather chart of the Mekong region during the 11 August 2016 at 01:00AM local time.

Figure 3.4-2 Weather chart of the Mekong region during the 15 August 2016 at 01:00AM local time.

#### 3.4.2 Rainfall on the second week of August 2016

During second week of August, some provinces of northern part of Lao PDR were covered by heavy rainfall, especially at Luang Prabang, Bokeo, Xayaboury, Borikhamxai, Xiengkhuang Provinces. The daily rainfall on that period at those abovementioned provinces reached from 100 to 120 mm. The heavy rainfall also was observed at some rainfall stations located in Northern Provinces of Viet Nam. Figure 3.4-3 to Figure 3.4-14 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Viet Nam and Lao PDR during the second week of August 2016. Figure 3.4-15 to Figure 3.4-18 present the 24 hours

accumulated satellite rainfall estimated for 10 to 13 August 2016, where show that northern part of Lower Mekong Region was covered by the heavy rain.











Figure 3.4-5 Accumulated rainfall at Moung Mai Station of Borikhamxai Province.







Figure 3.4-6 Accumulated rainfall at Moung Borikhan Station of Borikhamxai Province.



Figure 3.4-8 Accumulated rainfall at Ban Phienluang Station of Xieng Khuang Province.



Figure 3.4-9 Accumulated rainfall at Dien Bien Station of Lai Chau Province.



Figure 3.4-11 Accumulated rainfall at Son La Station of SonLa Province



Figure 3.4-13 Accumulated rainfall at Pha Din Station of Lai Chau Province



Figure 3.4-10 Accumulated rainfall at Quynh Nhai Station of Son La Province.



Figure 3.4-12 Accumulated rainfall at Mai Chau Station of Thanh Hao Province



Figure 3.4-14 Accumulated rainfall at Tuan Giao Station of Lai Chau Province



Figure 3.4-15 24 hourly satellite rainfall estimate from 00:00 UTC on 10 August to 00:00 UTC on 11 August 2016.



Figure 3.4-16 24 hourly satellite rainfall estimate from 00:00 UTC on 11August to 00:00 UTC on 12 August 2016.



Figure 3.4-17 24 hourly satellite rainfall estimate from 00:00 UTC on 12 August to 00:00 UTC on 13 August 2016.



Figure 3.4-18 24 hourly satellite rainfall estimate from 00:00 UTC on 13 August to 00:00 UTC on 14 August 2016.

#### 3.4.3 Flash flooding in Lao Cai Province of Viet Nam, caused by ITCZ

On 12 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at Lao Cai, Ha Giang, Lai Chau Provinces of northern part of Viet Nam. Figure 3.4-19 presents the 3 hourly flash flood risk areas in the Northern Provinces of Viet Nam on12 August 2016 at 00:00 UTC, Lao Cai, Bat Xat, Sa Pa districts in Lao Cai Province were the high risk districts. The detection of the flash flood risk areas by the MRC FFG system on 14 August 2016 at 00: 00 UTC, was extended to other districts and provinces of the northern part of the Viet Nam, (see Table 3.4-2). The Figure 3.4-20 present the 3 hour flash flood risk areas detected by MRC-FFG on 14 August 2015 at 00:00 UTC. This FFG detection has been verified by the available information from the online newspaper "Viet Nam plus" and "Viet Nam New", which informed that the flash flood had been occurred at Lao Cai and Lai Chau Province of Viet Nam on 14 August 2016.

This newspaper also provided in the annex A of this report.



Figure 3.4-19 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 12 August 2016 at 00:00 UTC.

Figure 3.4-20 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 August 2016 at 00:00 UTC.

Date of FFG prod	ducts 12/08/2016	00:00 UTC time				
1hour	1hour Flash Flood Guidance in Vietnam			3hours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	
Lao Cai	Bat Xat	17.30	Ha Giang	Yen Minh	45.47	
Lao Cai	Sa Pa	17.81	Ha Giang	Bac Me	45.47	
Lao Cai	Than Uyen	18.01	Ha Giang	Hoang Su Phi	42.32	
Lai Chau	Phong Tho	17.65	Ha Giang	Vi Xuyen	43.36	
			Ha Giang	Xin Man	39.98	
			Ha Giang	Bac Quang	42.89	
			Cao Bang	Bao Lac	45.47	
			Lao Cai	TX. Lao Cai	36.53	
			Lao Cai	Muong Khuong	46.44	
			Lao Cai	Bat Xat	25.83	
			Lao Cai	Bac Ha	41.34	
			Lao Cai	Bao Thang	46.44	
			Lao Cai	Sa Pa	26.50	
			Lao Cai	Bao Yen	43.24	
			Lao Cai	Than Uyen	23.60	
			Lai Chau	Muong Te	42.33	
			Lai Chau	Phong Tho	28.24	
			Lai Chau	Sin Ho	41.12	
			Lai Chau	Muong Lay	42.61	

Table 3.4-1	List of Flash flood risk areas detected by MRC- FFG on 12 August 2016 at 00:00
	UTC

Table 3.4-2	List of Flash flood risk areas detected by MRC- FFG on 14 August 2016 at 00:00
	UTC

Date of FFG produ	cts 14/08/2016 00:	00 UTC time				
1hour Flash Flood Guidance in Vietnam				Shours Flash Flood Guidance in Vietnam		
Provinces	Districts	FFG value	Pro	ovinces	Districts	FFG Value
Ha Giang	Dong Van	21.994	Ha	Giang	TX. Ha Giang	34.2
Ha Giang	Meo Vac	21.9567	Ha	Giang	Dong Van	29.674
Ha Giang	Yen Minh	20.33	Ha	Giang	Meo Vac	30.6375
Ha Giang	Quan Ba	22.522	Ha	Giang	Yen Minh	28.3933
Ha Giang	Bac Me	21.1433	Ha	Giang	Quan Ba	30.47
Ha Giang	Hoang Su Phi	22.4075	Ha	Giang	Bac Me	31.8357
Ha Giang	Vi Xuyen	21.3829	Ha	Giang	Hoang Su Phi	34.6286
Ha Giang	Xin Man	19.45	Ha	Giang	Vi Xuyen	31.4718
Ha Giang	Bac Quang	23.57	Ha	Giang	Xin Man	39.5167
Cao Bang	Bao Lac	21.8717	Ha	Giang	Bac Quang	38.1767
Cao Bang	Ha Quang	21.7	Ca	o Bang	Bao Lac	31.0422
Cao Bang	Thong Nong	21.7	Ca	o Bang	Ha Quang	28.94
Cao Bang	Nguyen Binh	22.43	Ca	o Bang	Thong Nong	31.22
Cao Bang	Hoa An	21.7	Ca	o Bang	Nguyen Binh	33.6575
Lao Cai	Bat Xat	17.1167	Ca	o Bang	Hoa An	31.22
Bac Kan	TX. Bac Kan	18.09	Lao	o Cai	Bat Xat	29.4367
Bac Kan	Ba Be	23.2467	La	o Cai	Sa Pa	41.31
Bac Kan	Bach Thong	18.09	La	o Cai	Than Uyen	40.56
Tuyen Quang	Na Hang	23.51	Ba	c Kan	TX. Bac Kan	24.8
Lai Chau	TX. Lai Chau	22.04	Ba	c Kan	Ba Be	35.7929
Lai Chau	Muong Te	20.1825	Ba	c Kan	Ngan Son	40.34
Lai Chau	Phong Tho	18.606	Ba	c Kan	Bach Thong	24.8
Lai Chau	Sin Ho	19.385	Tu	en Quang	Na Hang	36.5357
Lai Chau	Muong Lay	19.4	Tu	en Quang	Chiem Hoa	38.13
Lai Chau	Tuan Giao	15.7633	Lai	Chau	TX. Lai Chau	29.49
Lai Chau	Dien Bien	16.3063	Lai	Chau	Muong Te	33.5082
Lai Chau	Dien Bien Dong	16.535	Lai	Chau	Phong Tho	32.2855
Hoa Binh	Ky Son	17.4729	Lai	Chau	Sin Ho	31.6117
Nghe An	Tuong Duong	17.4267	Lai	Chau	Muong Lay	28.16
Nghe An	Con Cuong	20.14	Lai	Chau	Tuan Giao	22.8367
Dak Lak	Dak Nong	21.5	Lai	Chau	Dien Bien	27.662
			Lai	Chau	Dien Bien Dong	25.9889
			So	n La	Thuan Chau	42.62
			So	n La	Mai Son	42.62
			So	n La	Song Ma	42.62
			Ho	a Binh	Ky Son	27.7722
			Tha	anh Hoa	Quan Son	49.08
			Tha	anh Hoa	Lang Chanh	49.08
			Tha	anh Hoa	Thuong Xuan	49.08
			Ng	he An	Que Phong	43.675
			Ng	he An	Tuong Duong	27.9825
			Nq	he An	Con Cuong	28.32
			Qu	ang Binh	Minh Hoa	48.42
			Da	k Lak	Dak Nong	27.95
			Lai	m Dong	Lac Duong	48.33
			Lai	m Dong	Lam Ha	48.33
				•		

#### 3.4.4 Flash flooding in Bokeo Province of Lao PDR on 13 August 2016

On 12 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at some villages of some provinces in northern part of Lao PDR, such as Phonsaly, Bokeo, Luang Namtha, Bolykhamxay, Xiengkhuan, Huaphan. The detection of the flash flood risk areas by the MRC FFG system on 14 August 2016 at 00: 00 UTC, was extended to other districts and provinces in the northern part of the Lao PDR, such as Luang Prabang, Oudomxai, Xayaboury Provinces. The Figure 3.4-21 and Figure 3.4-22 present the 3 hour flash flood risk areas detected by MRC-FFG on 12 and 14 August 2016 at 00:00 UTC.

The FFG detection was verified with the available information from the online newspaper "Vientiane Times" (this information provided in the annex A), which informed that some districts of Bokeo Province, were flooded on 14 August 2014, due to heavy rainfall. Those districts were detected as the high risk areas for the flash flood occurrence on 12 August 2016 at 00:00 UTC and also in 14 August 2016 at 00:00 UTC.



Figure 3.4-21 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 12 August 2016 at 00:00 UTC.

Figure 3.4-22 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 August 2016 at 00:00 UTC.

# 3.4.5 Flash flooding in Northern Province of Thailand on 14-15 August 2016

The ITCZ occurred on the second week of August also effected to some districts of the Northern Provinces of Thailand. Since 14 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at some districts in Northern Provinces of Thailand, such as Chiang Rai, Nan Provinces. The detection of the flash flood risk areas by the MRC FFG system on 15 August 2016 at 00: 00 UTC, was extended to other districts and provinces in the northern part of the Thailand, such as Chaing Mai, Lmpang, Phayao Provinces. The FFG detection was

verified with the available information from the online newspaper "Chiang Rai Time" and "NNT", which informed that some districts of Nan and Chaing Rai Provinces, were flooded on 14 August 2014, due to heavy rainfall. Those districts were detected as the high risk areas for the flash flood occurrence on 14 August 2016 at 00:00 UTC. The Figure 3.4-23 and Figure 3.4-24 present the 3 hour flash flood risk areas in northern part of Thailand detected by MRC-FFG on 14 and 15 August 2016 at 00:00 UTC. List of flash flood risk district in Thailand detected by MRC-FFG system on 14 and 15 August 2016 at 00:00 UTC present in Table 3.4-3 and Table 3.4-4.



Figure 3.4-23 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 August 2016 at 00:00 UTC.



Table 3.4-3List of Flash flood risk areas in Thailand detected by MRC- FFG on 14 August<br/>2016 at 00:00 UTC

Date of FFG products	14/08/2016 00:00	UTC time			
1hour Flash Flood Guidance in Thailand			<b>3hour Flash Flood</b>	Guidance in Thailand	
Provinces	Districts	FFG Value	Provinces	Districts	FFG Value
Chiang Rai	Chiang Khong	15.44	Chiang Rai	Chiang Khong	21.49
Chiang Rai	Chiang Saen	15.44	Chiang Rai	Chiang Saen	21.49
Nan	King Amphoe Song K	18.01	Nan	King Amphoe Song Khae	25.36

Date of FFG products	15/08/2016 00:00	UTC time				
1hour Flash F	lood Guidance in Thaila	and	3hour Flash Flood	3hour Flash Flood Guidance in Thailand		
Provinces	Districts	FFG Value	Provinces	Districts	FFG Value	
Chiang Rai	Chiang Khong	20.86	Chiang Rai	Chiang Khong	27.76	
Chiang Rai	Chiang Saen	20.86	Chiang Rai	Chiang Saen	27.76	
Chiang Rai	Thoeng	20.38	Chiang Rai	Thoeng	28.33	
Nan	King Amphoe Song Kl	22.82	Chiang Rai	Mae Suai	45.54	
Nan	Song Kwae	16.47	Chiang Mai	Fang	45.54	
Lampang	Ngao	14.82	Chiang Mai	Mae Ai	45.54	
Lampang	Wang Nua	14.82	Nakhon Ratchasim	a Pak Chong	44.00	
Phayao	Muang Phayao	14.82	Nakhon Ratchasim	aWang Nam Khieo	44.00	
Phayao	Chiang Kham	18.42	Nan	Mae Charim	48.84	
			Nan	King Amphoe Bokuai	48.84	
			Nan	King Amphoe Song Khae	30.56	
			Nan	Song Kwae	23.77	
			Prachinburi	Prachantakham	44.00	
			Lampang	Ngao	21.97	
			Lampang	Wang Nua	21.97	
			Phayao	Muang Phayao	21.97	
			Phayao	Chiang Kham	26.05	
				-		

Table 3.4-4List of Flash flood risk areas in Thailand detected by MRC- FFG on 15 August2016 at 00:00 UTC

### **3.4.6** Rising water level at some hydrological stations of Mekong River mainstream and Mekong tributaries

Due to effect from the ITCZ in upper part of LMB, the water levels at many hydrological stations located in the tributaries of the Mekong basin in the northern part of Lao PDR, such as at Nam Sane, Nam Ngum, Nam Khan, Nam Ou, was remarkably increase. The water level at all those mentioned sub-catchment was started to rise from the evening of 13 August 2016 about 3 to 4 meter, and get the pick level at the morning of 16 August 2016. Figure 3.4-25 and Figure 3.4-32 present the hydrograph of some monitoring stations along Mekong tributaries and the Mekong mainstream.



Figure 3.4-25 Hydrograph of Nam Khan River at Ban Mixai Station during the ITCZ from 11 to 15 Aug 2016.











10.35

.5/8/16 12:00 PM 16/8/16 12:00 AM .6/8/16 12:00 PM L7/8/16 12:00 AM 17/8/16 12:00 PM

15/8/16 12:00 AM

Hydrograph of Mahaxai

.3/8/16 12:00 PM 14/8/16 12:00 AM 14/8/16 12:00 PM

9.5 8.5

7.5 6.5

5.5

4.5

11/8/16 12:00 PM

11/8/16 12:00 AM

L2/8/16 12:00 AM

12/8/16 12:00 PM 3/8/16 12:00 AM











Figure 3.4-30 Hydrograph of Se Banfi River at Mahaxai Station during the ITCZ from 11 to 15 Aug 2016.

Mahava



#### 3.4.7 Conclusions

- 1. During August 10-15, the ITCZ stationary laid across the South of Myanmar, the middle of Thailand and Indochina Peninsular while the active cell low pressure at the end of ITCZ will develop as Tropical Depression. More rain with heavy and very heavy rain was most likely over Thailand, Lao PDR, the lower Mekong Basin and Viet Nam.
- 2. On 12-14 August some provinces of northern part of Viet Nam were covered by heavy rainfall, especially at Lao Cai, Lai Chau, Son La Provinces. The heavy rainfall also has been observed at some rainfall stations located in northern part of Lao PDR. The daily rainfall on 13 August 2016 at those above mentioned provinces reached 100-120 mm.
- 3. On 12 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at Lao Cai, Ha Giang, Lai Chau Provinces of northern part of Viet Nam. The detection of the flash flood risk areas by the MRC FFG system on 14 August 2016 at 00: 00 UTC was extended to other districts and provinces of the northern part of the Viet Nam. This FFG detection has been verified by the available information from the online newspaper "Viet Nam plus" and "Viet Nam New", which informed that the flash flood had been occurred at Lao Cai and Lai Chau Province of Viet Nam on 14 August 2016.
- 4. Since 12 August 2016 at 00:00 UTC the MRC-FFG system also detected some flash flood risk areas at some villages of some provinces in northern part of Lao PDR, such as Phonsaly, Bokeo, Luang Namtha, Bolykhamxay, Xiengkhuan, Huaphan. The detection of the flash flood risk areas by the MRC FFG system on 14 August 2016 at 00: 00 UTC, was extended to other districts and provinces in the northern part of the Lao PDR, such as Luang Prabang, Oudomxai, Xayaboury Provinces. The FFG detection was verified with the available information from the online newspaper "Vientiane Times", which informed that some districts of Bokeo Province, were flooded on 14 August 2014, due to heavy rainfall.
- 5. Since 14 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at some districts in Northern Provinces of Thailand, such as Chiang Rai, Nan Provinces. The detection of the flash flood risk areas by the MRC FFG system on 15 August 2016 at 00: 00 UTC, was extended to other districts and provinces in the northern part of the Thailand, such as Chaing Mai, Lumpang, Phayao Provinces. The FFG detection was verified with the available information from the online newspaper "Chiang Rai Time" and "NNT", which informed that some districts of Nan and Chaing Rai Provinces were flooded on 15 August 2016, due to heavy rainfall.
- 6. The ITCZ on 11 to 15 August 2016 was remarkably effected to the flow regime of some Mekong tributaries located in the northern part of Lao PDR, water level of some hydrological station in those sub-catchments has been increase about 2 to 4 meter.

7. Cause of insufficient of telemetry data from some MHYCOS station of the Mekong tributaries, the detail analysis of the pick water level during the flash flood could not be carried out, the water level data collected by the manual system is not enough information to conduct the analysis of the flash flood peak, as water level was recorded only two time per day at 07:00 AM and 07:00 PM ; and the peak of the flash flood can be occurred witching the short time (may be less than 6 hours). It is recommended that the MHYCOS stations should be reactivated.

# 3.5 Flash flooding in Luang Prabang Province in Lao PDR, caused by ITCZ on 17-18 August 2016

### 3.5.1 Weather situation on the third week of August 2016

During August 17 to August 18, the Inter Tropical Convergence Zone (ITCZ) continue lying across Myanmar, the upper North of Thailand and the North of Viet Nam while the Westerly wind prevails over Andaman Sea, the Gulf of Thailand, South of Thailand and South of Indochina Peninsular. More rain and heavy rain was occurred in Myanmar, the upper South, the East, the Central and the Northeast of Thailand, the Southwest Coastal areas of Cambodia, the Lower Mekong Basin, the Central and the North of Lao PDR, the North of Viet Nam during 17 to 18 August 2016. Figure 3.5-1 present the weather chart of the LMB region where ITCZ was cover this region. Figure 3.5-2 Present the satellite infrared taken on 17 August 2016 at 23:30 UTC (06:30 AM of 18 August 2016 local time).



Source: TMD

Figure 3.5-1 Weather chart of the Mekong region during the 18 August 2016 at 01:00AM local time.



Source: Japan Meteorological Agency

Figure 3.5-2 Infrared Image, MTSAT IR, at 23.30 UTC on August 17, 2016

#### 3.5.2 Rainfall on the third week of August 2016

During 16 to 18 of August, some provinces of northern part of Lao PDR were covered by heavy rainfall, especially at Luang Prabang Provinces. The daily rainfall on that period at those above mentioned province reached from 100 to 120 mm. Figure 3.5-3 to Figure 3.5-4present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Luang Prabang Province Lao PDR during the second week of August 2016. Figure 3.5-5 to Figure 3.5-6 present the 24 hours accumulated satellite rainfall estimated for 18 to 19 August 2016, where show that northern part of Lower Mekong Region was covered by the heavy rain.



Figure 3.5-3 Accumulated rainfall at Moung Ngoy Station of Luang Prabang Province, (Nam Ou catchment).

Figure 3.5-4 Accumulated rainfall at Luang Prabang Station of Luang Prabang Province.



Figure 3.5-5 24 hourly satellite rainfall estimate from 00:00 UTC on 17 August to 00:00 UTC on 18 August 2016.



Figure 3.5-6 24 hourly satellite rainfall estimate from 00:00 UTC on 18 August to 00:00 UTC on 19 August 2016.

# 3.5.3 Flash flooding in Luang Prabang Province of Lao PDR on 18 August 2016

On 18 August 2016 at 00:00 UTC the MRC-FFG system detected some flash flood risk areas at some villages of some provinces in northern part of Lao PDR, such as Luang Prabang, Khammuan Provinces. The Figure 3.5-7 present the 3 hours flash flood risk areas detected by MRC-FFG on 18 August 2016 at 00:00 UTC. Table 3.5-1 present the list of provinces where the MRC-FFG system was detected as the flash flood risk areas for the next 3 hour on 18 August 2016 at 00:00 UTC.

The FFG detection was verified with the available information from the online newspaper "Vientiane Times" dated on 19 August 2016, which informed that some districts of Luang Prabang Province were flooded on 18 August 2016, due to heavy rainfall. The information from the online newspaper "Vientiane Time "also provided in the annex A of this report.



Figure 3.5-7 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 18 August 2016 at 00:00 UTC.

Date of FFG prod	u 18/08	/2016 00:00	UTC time					
1ho	ur Flash Floo	od Guidance i	n Lao	3ho				
Provinces	Districts	Villages	FFG Value	Provinces	Districts	Villages	FFG Value	
No Risk Areas	to Flash Fl	Occurence		Luangprabang	Ngoi	HUAYLAAN	40.17	
				Luangprabang	Ngoi	LONGKHOUN	40.17	
				Luangprabang	Ngoi	CHORMYING	40.17	
				Luangprabang	Ngoi	HUAYTHONG	40.17	
				Luangprabang	Ngoi	PHONEXAI	40.17	
				Luangprabang	Ngoi	HUAYNGONE	40.17	
				Luangprabang	Ngoi	HUAYKHONG T	40.17	
				Luangprabang	Ngoi	HUAYKHONG N	40.17	
				Luangprabang	Ngoi	KEWKAAN	40.17	
				Khammuane	Bualapha	NA PHAO	37.31	
				Khammuane	Bualapha	NONG BOUA	37.31	
				Savannakhet	Phine	PATONG	39.32	
				Savannakhet	Phine	KAPANG	39.32	
				Sekong	Kaleum	SONGKHORN	40.45	
				Sekong	Kaleum	HATPAE	40.45	
				Sekong	Kaleum	CHING	40.45	
				Sekong	Kaleum	TAHEW	40.45	
				Sekong	Kaleum	VAK NEUA	40.45	
	1		1		12.1	1/ A 1/ TAI	40.45	

Table 3.5-1List of the flash flood risk areas in Lao PDR, where detected by MRC FFG 3hour<br/>at 18 August 2016 at 00:00 UTC.

#### 3.5.4 Conclusions

- 1. During August 17-18, the ITCZ stationary laid across the South of Myanmar, the middle of Thailand and Indochina Peninsular. More rain with heavy and very heavy rain was most likely over Thailand, Lao PDR of the lower Mekong Basin and northern Viet Nam.
- 2. On 18August 2016 at 00:00 UTC the MRC-FFG system also detected some flash flood risk areas at some villages of some provinces in northern part of Lao PDR, such as Luang Prabang, Khammuane Provinces. The FFG detection was verified with the available information from the online newspaper "Vientiane Times", which informed that some districts of Luang Prabang Province were flooded on morning of 18 August 2016, due to heavy rainfall.
- 3. Cause of insufficient of telemetry data from some MHYCOS station of the Mekong tributaries, the detail analysis of the pick water level during the flash flood could not be carried out, the water level data collected by the manual system is not enough information to conduct the analysis of the flash flood peak, as water level was recorded only two tome per day at 07:00 AM and 07:00 PM ; and the peak of the flash flood can be occurred within the short time (may be less than 6 hours). It is recommended that the MHYCOS stations in the main tributaries of Mekong Basin should be reactivated.

# 3.6 Flash flooding in the Northern Provinces of Viet Nam, caused by tropical storm "DIANMU"

#### 3.6.1 Weather condition during the third week of August 2016

Tropical Storm "DIANMU" was first noted as a tropical disturbance, by the United States Joint Typhoon Warning Center (JTWC) during August 14, while it was located

about 175 km (110 mi) to the south of Hong Kong, China. The disturbance was located within a narrow area of low vertical winds hear and had a good outflow. Over the next day the system's low level circulation centre started to consolidate as it moved westwards, before it was classified as a tropical depression by the Japan Meteorological Agency (JMA) during August 2015. Over the next couple of days the system moved gradually westwards, before the JTWC issued a tropical cyclone formation alert on the system during August 17. The depression was named "DIANMU" by the JMA during August 18, after it had developed into a tropical storm, while the JTWC initiated advisories on the system and classified it as Tropical Depression 11W. After being named, "DIANMU" continued to move westwards under the influence of a subtropical ridge of high pressure located to the north of the system and made landfall on China's Leizhou Peninsula. The system subsequently entered the Gulf of Tonkin later that day, where it developed an eve feature on microwave imagery, before it peaked with sustained winds of 75 km/h (45 mph) as it made landfall on northern Vietnam during August 19. Over the next day "DIANMU" gradually weakened as it moved westwards through Vietnam, Laos and China's Yunnan Province, before it degenerated into an area of low pressure over northern Myanmar during August 20. The remnant area of low pressure continued to be monitored, as it moved through parts of Myanmar and India, before it was last noted over Bangladesh. Figure 3.6-1 present the track of tropical storm "DIANMU" over the south China Sea and upper part of LMB.



Source: NOAA

Figure 3.6-1 Track map of Tropical Storm DINAMU of the 2016 Pacific typhoon season.

The points show the location of the storm at 6-hour intervals. The color represents the storm's maximum sustained wind speeds as classified in the Saffir–Simpson hurricane wind scale (see below), and the shape of the data points represent the nature of the storm, according to the legend below.



Figure 3.6-2 The color represents the storm's maximum sustained wind speeds as classified in the Saffir–Simpson hurricane wind scale.

#### 3.6.2 Rainfall during the period of tropical storm "DIANMU"

During the period from 18 to 20 August 2016, when typhoon storm "DIANMU" was active (and hit the northern part of Viet Nam at afternoon of 19 August 2016 (local time), also it was moved across the upper part of the LMB, heavy rainfalls occurred at some areas in the northern part of Viet Nam, Lao PDR and Thailand, Figure 3.6-3 to Figure 3.6-8 present the daily accumulated rainfall at some stations located at the Northern Provinces of Viet Nam, where the daily rainfall during this period almost reached 60 to 150 mm per day. Figure 3.6-9 present the 24 hour accumulated rainfall (Hydroestimator-satellite rainfall estimated) from 00:00 UTC on 18 August 2016 to 00:00 UTC on 19 August 2016, and Figure 3.6-10 present the 24 hours accumulated rainfall (Hydroestimator-satellite rainfall estimated) from 00:00 UTC on 19 August 2016 to 00:00 UTC on 20 August 2016.



Figure 3.6-3 Daily accumulated rainfall (in mm) at Moung Ngoy Station in Luang Prabang Province.









Figure 3.6-7 Daily accumulated rainfall (in mm) at Dien Bien Station in Lai Chau Province







Figure 3.6-8 Daily accumulated rainfall (in mm) at Quynh Nhai Station in Son La Province



Figure 3.6-9 24 hourly satellite rainfall estimate from 00:00 UTC on 18 August



Figure 3.6-10 24 hourly satellite rainfall estimate from 00:00 UTC on 19 August to 00:00 UTC on 20 August 2016.

to 00:00 UTC on 19 August 2016.

# 3.6.3 Flash flooding in the Northern Provinces of Viet Nam 19-20 August 2016, caused by tropical storm "DIANMU"

The tropical storm "DIANMU" is the ten storm of the year 2016, which was also the third storm that hit Viet Nam, and caused a flash flood with a serious damage to the Northern Provinces of Viet Nam.

From 19 August 2016 at 12:00 UTC (07:00 PM of 19 August 2016 local time) the MRC-FFG System detected many districts of the Lao Cai, Bac Kan Lai Chau, Son La Provinces in the northern part of Viet Nam were at the risk of flash flood occurrence. Figure 3.6-11 present the 3 hour flash flood risk areas at some districts in Northern Provinces of Viet Nam detected on 19 August 2016 at 12:00 UTC. This area was extend to other provinces on 20 August 2016 at 00:00 UTC, the Figure 3.6-12 present the location of 3 hours flash flood risk areas on 20 August 2016 at 00:00 UTC. The information on flash flood areas detected by MRC FFG system on 19 August at 12:00 UTC and 20 August 2016 at 00:00 UTC was confirmed by Viet Nam newspaper on "Viet Nam New "on Monday 22 August 2016. This information also provided in the annex A of this report. Table 3.6-1 present the list of the flash flood risk areas detected by the MRC-FFG system on 19 August 2016 at 12:00 UTC, which show that some of them has been occurred the flash flood in the next few hours (according to the newspaper).





Figure 3.6-11 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 19 August 2016 at 12:00 UTC.



Date of FFG products 19/08/2016 12:00 UTC time						
1hour Flash	Flood Guidance in Vi	etnam	3hours Flash Flood Guidance in Vietnam			
Provinces	Districts	FFG value	Provinces	Districts	FFG Value	
Ha Giang	Meo Vac	17.98	Ha Giang	Dong Van	45.82	
Ha Giang	Quan Ba	21.30	Ha Giang	Meo Vac	25.93	
Cao Bang	Bao Lac	17.98	Ha Giang	Yen Minh	45.82	
Bac Kan	TX. Bac Kan	16.22	Ha Giang	Quan Ba	38.28	
Bac Kan	Bach Thong	16.22	Ha Giang	Vi Xuyen	47.47	
Son La	TX. Son La	19.97	Cao Bang	Bao Lac	36.14	
Son La	Thuan Chau	19.79	Cao Bang	Thong Nong	43.72	
Son La	Mai Son	19.79	Cao Bang	Nguyen Binh	45.03	
Son La	Song Ma	19.37	Cao Bang	Hoa An	43.72	
Son La	Moc Chau	23.63	Lao Cai	Bat Xat	34.64	
Hoa Binh	Da Bac	23.63	Bac Kan	TX. Bac Kan	22.72	
Hoa Binh	Mai Chau	23.63	Bac Kan	Ba Be	46.34	
Hoa Binh	Ky Son	17.45	Bac Kan	Bach Thong	22.72	
Nghe An	Tuong Duong	14.93	Lai Chau	Phong Tho	39.50	
Nghe An	Con Cuong	18.58	Lai Chau	Tuan Giao	45.23	
Quang Binh	Minh Hoa	23.16	Lai Chau	Dien Bien	41.04	
Kon Tum	Sa Thay	22.83	Lai Chau	Dien Bien Dong	42.45	
			Son La	TX. Son La	27.26	
			Son La	Thuan Chau	30.11	
			Son La	Mai Son	30.11	
			Son La	Song Ma	32.34	
			Son La	Moc Chau	40.54	
			Hoa Binh	Da Bac	32.67	
			Hoa Binh	Mai Chau	38.01	
			Hoa Binh	Ky Son	24.36	
			Hoa Binh	Kim Boi	42.86	
			Hoa Binh	Tan Lac	37.93	
			Hoa Binh	Lac Son	42.86	
			Thanh Hoa	Muong Lat	47.81	
			Thanh Hoa	Quan Hoa	44.25	
			Thanh Hoa	Quan Son	47.20	
			Thanh Hoa	Ba Thuoc	37.93	
			Nghe An	Tuong Duong	21.71	
			Nghe An	Con Cuong	40.55	
			Nghe An	Anh Son	48.18	
			Nghe An	Thanh Chuong	43.70	
			Quang Binh	Minh Hoa	31.76	
			Kon Tum	Dak Glei	40.44	
			Kon Tum	Ngoc Hoi	34.63	
			Kon Tum	Sa Thay	40.52	
			Gia Lai	la Grai	42.69	
			Dak Lak	Dak R'Lap	42.90	
			Dak Lak	Dak Nong	45.19	
			Lam Dong	Bao Lam	46.51	
			Binh Phuoc	Bu Dang	40.41	
			Binh Thuan	Ham Thuan Nam	34.14	
			Binh Thuan	Tanh Linh	34.14	

Table 3.6-1List of the Flash flood risk areas detected by MRC –FFG system on 19 August<br/>2016 at 12:00 UTC.

#### 3.6.4 Flash flooding in the Northern and Central Provinces of Lao PDR 20 August 2016, caused by tropical storm "DIANMU"

From 19 August 2016 at 12:00 UTC (07:00 PM of 19 August 2016 local time) the MRC-FFG System detected many villages of the Oudomxay, Huaphan, Luang

Prabang, Xayaboury, Vientiane, Xiengkhuan, Borikhamxai Provinces in the northern and central parts of Lao PDR were at the risk of flash flood occurrence. Figure 3.6-13 present the 3 hour flash flood risk areas at some villages of Northern and Central Provinces of Lao PDR, detected by MRC FFG System on 19 August 2016 at 12:00 UTC. The information on flash flood areas detected by MRC FFG system on 19 August at 12:00 UTC was confirmed by Lao newspaper "Vientiane Time" on 20 and 23 August 2016, which informed that many province in the north and central parts of Lao PDR was affected by the flood and land slide cause by Topical storm "DIANMU" This information also provided in the annex A of this report.



Figure 3.6-13 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 19 August 2016 at 12:00 UTC.

# 3.6.5 Flash flooding in the Northern Provinces of Thailand 20 August 2016, caused by tropical storm "DIANMU"

When the Tropical storm "DIANMU" moved from Viet Nam to the west direction and cross the northern part of Thailand, the MRC FFG system has been detected a number of flash flood risk areas on 20 August 2016 at 00:00 UTC at some district in Chiang Rai, Chiang Mai and Phayao Provinces. According to the information from the newspaper "Chiang Rai Time "published on 23 August 2016 (see this information in the annex A of this report) informed that 3 people in the Mae Chan and Mae Suai districts was dead caused by the flash flood on Saturday 20 august 2016.

The Figure 3.6-14 present the flash flood risk areas detected by MRC-FFG (3 hour FFG) on 20 August 2016 at 00:00 UTC. Table 3.6-2 present the list of flash flood risk district in Thailand detected by MRC-FFG on 20 August 2016 at 00:00 UTC, when Tropical storm move across the northern part of Thailand.



Figure 3.6-14 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 20 August 2016 at 00:00 UTC.

Date of FFG products	20/08/2016 00:00	UTC time				
1hour Flash F	ood Guidance in Thaila	and	3hour Flash Floo	3hour Flash Flood Guidance in Thailand		
Provinces	Districts	FFG Value	Provinces	Districts	FFG Value	
Chiang Rai	Muang Chiang Rai	14.07	Chiang Rai	Muang Chiang Rai	35.77	
Chiang Rai	Chiang Khong	8.62	Chiang Rai	Chiang Khong	27.65	
Chiang Rai	Chiang Saen	8.62	Chiang Rai	Chiang Saen	22.92	
Chiang Rai	Thoeng	15.75	Chiang Rai	Thoeng	23.25	
Chiang Rai	Mae Suai	15.85	Chiang Rai	Phan	46.14	
Chiang Rai	Wiang Pa Pao	14.24	Chiang Rai	Mae Chan	49.92	
Chiang Rai	King Amphoe Mae La	14.07	Chiang Rai	Mae Suai	23.77	
Chiang Mai	Fang	17.03	Chiang Rai	Wiang Pa Pao	21.48	
Chiang Mai	Phrao	14.24	Chiang Rai	King Amphoe Mae Lao	21.62	
Chiang Mai	Mae Ai	16.41	Chiang Mai	Fang	25.10	
Chiang Mai	King Amphoe Chaipak	17.21	Chiang Mai	Phrao	21.48	
Nan	King Amphoe Song K	16.10	Chiang Mai	Mae Ai	24.44	
Nan	Song Kwae	15.58	Chiang Mai	King Amphoe Chaipakan	25.29	
Lampang	Ngao	13.73	Nan	King Amphoe Song Khae	23.21	
Lampang	Wang Nua	13.73	Nan	Song Kwae	22.78	
Phayao	Muang Phayao	13.73	Phitsanulok	Chat Trakan	45.99	
Phayao	Chiang Kham	15.67	Lampang	Ngao	20.72	
			Lampang	Wang Nua	20.72	
			Uttaradit	Nam Pat	42.67	
			Phayao	Muang Phayao	20.72	
			Phayao	Mae Chai	45.04	
			Phayao	Chiang Kham	23.01	
				-		

Table 3.6-2List of the Flash flood risk areas in Thailand, detected by MRC –FFG system on 20August 2016 at 00:00 UTC.

# **3.6.6** Rising water level at some hydrological stations of Mekong River mainstream and Mekong tributaries

Due to heavy rain occurred in upper part of LMB during the tropical storm "DIANMU" moved across the LMB, the water levels at many hydrological stations located in the tributaries of the Mekong basin in the northern and central parts of Lao PDR, such as at Nam Sane, Nam Ngum, NamKhan, Nam Ou, was remarkably increase. The water level at all those mentioned sub-catchment was started to rise from the morning or evening of 19 August 2016 about 4 to 8 meter, and get the pick level at the morning of 20 August 2016. Figure 3.6-15 to Figure 3.6-21 present the hydrograph of some monitoring stations along the Mekong tributaries. Rising water level at the main tributaries of the Mekong has also influent to increase water level at the Mekong mainstream especially for the hydrological stations from Luang Prabang down to Paksane station. The Figure 3.6-22 to Figure 3.6-26 present the hydrograph of the Mekong River from Luang Prabang to Paksane station.





Figure 3.6-17 Hydrograph of Nam Khan River at Ban Mixay Station during the during the "DIANMU"



Figure 3.6-19 Hydrograph of Nam Sane River at Moung Keo Station during "DIANMU"



Figure 3.6-18 Hydrograph of Nam Ou River at Moung Ngoy Station during "DIANMU"







Figure 3.6-25 Hydrograph of Mekong River at Paklay Station during "DIANMU"

Figure 3.6-26 Hydrograph of Mekong River at Luang Prabang Station during "DIANMU"

#### 3.6.7 Conclusions

1. During 19 to 20 August 2016, the Tropical storm "DIANMU" hid the Northern Provinces of Viet Nam and moved across the upper part of LMB. More rain with heavy and very heavy rain was occurred over northern Thailand, Lao PDR of the lower Mekong Basin and northern Viet Nam.

- 2. Since 19 August 2016 at 12:00 UTC the MRC-FFG system also detected some flash flood risk areas at some villages and districts of provinces in northern part of Viet Nam, Lao PDR, such as the Lao Cai, Bac Kan Lai Chau, Son La Provinces of Viet Nam, and also at Oudomxay, Huaphan, Luang Prabang, Xayaboury, Vientiane, Xiengkhuan, Borikhamxai Provinces of Lao PDR. The FFG detection was verified with the available information from the online newspaper "Viet Nam New", and "Vientiane Times", which informed that some districts of above mentioned provinces were flooded on 20 August 2016, due to heavy rainfall.
- 3. Also on 20 August 2016 at 00:00 UTC the MRC-FFG system was detected some flash flood risk areas at some districts of Chiang Rai, Chiang May, Nan Provinces of Northern part of Thailand. According to the newspaper "Chiang Rai Time" informed that some district of above mentioned provinces has been occurred a flash flood Saturday 20 August 2016 (newspaper not mentioned the exact time (hour) when the flash flood occurred).
- 4. During the Tropical storm "DIANMU" activated in the upper Mekong Basin, from 18 to 20 August 2016 was remarkably effected to the flow regime of some Mekong tributaries located in the northern part of Lao PDR, water level of some hydrological station in those sub-catchment has been increase about 3 to 8 meter.
- 5. Cause of insufficient of telemetry data from some MHYCOS stations of the Mekong tributaries, the detail analysis of the pick water level during the flash flood could not be carried out, the water level data collected by the manual system is not enough information to conduct the analysis of the flash flood peak, as water level was recorded only two time per day at 07:00 Am and 07:00 PM ; and the peak of the flash flood can be occurred within the short time (may be less than 6 hours). It is recommended that the MHYCOS stations in the main tributaries of Mekong Basin should be reactivated.

### 3.7 Flash flooding in Southern Provinces of Lao PDR, and Central Provinces of Viet Nam caused by ITCZ and Tropical Storm "RAI"

### 3.7.1 Weather situation on the second week of September

#### 3.7.1.1 Inter convergence Zone

On September 11 2016 at 01.00 AM Local Time (LCT), the latitude from 0<sup>0</sup>N to 28<sup>0</sup>N and the longitude from 90<sup>0</sup>E to 125<sup>0</sup>E, the Inter Convergence Zone (ITCZ) lies across Myanmar, the North and the Northeast of Thailand. The moderate Southwest monsoon prevails over Myanmar, Thailand and Indochina Peninsular (Figure 3.7-1).

During September 11-13, the Inter Convergence Zone (ITCZ) moved downward and lies across Myanmar, the lower North and the East of Thailand. Rain gradually

increasing and heavy to very heavy rain will be likely in Myanmar, Cambodia, Thailand, the Lower Mekong Basin, Lao PDR and Viet Nam during 11-14 September 2016 (Figure 3.7-2).

#### 3.7.1.2 Tropical storm "RAI"

During September 11, the Japan Meteorological Agency started to monitor a tropical depression that had developed within an unfavorable environment for further development, about 860 km (535 mi) to the northeast of Ho Chi Minh City, Vietnam. The system had a broad low level circulation centre (LLCC), with unorganized deep convection located along the southern edge of the system. During that day the system gradually developed further, before the Joint Typhoon Warning centre initiated advisories and classified it as Tropical depression 19W during the next day.

By the next day, the JTWC upgraded the system to a tropical depression with the given designation of *19W*. Satellite then showed that the LLCC of 19W was broad and defined with some deep convective banding. However, its LLCC became exposed, though its deep convection remained in place. Hours later, the JMA had declared that 19W had strengthened into a tropical storm, with the name "*RAI*". Although it has strengthened, the JTWC issued its final advisory without upgrading it to a tropical storm.

On late September 12, Tropical Storm "RAI", known in Vietnam as **Con bão số 4** (*the 4th storm in 2016*), made landfall in Quảng Nam Province and Quảng Ngãi Province in Central Vietnam. The storm killed 12 people in Vietnam. Heavy rains in Central Vietnam caused flooding and the bursting of the Bung River 2 hydroelectricity plant in Quảng Nam Province of Vietnam, which released 28 million cubic meters of water and washed away 2 workers.

On September 13, the Thai Meteorological Department issued a warning to people in 34 provinces in the North, Northeast and East to brace for heavy rain and stay tuned for weather updates, when Tropical Storm "RAI" moved through Laos and Thailand. Track of the tropical storm "RAI" present in the Figure 3.7-3, where show that the storm was disappear in the areas of the Mum Chi Catchment of LMB.





Figure 3.7-1 Weather chart of the Mekong region during the 11 September t 2016 at 01:00AM local time.





Weather chart of the Mekong region during the 13 September t 2016 at 01:00AM local time.



Figure 3.7-3 Track of tropical storm "RAI".

# **3.7.2** Rainfall during the period of ITCZ and Tropical Storm "RAI", (11-13 September 2016)

During the period from 11 to 14 September 2016, when the Inter Convergence Zone (ITCZ) lies across upper part of LMB, also Tropical storm "RAI" was landed in central parts of Viet Nam and moved across the LMB, heavy rainfalls occurred at some areas in the central part of Viet Nam, Lao PDR and Thailand, Figure 3.7-4 to Figure 3.7-19 present the daily accumulated rainfall at some stations located at the Central Provinces

of Lao PDR and also at eastern part of Thailand, where the daily rainfall during this period almost reached 100 to 120 mm per day. Then Figure 3.7-20 to Figure 3.7-27 present the chart of accumulated rainfall at some rainfall stations located in the Central Provinces of Viet Nam, where the daily amount of rainfall some station reached more than 150 mm. Figure 3.7-28 present the 24 hour accumulated rainfall (Hydroestimator, satellite rainfall estimated) from 00:00 UTC on 12 September 2016 to 00:00 UTC on 13 September 2016, and Figure 3.7-29 present the 24 hours accumulated rainfall (Hydroestimator; satellite rainfall estimated) from 00:00 UTC on 13 September 2016 to 00:00 UTC on 13 September 2016, when the tropical storm "RAI" was landed at central part of Viet Nam and moved across Viet Nam to the southern part of Lao PDR.



Figure 3.7-4 Daily accumulated rainfall (in mm) at Thakhek Station in Khammuane Province.



Figure 3.7-5 Daily accumulated rainfall (in mm) at Savannakhet Station in Savannakhet Province.



Figure 3.7-6 Daily accumulated rainfall (in mm) at Paksane Station in Borikhamxai Province.



Figure 3.7-7 Daily accumulated rainfall (in mm) at Pakse Station in Champassak Province.











Figure 3.7-10 Daily accumulated rainfall (in mm) at Mahaxai Station in Khammuane Province.



Figure 3.7-11 Daily accumulated rainfall (in mm) at Saravanne Station in Saravane Province.



Figure 3.7-12 Daily accumulated rainfall (in mm) at Kuanpho Station in Khammaune Province



Figure 3.7-13 Daily accumulated rainfall (in mm) at Highway Bridge Station in Savanakhet Province.



Figure 3.7-14 Daily accumulated rainfall (in mm) at Sekong Station in Attapeu Province.



Figure 3.7-16 Daily accumulated rainfall (in mm) at Nakhon Phanom Station in Nakhon Phanom Province.



Figure 3.7-18 Daily accumulated rainfall (in mm) at Khong Chiam Station inUbong Province.



Figure 3.7-15 Daily accumulated rainfall (in mm) at Aluoi Station in Sekong Catchment.



Figure 3.7-17 Daily accumulated rainfall (in mm) at Mukdahan Station in Mukdahan Province.



Figure 3.7-19 Daily accumulated rainfall (in mm) at Ban Had Paeng Station in Nam Songkhram catchment.



Figure 3.7-20 Daily accumulated rainfall (in mm) at Ha Tinh Station in Ha Tinh Province.



Figure 3.7-22 Daily accumulated rainfall (in mm) at Ky Anh Station in Ha Tinh Province.







Figure 3.7-23 Daily accumulated rainfall (in mm) at Tuyen Hao Station in Quang Binh Province.



Figure 3.7-24 Daily accumulated rainfall (in mm) at BaDon Station in Quang Binh Province.



Figure 3.7-25 Daily accumulated rainfall (in mm) at Dong Hoi Station in Quang Binh Province.



Figure 3.7-26 Daily accumulated rainfall (in mm) at Dong Ha Station in Quang Tri Province.



Figure 3.7-27 Daily accumulated rainfall (in mm) at Hue Station in Thua Thien Hue Province.



Figure 3.7-28 24 hourly satellite rainfall estimate from 00:00 UTC on 12 September to 00:00 UTC on 13 September 2016.



#### 3.7.3 Flash flooding in the Southern and Central Provinces of Lao PDR 13 September 2016, caused by tropical storm "RAI"

From 12 September 2016 at 12:00 UTC (07:00 PM of 12 September 2016 local time) the MRC-FFG System detected many villages of the Central and Southern Provinces in Lao PDR, such as Xayaboury, Vientiane, Xiengkhuan, Borikhamxai, Sekong were at the risk of flash flood occurrence. On the 13 September 2016 at 00:00 UTC, the MRC-FFG system detected the risk areas to flash flood was extended to other provinces in the southern part of the Lao PDR, included the Saravan, Savannakhet,

Attapeu and Champasak Provinces. Figure 3.7-30 present the 3 hour flash flood risk areas at some villages of Southern and Central Provinces of Lao PDR, detected by MRC FFG System on 12 September 2016 at 12:00 UTC. And Figure 3.7-31 present the 3 hour flash flood risk areas at some villages of Southern and Central Provinces of Lao PDR, detected by MRC FFG System on 13 September 2016 at 00:00 UTC.

The information on flash flood areas detected by MRC FFG system on 12 September at 12:00 UTC was confirmed by Lao newspaper "Vientiane Time "on 14 September 2016, which informed that many province in the southern and central parts of Lao PDR was affected by the flood on 13 September 2016, cause by Topical storm "RAI" This information also provided in the annex A of this report.



Figure 3.7-30 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 12 September 2016 at 12:00

Figure 3.7-31 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 13 September 2016 at 00:00 UTC.

# **3.7.4** Flash flooding in the Central Provinces of Viet Nam, caused by tropical storm "RAI"

At 12 September, the tropical storm "RAI" was landed in the central part of the Viet Nam at the coastal areas of the central Thua Thien Hue and Binh Dinh Provinces. On 12 September 2016 at 12:00 UTC (07:00 PM local time) the MRC-FFG system was detected a flash flood risk areas at some districts of the Central Provinces of the Viet Nam, such as Nghe An, Ha Tinh, Danan, Quang Nam, Binh Dinh, Phu Yen Provinces. Then on 13 September 2016 at 00:0 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Quang Ngai. The Figure 3.7-32 and Figure 3.7-33 present the map of flash flood risk areas detected by MRC-FFG system (3 hour FFG) on 12 September 2016 at 12:00 UTC and on 13 September 2016 at 00:00 UTC.

The information on flash flood areas detected by MRC FFG system on 12 Septemberat 12:00 UTC and on 13 September 2016 at 00:00 UTC was confirmed by Viet Nam newspaper "Viet Nam News "on 16 September 2016, which informed that many province in the southern and central parts of Viet Nam was affected by the flood on 14 to 15 September 2016, cause by Topical storm "RAI". This information also provided in the annex A of this report



Figure 3.7-32 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 12 September 2016 at 12:00 UTC.

Figure 3.7-33 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 13 September 2016 at 00:00 UTC.

### **3.7.5** Rising water level at some hydrological stations of Mekong River mainstream and Mekong tributaries

Due to heavy rain occurred in upper part of LMB during the ITCZ and the tropical storm "RAI" moved across the LMB, the water levels at many hydrological stations located in the tributaries of the Mekong basin in the southern and central parts of Lao PDR, such as at Sebanfai, Sebanhien, Sedone, Sekong, was remarkably increase. The water level at all those mentioned sub-catchment was started to rise from the morning or evening of 12 September 2016 about 3 to 8 meter, and get the pick level at the morning of 14 September 2016. Figure 3.7-34 to Figure 3.7-43 present the hydrograph of some monitoring stations along the Mekong tributaries. Rising water level at the Mekong mainstream especially for the hydrological stations located from Savannakhet down to
Stung Treng station. The Figure 3.7-44 to Figure 3.7-47 present the hydrograph of the Mekong river from Savannakhet to Stung Treng station.



Figure 3.7-34 Hydrograph of Nam Khan River at Ban Mixay Station during the "RAI"





Figure 3.7-36 Hydrograph of Sedone River at Khong Sedone Station during the "RAI"







Figure 3.7-38 Hydrograph of Sekong River at Veun Khen Station during "RAI"



Figure 3.7-39 Hydrograph of Sebanhien River at Ban Keng Don Station during "RAI"



Figure 3.7-40 Hydrograph of Se Done River at Souvanna Khill Station during the "RAI"



Figure 3.7-41 Hydrograph of Sekong River at Sekong Station during the "RAI"

Hydrograph at Siempang



Figure 3.7-42 Hydrograph of Sesan River at Veoeun Sai Station during the "RAI"



Figure 3.7-43 Hydrograph of Sekong river at Siempang Station during "RAI"



Figure 3.7-44 Hydrograph of Mekong River at Savannakhet Station during "RAI"



Figure 3.7-45 Hydrograph of Mekong River at Khong Chiam Station during "RAI"







#### 3.7.6 Conclusions

- 1. During 10 to late of 12 September 2016, the ITCZ was covered the central part of Lao PDR and moved to the southern part of Lao PDR. More rain with heavy and very heavy rain was occurred over Thailand, Lao PDR of the lower Mekong Basin.
- 2. Follow the ITCZ, on the evening of 12 September 2016, the tropical storm "RAI" Has been landed at the coastal areas of central part of the Viet Nam, and moved across the southern part of Lao PDR then disappear at the Mum- Chi catchment of LMB in Thailand. More rain with heavy and very heavy rain was continued to occurred at central part of Viet Nam, over eastern part of Thailand, and also at southern part of Lao PDR.
- 3. From 12 September 2016 at 12:00 UTC (07:00 PM of 12 September 2016 local time) the MRC-FFG System detected many villages of the Central and Southern Provinces in Lao PDR, such as Xayaboury, Vientiane, Xiengkhuan, Borikhamxai, Sekong were at the risk of flash flood occurrence. The information on flash flood areas detected by MRC FFG system on 12 September at 12:00 UTC was confirmed by Lao newspaper "Vientiane Time "on 14 September 2016, which informed that many province in the southern and central parts of Lao PDR was affected by the flood on 13 September 2016, cause by Topical storm "RAI".
- 4. Also on 12 September 2016 at 12:00 UTC (07:00 PM local time) the MRC-FFG system was detected a flash flood risk areas at some districts of the Central Provinces of the Viet Nam, such as Nghe An, Ha Tinh, Danan, Quang Nam, Binh Dinh, Phu Yen Provinces. Then on 13 September 2016 at 00:0 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Quang Ngai. The information on flash flood areas detected by MRC FFG system on 12 September at 12:00 UTC and on 13 September 2016 at 00:00 UTC was confirmed by Viet Nam newspaper "Viet Nam News" on 16 September 2016, which informed that many province in the southern and central parts of Viet Nam

was affected by the flood on 14 to 15 September 2016, cause by Topical storm "RAI".

5. During the ITCZ and tropical storm "RAI" activated in the Mekong Basin, from 11to 13 September 2016 was remarkably effected to the flow regime of some Mekong tributaries located in the central and southern part of Lao PDR, water level of some hydrological station in those sub-catchment has been increase about 3 to 8 meter.

## 3.8 Flash flooding in Central Provinces of Viet Nam, caused by ITCZ on 14 October 2016

### **3.8.1** Weather situation on the middle of October:

On October 12 2016 at 07.00 AM Local Cambodia Time (LCT), the latitude from  $0^{0}$ N to  $28^{0}$ N and the longitude from  $90^{0}$ E to  $125^{0}$ E, the Inter Tropical Convergence Zone (ITCZ) lies across the upper South of Thailand, the middle of Cambodia while active low pressure over the middle South China Sea. The moderate Southwest monsoon prevails over Myanmar, Thailand and Indochina Peninsular (Figure 3.8-1).

On October 14 2016 at 01.00 am Local Cambodia Time (LCT), the latitude from 0<sup>0</sup>N to 28<sup>0</sup>N and the longitude from 90<sup>0</sup>E to 125<sup>0</sup>E, the Inter Tropical Convergence Zone (ITCZ) lies across the upper South and the East of Thailand and the upper of Cambodia while the Tropical Depression (TD) over Danang, Viet Nam. The TD is moving to the middle Lower Mekong Basin the middle South China Sea. During October 14-16, the Inter Tropical Convergence Zone (ITCZ) lies across the Central and the East of Thailand, the South of Lao PDR and the middle of Viet Nam. Less rain will be likely over Myanmar, while widely scattered rain with isolated heavy to very heavy rain in Cambodia, Thailand, Lao PDR and Central Viet Nam during 14-16 October (Figure 3.8-2).







2016 at 07:00AM local time.





Weather chart of the Mekong region during the 14 October 2016 at 01:00AM local time.

#### 3.8.2 Rainfall on the second week of October 2016

During Second week of October some areas in Central Provinces of Viet Nam were covered by heavy rainfall, especially at, Ha Tinh, Quang Nam, Quang Tri, Thua Thien Hue Provinces. The daily rainfall on that period at those above mentioned provinces reached from 200 to 400 mm. Figure 3.8-3 to Figure 3.8-14 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Central Provinces of Viet Nam during the second week of October 2016, where show that amount of daily rainfall from hydroestimator and Map was less compared to the observed rainfall (Hydmet). Figure 3.8-15 to Figure 3.8-16 present the 24 hours accumulated satellite rainfall estimated for 13 to 14 September 2016.



Figure 3.8-3 Accumulated rainfall at Tuyen Hoa Station of Quang Binh Province.









Figure 3.8-7 Accumulated rainfall at Ky Anh Station of Ha Tinh Province.



Figure 3.8-9 Accumulated rainfall at Ba Don Station of Quang Binh Province.



Figure 3.8-6 Accumulated rainfall at Ha Tinh Station of Ha Tinh Province.



Figure 3.8-8 Accumulated rainfall at Con Cuong Station of Nghe An Province.



Figure 3.8-10 Accumulated rainfall at Dong Hoi Station of Quang Binh Province.



Figure 3.8-11 Accumulated rainfall at Dong Ha Station of Quang Tri

400

350

300

250

200

150

100

50

0



Figure 3.8-13 Accumulated rainfall at Hue Station of Thua Thien Hue Province.







Figure 3.8-14 Accumulated rainfall at Houng Son Station of Ha Tinh Province.



Legend est20161015-00.txt 0.01 - 30 31 - 70 71 - 120 121 - 180 181 - 240 241 - 300 4.

Figure 3.8-15 24 hourly satellite rainfall estimate from 00:00 UTC on 13 October to 00:00 UTC on 14 October 2016.



# **3.8.3** Flash flooding in the Central Provinces of Viet Nam, caused by ITCZ (14 October 2016)

On 14 October 2016 at 00:00 UTC (07:00 AM local time) the MRC-FFG system was detected a flash flood risk areas at some districts of the Central Provinces of the Viet Nam, such as Quang Tri, Thua Thien Hue Phu Yen, Khan Hao Provinces. Then on 14 October 2016 at 06:00 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Quang Nam. Figure 3.8-17 and Figure 3.8-18 present the map of flash flood risk areas detected by MRC-FFG system (3 hour FFG) on 14 October 2016 at 00:00 UTC and on 14 October 2016 at 06:00 UTC.

According to the online Vietnam newspaper "Nhandan" dated 14 October 2016 at 10:00 PM was informed that on 14 October 2016 at 06:00 PM some areas in Central Provinces of Viet Nam has been flooded, cause of the heavy rainfall. On 15 October 2016 The newspaper "Viet Nam News "was informed that the flood has been seriously impact to the province Thuan Thien Hue, Quantri, Danan, Quang Ngai, Quang Binh. The provinces impacted by the flood almost the same provinces has been detected by the MRC- FFG except the province Quang Binh, Nghe Anh and Ha Tinh, where the FFG did not detected. Base on primary investigation on the problem miss detection of the system where found that during the TD and ITCZ on 14October the hydroestimator was underestimate the rainfall value compared to the observed rainfall. It is suggested to reviews the rainfall scale of hydroestimator (satellite rainfall estimate).





Figure 3.8-17 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 October 2016 at 00:00 UTC.

Figure 3.8-18 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 October 2016 at 06:00 UTC.

### 3.8.4 Conclusions

- 1. During 12 to late of 14 October 2016, the ITCZ was across the upper South of Thailand, the middle of Cambodia while active low pressure over the middle South China Sea then moved to the coastal areas of the Central Provinces of Viet Nam.
- 2. Caused of ITCZ and TD, Heavy rainfall has been occurred in many areas in the Central Provinces of Viet Nam. The daily rainfall of some rainfall station has been reached to 300 to 400 mm. Comparing the daily value of rainfall estimated by hydroestimator (satellite rainfall estimate) with the observed rainfall we found that the rainfall estimated by hydroestimator was under estimate for all rainfall station.
- 3. From 14 October 2016 at 00:00 UTC (07:00 AM of 14 October 2016 local time) the MRC-FFG System detected many villages of the Central Provinces in Viet Nam, such as Quang Tri, Thua Thien Hue, Phu Yen, Khan Hao were at the risk of flash flood occurrence. On 15 October 2016 the newspaper "Viet Nam News "was informed that the flood has been seriously impact to the province Thuan Thien Hue, Quantri, Danan, Quang Ngai, Quang Binh. The provinces impacted by the flood almost the same provinces has been detected by the MRC- FFG except the province Quang Binh, Nghe Anh and Ha Tinh, where the FFG did not detected.
- 4. Insufficient of the FFG system to detect the flash flood at that time for some provinces in central part of Viet Nam mainly cause of the under estimate the rainfall value of MAP product of FFG.
- 5.

# 3.9 Tropical Storm "SARIKA" affected to North-East Provinces of Viet Nam, - 19 October 2016

### **3.9.1** Weather situation on the third week of October.

"SARIKA" was first noted as a tropical depression located about 1,200 km (750 mi) east-southeast of Manila, Philippines. When 24W entered their area of responsibility, PAGASA assigned it the local name *Karen*. By October 13, images depicted a broad LLCC; sea surface temperatures were high, at 31 °C (88 °F). Hours later, the system became a tropical storm, with the JMA naming it as "SARIKA".

"SARIKA" continued organizing and reached severe tropical storm intensity Several hours later, "SARIKA" started to form an eye feature as it became a typhoon. The storm eventually reached its peak intensity as a Category 4 typhoon with 1-minute sustained winds of 215 km/h (130 mph) and a minimum barometric pressure of 935 mbar. Early on October 16, "SARIKA" made landfall over in Baler, Aurora. Dramatic weakening occurred as "SARIKA" traversed the islands, by the time the storm entered the South China Sea. After moving westward rapidly for two days, "SARIKA" weakened to a severe tropical storm as it made landfall over in Hainan. By October 19, imagery depicted that "SARIKA" was rapidly deteriorating as it made its final

landfall over in the coastline and border of Vietnam and China, while the JTWC issued its final advisory. The JMA followed suit three hours later and dissipated in the same day. Figure 3.9-1 present the track of tropical storm "SARIKA".



Figure 3.9-1 Track of tropical storm "SARIKA".

# **3.9.2 Rainfall during the period of Tropical Storm "SARIKA", 19 October** 2016

When the Tropical storm "SARIKA" was approached to the coastal areas of the northern part of Viet Nam on 19 October 2016, rainfalls was occurred at some areas from Quang Ninh to Thai Bin Provinces of Viet Nam, (newspaper "Viet Nam News"), unfortunately RFMMC could not did rainfall analysis between observed and satellite rainfall estimate (Hydroestimator) because of not availability of observed rainfall data from those areas, as it was out site of the LMB. Figure 3.9-2 present the 24 hour accumulated rainfall (Hydroestimator, satellite rainfall estimated) from 00:00 UTC on 18 October 2016 to 00:00 UTC on 19 October 2016, and Figure 3.9-3 present the 24 hours accumulated rainfall (Hydroestimator; satellite rainfall estimated) from 00:00 UTC on 19 October 2016 to 00:00 UTC on 20 October 2016, when the tropical storm "SARIKA" was approached to coastal areas of the northern part of Viet Nam. Through this Rainfall map, it clear that the heavy rainfall occurred almost at the sea areas.



# **3.9.3** Detection of the FFG system during the Tropical storm "SARIKA", 19 October 2016

From 19 October 2016 at 00:00 UTC (07:00 AM of 19 October 2016 local time) to 20 October 2016 at 00:00 UTC the MRC-FFG system did not detected any flash flood risk areas especially in the North-East Provinces of the Viet Nam, where expected to be hit by the tropical storm on 19 October to 20 October 2016. The Figure 3.9-4 and Figure 3.9-5 present the 3 hour FFG on 19 October 2016 at 00:00 UTC and 3hour FFG on 20 October 2016.



Figure 3.9-4 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 19 October 2016 at 00:00 UTC.

Figure 3.9-5 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 20 October 2016 at 00:00 UTC.

#### 3.9.4 Conclusions

- Early on October 16, "SARIKA" made landfall over in Baler, Aurora. Dramatic weakening occurred as "SARIKA" traversed the islands, by the time the storm entered the South China Sea. After moving westward rapidly for two days, "SARIKA" weakened to a severe tropical storm as it made landfall over in Hainan. By October 19, imagery depicted that "SARIKA" was rapidly deteriorating as it made its final landfall over in the coastline and border of Vietnam and China.
- 2. October 19 to 20, 2016, while the tropical storm deteriorated at the coast line and border of Viet Nam China, the heavy rainfall was occurred at the sea and at some island areas (out site of FFG system).
- 3. MRC- FFG system did not detect any flash flood risk areas when the tropical storm "SARIKA" was activated in the coastal areas of the North-East Provinces of Viet Nam.

# 3.10 Flash flooding in Central Provinces and Central Highland of Viet Nam, caused by low pressure and Tropical Depression, on 31 October to 5 November 2016

### 3.10.1 Weather situation on the End of October and Beginning of November:

### 3.10.1.1 Low Pressure

During October 30- November 03, the ridge of high pressure from china will continue covered over the North, the Northeast, the East and the Central of Thailand, Lao PDR, the North of Cambodia, the North and the Central of Viet Nam. More rain and heavy rain will be likely in the East the Southeast, the lower Central, the South and the Coastal areas of Cambodia, the South of Thailand the South and the Central of Viet Nam during 30 October-01 November. The Figure 3.10-1 presents the weather chart of the LMB region on 31 October 2016 at 01:00 AM local time. The Figure 3.10-2 presents the weather chart of the LMB region on 04 November 2016 at 01:00 AM local time. Where show the low pressure covered the South China Sea and lower part of Mekong.



Source: TMD





Figure 3.10-2 Weather chart of the Mekong region during the 01 November 2016 at 07:00AM local time.

### 3.10.1.2 Tropical Depression

From the 02 to 05 November 2016, the tropical depression was approached and cross the central highland of Viet Nam to the lower part of the LMB. While rain was occurred in the central highland and southern part of Viet Nam, and also in some part of Cambodia. The Figure 3.10-3 presents the weather chart of the LMB region on 03 November 2016 at 01:00 AM local time. The Figure 3.10-4 present the weather chart of the LMB region on 06 November 2016 at 01:00 AM local time.





Source: TMD

Figure 3.10-3 Weather chart of the Mekong region during the 03 November 2016 at 01:00AM local time.

Source: TMD

Figure 3.10-4 Weather chart of the Mekong region during the 06 November 2016 at 01:00AM local time.

# **3.10.2** Rainfall at Central Provinces of Viet Nam at the end of October to first week of November 2016

Caused the low pressure occurred at last week of October, some areas in Central Provinces of Viet Nam were covered by heavy rainfall, especially at, Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue Provinces. The daily rainfall on that period at those above mentioned provinces reached from 200 to 400 mm. Figure 3.10-5 to Figure 3.10-14 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Central Provinces of Viet Nam during the last week of October 2016, where show that amount of daily rainfall from hydroestimator and Map was less compared to the observed rainfall (Hydmet). Figure 3.10-15 to Figure 3.10-16 present the 24 hours accumulated satellite rainfall estimated for 01 November and 02 November 2016.



Figure 3.10-5 Accumulated rainfall at Tuyen Hoa Station of Quang Binh Province.











Figure 3.10-9 Accumulated rainfall at Ky Anh Station of Ha Tinh Province.





Figure 3.10-10 Accumulated rainfall at Houng Son Station of Ha Tinh Province.



Figure 3.10-11 Accumulated rainfall at Ba Don Station of Quang Binh Province.



Figure 3.10-13 Accumulated rainfall at Dong Ha Station of Quang Tri Province.



Figure 3.10-12 Accumulated rainfall at Dong Hoi Station of Quang Binh Province.



Figure 3.10-14 Accumulated rainfall at A Luoi Station of Thua Thien Hue Province.



Figure 3.10-15 24 hourly satellite rainfall estimate from 00:00 UTC on 31 October to 00:00 UTC on 01 November 2016.



Figure 3.10-16 24 hourly satellite rainfall estimate from 00:00 UTC on 01 November to 00:00 UTC on 02 November 2016.

# 3.10.3 Rainfall at Central Highland of Viet Nam at first week of November 2016

Cause of the Tropical depression occurred at first week of November, some areas in central highland of Viet Nam were covered by heavy rainfall, especially at Dak Lak, Gia Lai Provinces. The daily rainfall on that period at those above mentioned provinces reached from 200 to 400 mm. Figure 3.10-17 to Figure 3.10-22 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Central Provinces of Viet Nam during the first week of November 2016, where show that amount of daily rainfall from hydroestimator and Map was less compared to the observed rainfall (Hydmet). Figure 3.10-23 to Figure 3.10-24 present the 24 hours accumulated satellite rainfall estimated for 03 November and 04 November 2016.



Figure 3.10-17 Accumulated rainfall at An Khe Station of Gia Lai Province.





Figure 3.10-19 Accumulated rainfall at Buon Me Thuot Station of Dak Lak Province.







Figure 3.10-21 Accumulated rainfall at Buon Ho Station of Dak Lak Province.



Figure 3.10-22 Accumulated rainfall at Duc Xuyen Station of Dak Lak Province.



Figure 3.10-23 24 hourly satellite rainfall estimate from 00:00 UTC on 02 November to 00:00 UTC on 03 November 2016.



Figure 3.10-24 24 hourly satellite rainfall estimate from 00:00 UTC on 03 November to 00:00 UTC on 04 November 2016.

# 3.10.4 Flash flooding in the Central Provinces of Viet Nam, caused by Low Pressure (01 November 2016)

On 01 November 2016 at 00:00 UTC (07:00 AM local time) the MRC-FFG system was detected a flash flood risk areas at some districts of the Central Provinces of the Viet Nam, such as Ha Tinh and Quang Binh Provinces. Then on 01 November 2016 at 06:00 UTC (6 hours later) the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Quang Ngai. Figure 3.10-25 and Figure 3.10-26 present the map of flash flood risk areas detected by MRC-FFG system (3 hour FFG) on 01 November 2016 at 00:00 UTC and on 01 November 2016 at 06:00 UTC.

According to the on line Vietnam newspaper "Vietnam Plus" dated 01November 2016 at 09:52 AM was informed that on 01 November 2016 sever flood are expected as the river water level is swiftly in the Central Provinces of Quang Binh and Ha Tinh in Central Provinces of Viet Nam caused of the heavy rainfall. The provinces impacted by the flood almost the same provinces has been detected by the MRC- FFG except the provinces Quang Tri, Thua Thien Hue, where the FFG did not detected. Base on primary investigation on the problem miss detection of the system where found that during the low pressure 01 November the rainfall value of hydroestimator was underestimate compared to the observed rainfall (see Figure 3.10-17 to Figure 3.10-22). It is suggests to reviews the rainfall scale of hydroestimator (satellite rainfall estimate).



Figure 3.10-25 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 01 November 2016 at 00:00 UTC.

Figure 3.10-26 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 01 November 2016 at 06:00 UTC.

# 3.10.5 Flash flooding in the Central Highland of Viet Nam, caused by Tropical Depression (04 November 2016)

Due to the heavy rainfall caused by the tropical depression covered the central highland and southern part of the Viet Nam, some areas in the Central Highland at provinces Phu Yen, Khanh Hao, Gia Lai and Ninh Thuan, was detected a flood risk by the MRC-FFG system on 03 November 2016 at 12:00 UTC (07:00 PM local time). Then on 04 November 2016 at 00:00 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Kon Tum and Dak Lak Provinces. Figure 3.10-27 and Figure 3.10-28 present the map of flash flood risk areas detected by MRC- FFG system (3 hour FFG) on 01 November 2016 at 00:00 UTC and on 01 November 2016 at 06:00 UTC. The flash flood risk areas that detected by the MRC-FFG at 03 November 2016 at 12:00 UTC and at04 November 2016 at 00:00 was confirmed by the newspaper "Viet Nam News" dated on Monday 07 November 2016. The information of this newspaper provided in the annex A of this report.



Figure 3.10-27 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 03 November 2016 at 12:00 UTC.

Figure 3.10-28 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 04 November 2016 at 00:00 UTC.

#### 3.10.6 Rising water level at some hydrological stations of Mekong tributaries

Due to heavy rain occurred in Central Provinces of Viet Nam and also at some areas in central part of LMB during the Low pressure and also the Tropical Depression moved across the Central highland of Vet Nam and lower part of LMB, the water levels at many hydrological stations located in the tributaries of the Mekong basin in the southern and central parts of Lao PDR, such as at Sebanfai, Se Banhien, Sekong, was remarkably increase. The water level at all those mentioned sub-catchment was started to rise from the morning or evening of 02 November 2016 about 4 to 6 meters, and get the pick level at the morning of 04 November 2016. Figure 3.10-29 to Figure 3.10-33 present the hydrograph of some monitoring stations along the Mekong tributaries located in central and southern part of Lao PDR

Increase water level also was happen for all hydrological station located in the Srepork and Sesan Catchment, where water level started to increase from the morning of 04 November 2016 about 3 to 6 meters, and get the pick level at morning of 05 November 2016. Figure 3.10-34 to Figure 3.10-36 present the hydrograph of the Sesan and Srepork Rivers.



Hydrograph of Mahaxai 11 10 9 0 75 8 .69 7 6.02 5 5.12 4.27 L/11/16 12:00 PM 1/11/16 12:00 AM 2/11/16 12:00 AM 2/11/16 12:00 PM 3/11/16 12:00 AM 3/11/16 12:00 PM 4/11/16 12:00 AM 1/11/16 12:00 PM 5/11/16 12:00 AM 5/11/16 12:00 PM 6/11/16 12:00 PM Ş 7/11/16 12:00 PM 5/11/16 12:00 AM /11/16 12:00 / Mał axai

Figure 3.10-29 Hydrograph of Se Banhien River at Highway Bridge Station

Figure 3.10-30 Hydrograph of Se Banfi River at Mahaxai Station



Figure 3.10-31 Hydrograph of Se Banhien River at Ban Keng Don Station



Figure 3.10-32 Hydrograph of SeKong River at Sekong Station



Figure 3.10-33 Hydrograph of Sekong River at Veun Khen Station.



Figure 3.10-34 Hydrograph of Srepork River at Duc Xuyen Station



Figure 3.10-35 Hydrograph of Srepork River at Giang Son Station.



Figure 3.10-36 Hydrograph of Srepork River at Lumphat Station.

#### 3.10.7 Conclusions

- 1. During period from the end of October to the first week of November, the Lower Mekong region has been covered by two weather Phenomenon, such as Low Pressure and Tropical Depression, which leaded to the flash flood at many provinces in the central and central highland of Viet Nam.
- 2. Caused of Low pressure, heavy rainfall has been occurred in many areas in the Central Provinces of Viet Nam. The daily rainfall of some rainfall station has been reached to 200 to 300 mm. Comparing the daily value of rainfall estimated by hydroestimator (satellite rainfall estimate) with the observed rainfall we found that the rainfall estimated by hydroestimator was under estimate for all rainfall stations.
- 3. Cause of the Tropical depression from 03 to 04 November, some rainfall stations in the central highland of the Viet Nam has been record the daily rainfall up to 200 or 250 mm. where lead to the flash flood at many areas in the central highland.
- 4. On 01 November 2016 at 00:00 UTC (07:00 AM local time) the MRC-FFG system was detected a flash flood risk areas at some districts of the Central Provinces of the Viet Nam, such as Ha Tinh and Quang Binh Provinces. Then on 01 November 2016 at 06:00 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Quang Ngai
- 5. Due to the heavy rainfall caused by the tropical depression approached the central highland of Viet Nam, some areas in the Central Highland at Provinces Phu Yen, Khanh Hao, Gia Lai and Ninh Thuan, was detected a flood risk by the MRC-FFG system on 03 November 2016 at 12:00 UTC (07:00 PM local time). Then on 04 November 2016 at 00:00 UTC the flash flood risk areas detected by MRC-FFG system was extended to other provinces such as Kon Tum and Dak Lak Provinces.
- 6. Newspaper "Viet Nam News "was informed that the flood has been seriously impact to the provinces in central and central highland of Viet Nam. The provinces

impacted by the flood almost the same provinces has been detected by the MRC-FFG except the few location (districts) where the FFG did not detected.

7. Insufficient of the FFG system to detect the flash flood at that time for some districts in central part of Viet Nam mainly cause of the under estimate the rainfall value of MAP product of FFG system.

# 3.11 Flash flooding in Central Provinces, caused by low pressure 30 November to 8 December 2016

### **3.11.1** Weather situation on the Beginning of December:

During the first week of December, the ridge of high pressure from china will continue covered over the North, the Northeast, the East and the Central of Thailand, Lao PDR, the North of Cambodia, the North of Viet Nam. The lower part of LMB region was covered by the Low Pressure. More rain and heavy rain will be likely in the East the Southeast, the South and the Coastal areas of Cambodia, the South of Thailand the South and the Central of Viet Nam during 30 November to 06 December. The Figure 3.11-1 presents the weather chart of the LMB region on 30 November 2016 at 01:00 AM local time. The Figure 3.11-2 presents the weather chart of the LMB region on 08 December 2016 at 04:00 AM local time. Where show the low pressure covered the south china sea and lower part of Mekong.





Figure 3.11-1 Weather chart of the Mekong region during the 30 November 2016 at 01:00AM local time.





# 3.11.2 Rainfall at Central Provinces of Viet Nam at the first week of December 2016

Caused the low pressure occurred at first week of December, some areas in Central Provinces south Central Provinces of Viet Nam were covered by heavy rainfall, especially at, Thua Thien Hue, Quang Ngai, Binh Dinh, Dak Lak Provinces. The daily rainfall on that period at those above mentioned provinces reached from 100 to 300 mm. Figure 3.11-3 to Figure 3.11-8 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Central Provinces of Viet Nam during the first week of December 2016, where show that amount of daily rainfall from hydroestimator and Map was less compared to the observed rainfall (Hydmet). Figure 3.11-9 and Figure 3.11-10 present the 24 hours accumulated satellite rainfall estimated for 02 December and 03 December 2016.



Figure 3.11-3 Accumulated rainfall at ALuoi Station of Thua Thien Hue Province.



Figure 3.11-4 Accumulated rainfall at Hue Station of Thuan Thien Hue Province.



Figure 3.11-5 Accumulated rainfall at An Khe Station of Gia Lai Province.



Figure 3.11-6 Accumulated rainfall at MDrak Station of Dak Lak Province.



Figure 3.11-7 Accumulated rainfall at Dong Xoai Station of Binh Duong Province.







According to the Vietnam newspaper "Viet Nam News" page 3 dated 02 December 2016 was informed that on 01 December 2016 caused by torrential rainfall measuring 100-200 mm in Quang Ngai, Binh Dinh Provinces has flooded nearly 1,000 houses and over 3,000 ha of sowed rice and raised river levels. The miss detection of the flash flood risk areas for those 2 provinces has been occurred with the MRC-FFG system for that flood even. The Figure 3.11-11 show the 3 hour FFG on 30 November 2016 at 18:00 UTC, where the flood risk areas was detected on level 3 (yellow color scale ) for some areas in Phu Yen Province. Then 12 hours later on 01 December 2016 at

00:00 UTC, the MRC-FFG system still detected the same areas as detected on 30 November 2016 at 18:00 (see Figure 3.11-12). Base on primary investigation on the problem miss detection of the system we found that during the low pressure occurred at the last week of November and first week of December, the rainfall value of hydroestimator was underestimate compared to the observed rainfall (see Figure 3.11-3 to Figure 3.11-10). It is suggests to reviews the rainfall scale of hydroestimator (satellite rainfall estimate).



Figure 3.11-11 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 30 November 2016 at 18:00 UTC.



### 3.11.4 Conclusions

- 1. During period from the end of November to the first week of December, the Lower Mekong region covered by Low Pressure, which leaded to flash flood at many provinces in the central of Viet Nam.
- 2. Caused of Low pressure, heavy rainfall has been occurred in many areas in the Central Provinces of Viet Nam. The daily rainfall of some rainfall station has been reached to 100 to 300 mm. Comparing the daily value of rainfall estimated by

hydroestimator (satellite rainfall estimate) with the observed rainfall we found that the rainfall estimated by hydroestimator was under estimate for all rainfall stations.

- 3. Due to heavy rain some areas on the Central Provinces of Viet Nam such as Binh Dinh, Quang Ngai has been flooded on the 01 December 2012. The MRC-FFG system miss detected for some areas during this flood even.
- 4. The main cause of the miss detected of the MRC-FFG system is underestimate of the satellite rainfall (hydroestimator and also MAP value compared to the observed rainfall. It is suggest reviewing the scale factor that used for calculation the satellite rainfall estimate and bias correction factor for MAP.

# 3.12 Flash flooding in Central Provinces, caused by low pressure 12 to 15 December 2016

### 3.12.1 Weather situation on the Second week of December:

During the second week of December, the ridge of high pressure from china will continue covered over the North, the Northeast, the East and the Central of Thailand, Lao PDR. The lower part of LMB region was covered by the Low Pressure. More rain and heavy rain will be likely in the East the Southeast, the lower Central, the South and the Coastal areas of Cambodia, the South of Thailand the South and the Central of Viet Nam during second week of December. The Figure 3.12-1 presents the weather chart of the LMB region on 13 December 2016 at 01:00 AM local time. The Figure 3.12-2 presents the weather chart of the LMB region on 14 December 2016 at 07:00 AM local time. Where show the low pressure covered the South China Sea and lower part of Mekong.





Figure 3.12-1 Weather chart of the Mekong region on 13 December 2016 at 01:00AM local time.





# 3.12.2 Rainfall at Central Provinces of Viet Nam at the second week of December 2016

Caused the low pressure occurred at second week of December, some areas in central provinces south Central Provinces and central highland of Viet Nam were covered by heavy rainfall, especially at, Thua Thien Hue, Quang Ngai, Binh Dinh, Dak Lak provinces. The daily rainfall on that period at those above mentioned provinces reached from 100 to 200 mm. Figure 3.12-3 to Figure 3.12-8 present the daily accumulated observed rainfall, MAP and Hydroestimator at some rainfall stations located in Central Provinces and central highland of Viet Nam during the second week of December 2016, where show that amount of daily rainfall from hydroestimator and Map was less compared to the observed rainfall (Hydmet). Figure 3.12-9 to Figure 3.12-10 present the 24 hours accumulated satellite rainfall estimated for 13 December and 14 December 2016.



500

400

300

Figure 3.12-3 Accumulated rainfall at ALuoi Station of Thua Thien Hue Province.









Daily accumulated raifall MDrak

Figure 3.12-6 Accumulated rainfall at MDrak Station of Dak Lak Province.



Figure 3.12-7 Accumulated rainfall at Dong Hoi Station of Quang Binh Province.





Figure 3.12-9 24 hourly satellite rainfall estimate from 00:00 UTC on 13 December to 00:00 UTC on 14 December 2016.

Figure 3.12-10 24 hourly satellite rainfall estimate from 00:00 UTC on 14 December to 00:00 UTC on 15 December 2016.

# 3.12.3 Flash flooding in the Central Provinces of Viet Nam, caused by Low Pressure (14 December 2016)

Due to the heavy rainfall caused by the Low Pressure cover on the central part of the Viet Nam, some areas in the Central Provinces of Viet Nam such as Quang Nam, Binh Dinh, Thua Thien Hue, and Quang Binh, was detected a flood risk by the MRC-FFG system on 14 December 2016 at 12:00 UTC (07:00 PM local time). Figure 3.12-11 and Figure 3.12-12 present the map of flash flood risk areas detected by MRC-FFG system (3 hour FFG) on 14 December 2016 at 12:00 UTC and on 15 December 2016 at 00:00 UTC. The flash flood risk areas that detected by the MRC-FFG at 14 December 2016 at 12:00 UTC and at15 December 2016 at 00:00 was confirmed by the newspaper "Viet Nam News" dated on Saturday December 17, 2016.



Figure 3.12-11 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 14 December 2016 at 18:00 UTC.

Figure 3.12-12 Flash flood risk areas detected by MRC-FFG (3 hour FFG) system on 15 December 2016 at 00:00 UTC.

### 3.12.4 Conclusions

- 1. During second week of December 2016, the Lower Mekong region, especially the central part and central highland of Viet Nam was covered by Low Pressure, which leaded to flash flood at many provinces in the central and central highland of Viet Nam.
- 2. Caused of Low pressure, heavy rainfall has been occurred in many areas in the Central Provinces and central highland of Viet Nam. The daily rainfall of some rainfall station has been reached to 100 to 300 mm. Comparing the daily value of rainfall estimated by hydroestimator (satellite rainfall estimate) with the observed rainfall we found that the rainfall estimated by hydroestimator was under estimate for many rainfall stations.
- 3. Due to heavy rain some areas on the Central Provinces and central highland of Viet Nam such as Binh Dinh, Quang Ngai, Quang Nam, Khan Hao, Gia Lai, Thuan Thien Hue, Binh Dinh has been flooded on the 14 to 15 December 2012.
- 4. Newspaper "Viet Nam News "dated on 17 December 2016, was informed that the flood has been seriously impact to the provinces in central and central highland of Viet Nam. The provinces impacted by the flood almost the same provinces has been detected by the MRC- FFG.

# 4. Conclusion and Recommendations

The current report is seventh evaluation report of MRC Flash Flood Guidance (MRC-FFG) system after 7 years of operation. Although this evaluation report does not cover all of the flash flooding that occurred in 2016 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 MRC-FFG 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 the 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.

#### **ANNEXA Newspapers**

#### Annex A.1 Flash flooding in the northern part of Lao PDR, caused by low pressure on 23 July 2016

#### 2 | Home news | Tuesday July 26, 2016

**Flash flooding hits** farmers in Xayaboury

ost 200 families in Bota Intost 200 families in Bobasa strict, Xayaboury province, are lost some or all of their roops to final flooding after any rains last weekend but ackily no deaths or injuries are reported. Botaen District Governor for Bounsen Chanthaphong di Uentone Theor waterby Mentione Times yesterday in the evening of July 23 y rains caused widespread ing in low-lying areas. ome 174 families have

Some 174 families nave en affected to varying grees, mostly in Nakha, men, Donsavang, Tackeus

Nhai villages. The flooded area inclui The flooded area includes 60 heatrars of nice fields, 36 finh farms and some house. Mr Bounses said it was the flooting in the district District a authorities are proparing a report for the Xayaboury provincial authorities to they can take steps to help the worst affacted villagen.

This year, farming families many parts of the country see been hit by fissh flooding have lost crops as a result. From July 10-14, over 300 traves of Borkhan district, above of Borkhan district, Borikh

orikhamizay province, were so partially underwater. Some 900 families in

Some 900 families in communities along the Nam (an river have been affected to varying degrees, mostly 2 Varhat, Nahaes, Siavarda Varhat, Nahaes, Siavarda The flooded area includes 62 hectres of rice fields and 53 hectres of casara crops. A one-kilometre stretch



Over 60 hectares of rice fields in Botaen district, Xaya province, were affected by flash flooding last weekend.

of road running between Hadonkhoun and Phonkham villages and 500 metres of district were also inder water. Also in Pakwan district, Pachkow and district,

smore than 1,000 people are straggling to get in and out of their villages and are using boats to get around. These areas are vulnearable to flooding because they because they low-lying and flooding has low-lying and flooding has occurred here in the past. Paleon district authorities are alumine to unreade the read Borikhamitay province, over 1,000 people were cut off from neighbouring towns and districts after a road flooded planning to upgrade the road to protect it from flooding in the future. According to the Xinhua news agency, some 8.6 million people was affected by there recently, with two ages having to resort to asport by boat. According cording Thabor to divisit attherities, Thaber and Songkhons villages uwes million poople uwes affected by million poople uwes affected by foods and fandhides caused by heavy rain i China last uwek. occurred along a 300-mstre stretch of the road Some 200 families of another 124 are missing.



Program woman are in need of more information concerning healthcare which should be provided by specialist including mithwise, to reduce Laco High rate of child mortality. This was the control message delivered at a workshop and Usaniane yeatereday by the Deputy Director of the Modar and Newborn Houpital, Dr Sontamabauang Somborn. About 70 percent of child on of receive good healthcare, especially during delivery, he taid. A member of the Pardintic Association of Laco, relative and heaven by a sub-tantic A member of the Pardintic Association of Laco, Dr Alongkhone Phaegawanh, also told the workshop that more communication was needed between obstaticians and neoantology staff.

needed between contentians and neonatology staff. The workshop focused on theoretical considerations and the correct sequence of events in the resuscitation of newborn

in the resuscitation of newborn infrant. Familiarity with the negative equipmean for resuscitative shifty to use equipmean throug rouncitation was essential. Dr Alonghome said Emphasis should be placed on the modification of ismularity conditions requiring resuscitation, he added The newborn, or ascounts.

undergrap constraints and a set of the newborn, he added The newborn, or neonste, is generally defined as an infant during the first 28 days of life. The term 'newly born' refers specifically to the newborn within ministes until hours after

birth. Midhatives are important in helping with the early stages of the like of neutron babies but for many years they have lacked adequate have locked to babiesy. Prof. Dr. Thomas Hoelm of the Neomatology Resuscitation Unit at Heinrich-Heine Unitversity in Dusseldorf, Genmany, said 'If we know the reasons for the problem we can reduce the child mortality rate. If pregnant womas cannot

reduce the child mortally rate." If preparat woman cannot access health services at hopithil and dispanarias, then child mortality will be high This hack of hashittarus is one of the reasons that babies are born presentarely. The health sector in Loos meeds to encourage greater healthcore for mothers and hear children as well as more to

hashincus for mothan and their children as well as work to decrease the number of deafts among newborn babies, the doctor added A senior official from the Ministry of Health said "I think rural women still

suffer from this problem become of their powerty and lack of understanding about healthcare, mainly among the solinic groups in some provinces of Lacs. Following traditional practices, they prefar give birth at home rather than going to heaping. He also pointed out that the use of clean dispert was also a problem formul mothers, as the risk of inflection increased when mothers used turclean dispert.

Workshop 'News in Perinatolo

Vientiane Times

mothers used unclean di DEC.

mother used unclean dupper. According to 2015 figures from the Ministry of Health, the mortality rate of children under one-year is 40 out of every 1,000 live births, while for children under five it is 70 out of every

cas year is 40 cut of overy 1,000 live births, while for children under five it is 70 cut of every 1,000 live births. The death rate of newtowns is 30 cut of every 1,000 live births. By 2020 the ministry hopes to reduce the monthly rate of children less than one year old to 30 cut of every 1,000 live births, and to 45 cut of every 1,000 live births for children under five years of age.

Television show provides fun, education for children

#### Annex A.2 Flash flooding in the Northern Provinces of Viet Nam, caused by Tropical storm "MIRINAE" on 28 July 2016

Vatnam

#### Storm Mirinae takes heavy toll on northern Vietnam





/1660/Uploaded/KG2/2016\_07\_28/ttxm\_mua\_ngap.jpg) A tree fell down on a flooded road after heavy rains in Thai Binh province (Photo: VNA)

Hanoi (VNA) - Typhoon Minae, the first to hit Vietnam this year, has caused human and property damage in the north of the country after it rolled into the mainland from the midnight of July 27.

As of 6 am of July 28, a salior residing in Sam Son town of the northern central province of Thanh Hoa went missing after his boat broke down and sank in the sea area about 3.5km off Hon Me Island. Five other crewmembers were saved, according to the permanent board of the Central Steering Committee for Natural Disaster Prevention and Control.

About 74, 100ha of rice in Nam Dinh and another 35,000ha in nearby Ninh Binh province were flooded.

In Hanol, one person was killed and five others sustained injuries during the storm in Dai Thang commune, outlying Phu Xuyen district. Ten places were deluged by heavy rainfails while strong winds uprooted 667 trees, hampering traffic flow. Up to 130 electricity poles fell down and 7ha of crops were flooded in My Duc district alone.

As of the morning of July 29, two people in Thai Binh province were wounded. Tomential rains inundated 39,300ha of rice and destroyed 1,900ha of other crops. Storm Minae also damaged nearly 30 classrooms in Vu Thu district and two brick factories in Thai Thuy district, and flattened 9,000 trees in Thai Binh province.

Power blackouts were reported across Thai Binh since the midnight and the problem has yet to be fixed, said the province's steering board for natural disaster prevention, search and rescue.

Hundreds of trees fell down in Hung Yen province, where widespread power outages last for 12 hours from 10 pm of July 27. Around, 800ha of rice in Tien Lu province were deep under water, and nearly 800ha of longan trees in Hung Yen city were damaged. Strong winds also blew away roofs and advertising banners there.

In Ha Nam province, by 9 am of July 28, the tropical storm flooded almost 28,500ha of rice and 3,000ha of other crops, knocked down over 9,100 trees and unroofed some 1,000 houses, the local disaster prevention agency said.

Three residents in Thai Nguyen province and one other in Hoa Binh province were injured during the storm, which triggered blackouts in Hoa Binh and Hai Duong provinces. It also weaked havoc on crops, livestock and houses in these localities.

In the face of the heavy toil, the Prime Minister on July 28 requested the People's Committees of the northern localities and Thanh Hoa province, ministries, and the Central Steering Committee for Natural Disaster Prevention and Control to summon resources to address the storm's consequences.-VNA
#### Annex A.3 Flash flooding in the Northern Provinces of Viet Nam, caused by Tropical storm "NIDA" on 03 to 04 August 2016

11 killed or missing in floods Flood damage is estimated at more than VND200 billion



In Commune, Lão Cal City, Floods killed at le

Story on Page 3

# 11 killed or missing in Lào Cai Province floods

LÀO CAI — At least four people were dead and another seven missing after flooding struck northern Láo Cai Province, authorities reported yesterday.

Lão Cai People's Comminee said that they believed many others were still trapped under earth and rocks following a flash flood on Thursday night.

Typhoon Nida brought heavy rain and thunderstorms to northern Việt Nam after making landfall on Tuesday night.

The mountainous Bát Xát District suffered the beaviest human loss in the flooding with three people killed while six are still missing.

One of the dead was from Sa Pa District as was one of the missing.

Lão Cai Steering Committee for Disaster Prevention and Rescue (SCDPR) said that at least 76 households in Bát Xát's Phin Ngan and Quang Kim communes were isolated by the flooding as bridges and roads were cut off.

More than 100 households in Coc San commune were partially flooded.

Over 10,000ha of paddy fields and another 1,000ha of vegexplicit were under water or rocks brought with the flash flood, according to the SCDPR.

Farmers took another blow from the terrible weather as more than 300 animals were killed in the flood.

The SCDPR estimated damages caused by the flood so far at more than VND200 billion (US35.9 million).

Lio Cai Hydro-mereorological Centre Director Lutt Minh Håi said that Båt Xåt received 152mm of rain as of yesterday morning, while some 63mm and 72mm fell across Lio Cai City and Båo Yén District respectively.

"Lao Cai residents have not seen such a big flood and downpour since 2008," he told Dân Việt (Vietnamese folks) newspaper yesterday.

#### Traffic suspended

Heavy downpours triggered massive landslides in the region, temporarily halting traffic within Lão Cai and to other localities.

Municipal Department of Transportation (DoT) Director Nong Văn Hưng taid that about 13,000 cubic metres of earth and rocks fell over a section of the 4D National Highway in Sa Pa District. The highway connects Lão Cai and neighbouring Lai Châu Province.

Hung said that all vehicles are now barred from travelling on the Lão Cai – Lai Châu section of the 4D highway. The ban started yesterday and will last until further notice from the DoT.

Traffic jams were also reported on routes leading to 5a Pa and connecting Båt Xåt district centre to other communes including Phin Ngan, Quang Kim and Tông Sành.

#### Disaster relief

Deputy Minister Trinh Dinh Dùng yesterday afternoon visited Lho Cai to monitor the rescue and the disaster relief work.

He asked local authorities to urgently look for the missing persons and prepare temporary accommodation and enough food for residents who lost their houses in the flooding.

Prime Minister Nguyễn Xuân Phúc also ordered the National Committee for Search and Rescue and the ministries of Public Securicy and National Defence to deploy forces based in the region to look for the missing persons and provide disaster relief.

Local health facilities were asked to offer free treatment to the injured and to help residents in the clean-up work for disease prevention after the flood ceases. — VNS Annex A.4 Flash flooding in Lao Cai Province of Viet Nam, caused by ITCZ on 12 – 15 August 2016

## Deaths, damage in torrential northern rains



Nučnj Uzračeni i verse Trans Na Pratov na izlatilo za tako je presta poteniji, Danopavi in Pastoj na o resta n Nasa in nation stol nationici njani over te patrice daja, King a tako te paga "— VIXVIII Prato

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# Deaths, damage...

#### Prop Page 1

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Lond estimation of these lecolling multilized evolution forms to help progle in effected areas.

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The Couler wave of all the lag is major ables and select armaria H3 Mit H41 Palag. Qoing Mish, Th41 Blah, Man Djah, Mish Blah and H41 Debing. Flack flow and bank-life are forward in the method regime, separately Cou Bing Bin Kon, Long Sele, Qoing Mish, H3 Giong, Taylo Quang, Lin Coi, Yin Bil, His Blah, Th41 Mgayin, Thank His, and Nghi An, - VNS

### Annex A.5 Flash flooding in Bokeo Province of Lao PDR, caused by ITCZ on 12 - 13 August 2016



C TUESDAY AUGUST 16, 2016 ISSUE 189

Landslides follow heavy rains in nation's north

o province road workers are struggling to repair sections of a provincial link between the districts of Paktha and Huayazi after vehicles were left stranded on Sunday evening by dalides

A 38 km section of the Paktin

A 38 km section of the Poldin repairs on Mondry but waves to Haryoni road has been out at fing point hest boundhids. Solt the washer did down onto the road in two locations while it has collapsed in mother two places. An official from the province Public Works and more raim the road may be province Public Works and the road may be somboun Kenthkong told Mr Somboun Kenthkong told Mr Somboun seplained Machine Andre and Solt and the road landhids had cut off the road

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Xayanizm saction of Netional affemeon's section of National Road 2W at Vanglam Bridge in Horn district located between Xay and Palabaeng districts that was flooded on Friday morning has seen vehicles starting to cross on Monday after water receded.

receded She added there had been more rain and even sumhine again in Houn district on Monday morning. However, toms streets in the town of Oudomaxy province's Xay district remained Rooded Following some more rain in attantion to socio-socionentic development strategies in enhancing people's livelihoods after visiting several projects in the province. The PM lied his delegation to Phoognally province last Saturday after completing ender wints to Lang Prabeng and Oudomary provinces. During the visit Mr Thongloum was provided a report on the province's socio-sconomic development situation and potentials by district remained flooded following some more rain in the afternoon, but it started to recede by 3:30 pm that day after the ram stopped. About 170 houses in four villages of Hongsa district in Xayaboury province ware

oded dr also fi to heavy min on Friday

4500 ktp 111111 1 1 10 110 0 蛇 .........

Inister Thongloun Sis

### Boost economic development, PM urges authorities in Phongsaly

(GDP) GDP per capita reaching US\$840. He said the province Prime Minister Thongloun Sisoulith has urged leading authorities in Phongraly to pay attention to socio-economic approved 77 villages as model development villages, 123 villages as model cultural villages and 13,602 families as

villages as an willage as an 13,602 families as model development families. Phongsaly had mobilised revenue of more than 45.96 billion kip, accounting for 90.22 percent of the yearly also

The province has bolstered friendly relations and

ts neigh in Vietnam and Chi with seeking assistance and funds elsewhere to further contribute to socio-ec development. Mr Khami

ht re-progress on the implan-of the construction project of the new Phongaby provincial capital in Boumaus district. Mr Thongloun visited the building arts for the new CONTINUED PROE 2

ບໍລິສັດ ລາວ ບໍລິການຂື້ນສິ່ງ LAO FREIGHT FORWARDER CO., LTD



#### Annex A.6 Flash flooding in Northern Province of Thailand, caused by ITCZ on 14 – 15 August 2016

8/24/2016

Nan residents affected by flash floods | National News Bureau Of Thailand



Nan residents affected by flash floods

16 Aug 2016 | (90 Visitor ) | 🖶

### 🔂 💟 😵 🌚

NAN, 16 August 2016 (NNT) - Seven districts in Nan province have suffered heavy flooding, after a low pressure trough brought heavy rain to the North of Thailand.

Nan Governor Suwat Promsuwan has declared disaster zones across 127 subdistricts, as access to food and dean water has been cut off by the rising waters. Authorities have been trying to reach out to disaster-stricken people to deliver basic necessities. A group of soldiers from the 38th Military Circle used a large army truck to reach severely flooded areas to evacuate residents to higher ground.

Water levels in all rivers have reportedly increased significantly, with some overflowing the embankments and flooding riverside communities. Several roads in the capital district and a bridge over the Nan River remain inundated.

Authorities have deployed four water pumps to redirect water from the overflowing rivers. Water pumps have also been used at Nan Provincial Prison, as floodwaters have reached the inner cells. All inmates have been moved to the second level of the prison.

The communities of Phumin and Ban Thalee have been struggling as homes were submerged three meters deep in floodwaters. Nan City Mayor Surapol Thiensut and a team of municipal officials visited Ban Thalee and ordered the removal of all manholes covers, for fear the situation may exacerbate in the municipality. Mr. Surapol said it is possible the flood situation could reach the crisis levels seen in 2006 and 2011.

The low pressure trough is expected to linger over the upper parts of the country until the end of the week, during which residents have been warned of possible flash floods.

#### Annex A.7 Flash flooding in Luang Prabang Province of Lao PDR, caused by ITCZ on 17 - 18 August 2016





## **Flash flooding in Luang Prabang** kills woman, damages crops

#### Times Reporters

Flash flooding in northern parts of the country including Lump Probump province has taken one life, destroyed many hectares of rice and other crops and vanished away houses and irrigation channels and livestock. The woman who was killed was identified as Mr. Thong of Hourno village, Phoenzav

was identified as Ma Thong of Hourno village, Phontary district, the secretary of the Luang Probang provincial disatter management and prevention committee. Mis Champheag Photdars told Mentiour Theory wasterday. Official also reported that more than 1,000 families in ma district of Luang Dahang

more than 1,000 families in nine districts of Luang Prabang province ware impacted by the recent flash flooding after heavy rain over the period from August 5-15. More than 10 houses were

damaged, a tractor and a bicycle were broken and 900 hectares of upland and wet season rice were damaged or



Flash flooding in Oudomcay province has made road travel difficult

sease ince were damaged or Flash flooting in Concentry promotions and damage figures will rise by similar flooting but not all Some 73 shectares of other damages sustained by irrigation and damage figures will rise by similar flooding but not all crops also sufficed warying channels, wood bridges and after all reports are compiled reports have been compiled by local authorities, Ms as yet. buffalces, 39 pigs and almost The worst impacted areas lost. The flooding also saw It is expected that the loss Outcomary were also affected CONTINUED PAGE 2

Flash flooding in ... FROM PAGE 1

affected, the Bokeo provincial social welfare section deputy head, Mr Phousy Lattanaphak reported More than 200 hectares of

pland and wet seasonrice within he districts were damaged and almost 100 livestock and poultry deaths were reported. Some district roads were

also damaged, especially in Paktha and Pha-Oudom, which suffered from landslides and flooding he said. washouts. The heavy rains flooded

Atpresent, local authorities are continuing to collect information on the damage in order to seek assistance, Mr Phoney said.

In Xayaboury province, four villages of Hongsa district were the worst affected. Those were Napoung, Khaenkham, Sibounheuang and Phonsoung, the provincial social welfare section head, Mr Nouphone Xaypanyachit reported. More than 70 families or

891 people who live along the mountains and rivers have been impacted by recent flash

170 households, damaged 4.5 hectares of rice, sureet hectares of rice, sureet poultry and saw 15,000 fish escape from their fish ponds. Roads and irrigation provincial authorities.

channels were also damaged but there are no estimates on the expected costs as yet.

The provincial authorities have already provided initial assistance to victims by handing over drinking water, rice and some necessary equipment, Mr Nouphone said.

More than 2,000 families in 25 villages of Houn district, Oudomxay province were also impacted and over 2,000

hectares of rice, suvestoom and some cash crops were lost. Basing district also suffered losses but has yet to report to



escalates budgetary tensions

National revenue shortfall

escalates budgetary tensions someask Pongkhao Revenue collected over the part 10 months of the 2015-16 the Bank of the Lao FDR to source funding to respond to budget expenditure seeds to budget expenditure seeds to seek more studied by the summal plan approved by the Matematic and the second by the further secalated budgetary to seek more funding to respond to seek more funding to respond to seek more funding to to seek more funding to to seek more funding to source funding to respond to seek more funding to to seek more funding to to seek more funding to the second the sevense and national development tada in the aspirative and mational development badi in Ventuase from August TOP revenue collecting being bed in Ventuase from August TOP revenue collecting being bed in Ventuase from August TOP revenue collecting being bed in Ventuase from August TOP revenue collecting being bed in Ventuase from August TOP revenue collecting being bed in Ventuase from August TOP revenue collection the research funding to filmance to the servening being bed in Ventuase from August TOP revenue collection the research for the servenue sond primate from August to the servening being bed in Ventuase from August to the servening being bed in Ventuase from August to the servening being bed in Ventuase from August to the servening being bed in Ventuase from August to the servening being to film the person collection that need to be

Annex A.8 Flash flooding in Northern Provinces of Viet Nam, caused by Tropical Storm "DIANMU" 19 – 20 August 2016

# Typhoon Dianmu kills seven in VN

HÀ NỘI — Typhoon Dianmu has so far cost the lives of at least seven people and left another two missing after sweeping through northern Việt Nam over the weekend.

Eight people were also injured due to falling trees, collapsed houses and landslides as the raging typhoon made landfall on Friday, reported the Office of the Central Steering Committee for Disaster Prevention (OCSCDP) as of 7am yesterday.

Yên Bái Province was hit the hardest with two deaths and one injured. Other provinces of Sơn La, Lào Cai, Hòa Bình, Bắc Giang and Nghệ An each had one fatality.

Floods in Bắc Giang and Lào Cai provinces washed away two people who have yet to be found.

The capital Hà Nội, which witnessed several big trees uprooted in the typhoon, had three injuries reported. So did the neighbouring Vĩnh Phúc Province while the typhoon sent one member of the public to hospital in Phú Tho Province.

The OCSCDP reported 44 houses destroyed and washed away in the flooding across 13 localities hit by typhoon Dianmu, which also ripped the roofs from more than 650 houses and left others, over 1,510, under water. At least 2,154 families were forced to undergo emergency evacuation prior to the typhoon.

Nearly 2,000 cattle and poultry were killed, while over 10,000 ha of paddy fields and vegetables were flooded. Hà Nội accounted for one third of the destroyed farm land with about 3,064ha flooded, followed by Vinh Phúc Province with 2,698ha.

Some 252 trees were uprooted and strewn across streets, and in some cases damaged adjacent buildings and vehicles parked under them. Fourteen bridges across the affected provinces were severely damaged. Thousands of roads, canals and dams were submerged and degraded. Blackouts occurred in a number of areas due to fallen power poles and damaged transmission lines.

The national flag-carrier Vietnam Airlines had to cancel 10 flights due to the typhoon while Vietjet Air called off 15. Dozens of flights to and from the northern region were also delayed for hours as Dianmu caused heavy winds and downpours across the area.

Agriculture Minister-Head of the Central Steering Committee on Disaster Prevention and Control Nguyễn Xuân Cưởng on Saturday morning chaired a meeting reviewing storm response and post-storm recovery.

On-site missions were deployed across the affected localities to assess and promptly address the consequences of the storm and post-storm flash floods. Local authorities had pumping machines running around the clock to pump water from paddy fields, while residents were repairing damaged houses, roads and cleaning up their living environment.

Typhoon Dianmu was the third of its kind to batter Việt Nam this year. The first two typhoons, Mirinae and Nida, killed 20 people and injured another 82. They caused damages of more than VNĐ6.7 trillion (US\$297.7 million), according to the Ministry of Agricultural and Rural Development. — VNS

# Annex A.9 Flash flooding in Northern and Central Provinces of Lao PDR, caused by Tropical Storm "DIANMU" 19 – 20 August 2016

SATURDAY AUGUST 20, 2016 ISSUE 193

netimes la

## Typhoon Dianmu passes over northern provinces

#### Times Reporters

The remnants of Typhoon Dianna passed over northern Loos yesterday, bringing with it strong winds and heavy rain after making landfall in northcentral Vietnam on Thurwday

Notangia pical storm brought catchinge pacts to northern maximum file and xiang Khunng the maximum file cantral province, house, a to the Lao hivestock yr and Hydrology fish stoch z, some

Strong winds and heavy in rain as a result of the passing of the typhoon caused landslides, p fissh flooding, and rising river mbutanies. The my tributanies in already o m areas are now at high of the pub gerous levels. August 17

provinces, especially Amb living along the concerns fay and Xan river along the arb, can also expect Mekong pacts. impacts firsh flooding in quickly parthern remuinces

> ple's Rain is expected as of continue in the north mused provinces until August after which the worther sking emocred to clear.

> > Flash flooding so far this miny season has caused thousands of hectares of unland and ant season rice to

be damaged, along with the loss of hundreds of livestock, as well as poultry and fish stocks.

Many roads and irrigation systems have also suffered varying extents of damage. Most of the victims are people who live in northern and central provinces, local medio has reported. However, all scheduled

Lao Airlines domestic flights from Wattay International Airport in Visutiane still departed yesterday, despite the storm passing over Laos.

irlines had to cancel numerous flights arriving or leparting from the country's CONTINUED PAGE 2



Typhoon Dianmu passes over ... FROM PAGE 1

northern and central airports yesterday due to Typhoon Dianmu.

Diamu, the third Diamu, the third typhoon to hit Vietnam so far this year, was forecast to make landfall in the country's northern region from Hai Phong City to Ninh Binh province at around 10 am local time on Friday. The strongest gales were predicted at 75-100 km per hour, according to the National Centre of Hydro-Meteorological Forecasting of Vietnam.

Hy in order the order of the forefore-casting of Vietnam. Following such fore-casts, the national flag carrier Vietnam Airlines cancelled ten flights departing and arriving at northern Hai Phong City's Cat Bi airport, and central Thanh Hoa province's Tho Xuan airport yesterday.

South China's Hainan and Guangdong provinces were also hit by the same Typhoon, causing heavy rains and landslides in the region.



causing heavy rains and landslides in the region. Flash flooding in the aftermath of Typhoon Dianmu in Nonghaed district town, Xieng Khuang province.

### Annex A.10 Flash flooding in Northern Provinces of Thailand, caused by Tropical Storm "DIANMU" 19 – 20 August 2016

Tuesday, August 23rd, 2016 | Posted by Editor

## <u>Three Villagers Die from Flooding in Chiang</u> <u>Rai</u>



Residents have been warned of possible flash floods and forest runoffs due to torrential rain

CHIANG RAI – The Northern Meteorological Centre warned that more heavy rain is expected in Chiang Rai and 11 other northern provinces. Three villagers died from flooding in separate areas of Chiang Rai on Saturday.

They were identified as Chan Yuenyongsaen, 80, from Mae Chan district, Thep Saengkaew, 58, from Mae Suai district, and Boonruang Phumthawong, from Muang district.

Residents have been warned of possible flash floods and forest runoffs due to torrential rain.

The Northern Meteorological Centre warned that more heavy rain is expected in Chiang Rai and 11 other northern provinces as Tropical Storm Diannu batteres northern Thailand.

Residents in the north have been urged to get prepared and keep monitoring information about the water situation from authorities and the media.

#### Annex A.11 Flash flooding in Southern and Central Provinces of Lao PDR, caused by ITCZ and tropical storm "RAI" 13 September 2016

WEDNESDAY SEPTEMBER 14, 2016 ISSUE 214

## Heavy rain lashes southern provinces

#### Times Reporters

While areas remain While some unaffected by strong winds unaffected by strong winds and heavy rain as forecast from September 13-15, there has been significant rainfall in other parts of the south, according to the Meteorology and Hydrology Department. Officials in at-risk areas the memory provided the strong bands

Officials in at-risk areas are monitoring river levels in Khammuan, Savannakhet, Champassak, Saravan, Xekong and Attapeu provinces and are ready to respond to flash flooding if the rainfall

increases. An official from the meteorology and hydrology office in Xekong province told Vientiane Times yesterday that Xekong is one of the areas in the path of a storm blowing in from the east, after weather forecasters warned of strong

winds and heavy rain. After hours of heavy rain that began on the evening of September 12 and continued into the morning of September 13, some communities on low-lying ground in Lamam district CONTINUED PAGE 2



w-lving areas of Xekong province were flooded yesterday

## Heavy rain lashes ... FROM PAGE 1

were under water yesterday. But the floodwater receded after the rain abated, an official said

The provincial meteorology and hydrology office said officials were monitoring the level of the Xekong River which was now at 11 metres. If it rises above 15 metres, there is a risk of flooding which would seriously impact riverside communities and farmland.

In Champassak province, media personnel reported that there had been light rain on September 12 becoming heavier yesterday morning in Pakxe district.

Some roads in the town centre were flooded, but the water had not caused any

damage. The water in the province's main rivers has now reached a height of almost 9 metres, which is still well short of the 11-metre danger level.

Parts of Khammuan and Savannakhet provinces also experienced heavy downpours yesterday.

The Weather Forecasting and Aeronautical Meteorology Division of the Meteorology and Hydrology Department yesterday warned that strong wind gusts and heavy rain would likely affect parts of Laos from September 13-15.

Squalls could affect the provinces of Khammuan, Savannakhet, Champassak, Saravan, Xekong and Attapeu, and also Vientiane, but are unlikely to be severe.

The public is urged to take care and be alert to the possibility of falling trees and damage to houses and other buildings. Landslides may also occur, along with flash flooding caused by heavy rain, and everyone is advised to listen to weather forecasts issued by the Meteorology and Hydrology Department.

The warning came after high winds were detected over the South China Sea on September 12. The storm was predicted to reach Danang on the Vietnamese coast yesterday morning and to move across Laos in the afternoon, with most of the effects felt in Xekong and Saravan provinces.

#### Annex A.12 Flash flooding in Central Provinces of Viet Nam, caused by ITCZ and tropical storm "RAI" 12-13 September 2016

Friday September 16, 2016

## NATIONAL

#### s.vn Viêt Nam News 3

#### 5 dead, 10 missing following Storm Rai BRIEFS VN bans antibacterial

HÀ NỘI — Storm Rai has killed at least five people and left ten others missing over the past few days in central localities, accord-ing to the latest report from the National Steering Committee for Disaster Prevention and Control.

Some 26 people were also in-jured due to falling trees, col-lapsed houses and landslides after the storm, the fourth to hit Việt Nam this year, made landfall in the central region early this week.

Heavy rains caused flash flood and landslide in Nghê An Province's Quỳ Châu District, which borders Như Xuân District of Thanh Hóa Province, yester-day, killing two people from Thanh Hóa and one from Nghệ An while leaving five others missing. Two people from Quảng Bình

Province reportedly died. Local authorities of the two provinces have mobilised all their forces to search for the missing people. The Committee for Disaster

Prevention and Control also re-ported that 90 houses were de-stroyed, 612 houses were damaged and 53 houses had their roofs blown away.

More than 1 700 houses and 11,655ha of rice were submerged, while thousands of trees had fallen.



In addition, thousands of poultry and cattle had died due to flooding in the localities hit by the storm, while over 1,000ha of aquaculture farmland was damaged. Hundreds of kilometres of national and provincial highways were also damaged and 19 small

bridges were destroyed. Meanwhile, thousands of students in Hà Tĩnh and Nghê An were kept home from schools due to floods.

The committee has urged authorities of localities in the cen-tral region to take measures to deal with the aftermath of the storm.

The central localities have been requested to assess the dam-age caused by Storm Rai and mobilise forces to help people stabilise their lives. The Steering Committee also asked the provinces to undertake active mea-sures to deal with the effects of Super Typhoon Meranti, which hit China's Taiwan yesterday and is forecast to land in Guangdong Province today. Provinces from Nghệ An to

Heavy rainfall

landslide in central Nghệ An

Province's Quy Châu District,

caused a

Ouang Binh have been told to implement measures to deal with the rain and the floods caused by the typhoon and inspect the safety of lakes and dams, especially those under construction on rivers and streams in areas where heavy rainfall is expected. — VNS soaps with triclosan HCM CITY — The Ministry of Health's Drug Administration will Heath's Drug Administration will withdraw registration numbers and stop selling antibacterial soaps on the market if they find them unsafe or if warnings about the soap are issued by international empeiedies. organisations. The ministry has instructed manufacturers and importers in the country to report about the use of any of 19 ingredients, including triclosan and triclosarbon which the

triciosan and triciosarbon which the US Food and Drug Administration banned in over-the-counter consumer antiseptic wash products on September 2. According to a press release from the US FDA, the rule which it issued does not affect consumer band sanitisers or whose or

hand sanitisers or wipes, or antibacterial products used in health care settinos.

Consumers may think "Consumers may think antibacterial washes are more effective at preventing the spread of germs, but we have no scientific evidence that they are any better than plain scap and water," said Janet Woodcock, director of the D L Concert for Due Schuckbo FDA's Center for Drug Evaluation and Research.

"In fact, some data suggests that antibacterial ingredients may do more harm than good over the long-

#### IT vacancies, applications a the rice

Page 102

#### Annex A.13 Flash flooding in Central Provinces of Viet Nam, caused by ITCZ on 14 October 2016

Landslides in Quang Binh shut down North-South railway

Friday, 2016-10-14 10:01:28

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(/cdn/en/media/k2/items/src/470/0052b255334d70587dbfd684a9fa2103.jpg) A flooded section of the Ho Chi Minh Highway

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NDO/VNA - Landslides in the central province of Quang Binh have paralysed sections of the North-South railway, according to the Vietnam Railways (VNR).

As of 6:00 pm on October 14, a total of nine landslide sites were recorded in the province due to extensive rain.

The Dong Hoi railway station was totally flooded, the VNR said, adding that nine passenger trains and nine cargo trains had to stop their journey on the evening of October 13.

Trains running through the North-South line in Hanoi and Ho Chi Minh City were all suspended.

All VNR units are doing their utmost to address the incident.

The Ho Chi Minh Highway in Quang Binh's Minh Hoa District is also deep under water and closed to traffic.

Torrential rain over the past two days has flooded most cities, districts and towns in Quang Binh province, according to the provincial steering committee for natural disaster prevention and search and rescue.

A 62-year-old man went missing on the morning of October 14 and is still unaccounted for.

Heavy inundation was reported in Minh Hoa, Tuyen Hoa, Bo Trach, Le Thuy, Quang Ninh and Quang Trach districts.





## Central provinces hit by storm

Update: October, 15/2016 - 01:00



Flooding in Quảng Bình Province. — Photo courtesy of Nguyen Chau A Viet Nam News

THỪA THIÊN - HUẾ — Three people died and two others have been reported missing in Việt Nam's central provinces after a low tropical depression made impact Thursday.

The depression caused continuous heavy rains in Thừa Thiên -Huế, Quảng Trị and Quảng Bình in both day and night, blowing roofs off hundreds of houses and wrecking trees. One man died after falling from his rooftop during home repair, and two others are presumed dead and still missing after strong flood currents in Thừa Thiên - Huế and Quảng Bình washed them away.

Another in Quảng Trị got heavy facial injury from falling roof tiles.

8

A report released yesterday morning by Thừa Thiên - Huế Centre for Flood and Storm Rescue said the storm blew away roofs of 87 houses in Phong Điền, Phú Vang and Phú Lộc districts. About 2,000 hectares of cassava are possibly rotten and 26 hectares of vegetable destroyed because of floods.

Phong Điền roads were flooded, while traffic circulation in many streets in Huế City has been hindered by falling trees. Blackouts occured in many areas around the province, and all schools shut down yesterday to ensure childrens' safety.

Water in local rivers continues to rise and heavy rains continue in several zones around the province.

In Quảng Trị, 180 house roofs were blown off and five fishing boats wrecked because of strong winds. Large plots of rubber and black pepper were devastated.

Flooding occured in many areas in Hướng Hóa and Vĩnh Linh districts. All students stayed home yesterday.

In Quảng Bình, almost all of Tân Hóa Commune has been flooded, with river water everywhere.

According to the national Centre for Hydro-Meteorology Forecasting, heavy rains will continue in central provinces of Thừa Thiên - Huế, Quảng Trị, Quảng Bình, Hà Tĩnh and Nghệ An till Tuesday next week.

The national steering committee on natural disaster prevention held an online conference with the central provinces of Thừa Thiên-Huế, Quảng Trị, Đà Nẵng, Quảng Ngãi and Quảng Bình.

These localities were tasked with closely monitoring the situation, setting up response teams in vulnerable areas and spreading storm updates and warnings to remote areas.

— VNS

#### Annex A.14 Flash flooding in Central Provinces of Viet Nam, caused by Low Pressure and Tropical depression on 31 October to 5 November 2016

vietnam

#### Floods woes continue for central region

VNA LÚC : TUESDAY, NOVEMBER 01, 2016 - 9:52:00



(http://img.en.vietnamplus.vn/t660/Uploaded/KG1/2016\_11\_01/20131116\_mienTrung1.jpg) Flood in central region (Illustrative image. Source: VNA)

Hanoi (VNA) - Severe floods are expected as the river water level is rising swiftly in the central provinces of Quang Binh and Ha Tinh, which were devastated by historic floods earlier this month.

Water from the floods in the beginning of the month has yet to flow out in several remote areas in the provinces, resulting in repeated floods in the locality.

According to a report by commune authorities in this province's Ba Don district, the latest flood submerged their residency on October 31 monring. A dyke broken and locals attempted to reinforce it but failed, and floodwater from Gianh River poured into the communes again.

Nguyen Van Hoa, head of Quang Hai commune, said local authorities managed to evacuate residents of a village in the lowest-lying area in the district.

Flooding approximately one metre deep filled communes in Tuyen Hoa and Bo Trach districts. In Quang Trach, floods swept away a floating bridge, isolating 1,000 residents in the district.

All schools in the flooded areas were shut down.

Railway authorities in the province deployed trucks to assist trains travelling through the flooded areas. The trains were forced to travel at an average speed of 5km per hour.

In Ha Tinh, the three lowest communes of Huong Khe district, which were hit hardest by the early October flood, were flooded again today. The water also blocked roads leading to the communes, isolating them even further.

Hoang Xuan Tan, head of Phuong Minh commune, said all residents were forced to travel by boats. Several houses were flooded right after locals attempted to clean them up following the last flood.

The district agriculture sector reported that 75,000ha of farming land cultivated by local farmers was affected again by the new flood.

Traffic has also been blocked in several areas in this province's Ky Anh district. Education authorities ordered 16,000 students remain at home to ensure safety.

Continuous heavy rainfall during the weekend has made water in Quang Binh's Gianh River and Ha Tinh's Ngan Sau River rise swiftly.

Water released from the Ho Ho power plant, which is located between the two localities, has worsened the situation. Fortunately, the release is being made in a low and gradual volume, unlike the unannounced release of a huge volume of water the last time.

The National Centre for Meteorology and Hydrology Forecast late last week warned central provinces of flood risk due to the heavy rains. According to the centre, water in all the rivers in Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien-Hue is reaching an alarmingly high level.-VNA Annex A.15 Flash flooding in Central highland of Viet Nam, caused by Low Pressure and Tropical depression on 31 October to 5 November 2016

# Flooding toll: 15 dead, six missing

HÀ NỘI - Up to 15 people were killed and another six are missing from heavy downpours and flooding in the central region and Central Highlands.

The figures were updated yesterday by the Central Steering Committee for Disaster Prevention and the National Committee for Search and Rescue, compiled from damage reports of 13 localities affected in the prolonged downpour.

Flooding affected ten provinces: Hà Tinh, Quảng Bình, Quảng Trị, Thừa Thiên-Huế, Quảng Ngãi, Bình Định, Phú Yên, Khánh Hòa, Ninh Thuận and Bình Thuận. Another three in the Central Highlands including Kon Tum, Gia Lai and Đấk Lấk were also on the map of disaster-hit localities.

The current death toll rose from 10 announced in Saturday's report. Phú Yên province suffered the heaviest loss, with a total of seven killed and one missing. Quảng Bình had three deaths while Quang Tri and Binh Dinh each lost two residents. The last victim was from Dák Lák Province

Heavy rain started last Monday and continued throughout the week, flooding nearly 41,000 houses across the two regions, of which 223 houses were damaged by 50 to 70 per cent, according to yesterday's report of the Department of Disaster Prevention in the Central region and Central Highlands (DDPCCH).



A cow dies in flooding in Hoà An Commune, Phù Hoà District, Phù Yén Province. Recent severe flooding in the central region and Central Highlands killed 15 people and left another six missing. VNA/VNS Photo Phan Sáu

## Flooding toll: 15 dead...

The agriculture sector was hit badly with about 12,000 hectares of paddy and vegetable fields un-der water, while some 42,724 poultry and another 440 cattle were wned or washed away. The DDPCCH estimated the

the DDPCCH estimated the conomic damages caused by the flooding at VND492 billion (US\$21.8 million) as of yester-day morning. Damage in Phú Yên alone amounts to about VNÐ337 billion, accounting for nearly 70 per cent of the total losses

losses. Phú Yén People's Committee yesterday asked the Government to urgently send 1,100 tonnes of rice as aid relief for some 33,600 people affected by the flooding. Phú Yén and Đấk Lák were the cally two proginges with most of only two provinces with most of the land still under water as of vesterday

Flood waters fully receded in Flood waters nully receded in HA Tinh, Quang Tin, and Thita Thién-Huế, while low lands in the remaining provinces were still submerged. The Central Steering Com-mittee for Disaster Prevention warned the provinces to keep

monitoring rain and flood fore-casts, and be prepared to evacu-ate residents from areas prone to flash flooding and landslides. the 2016-17 winter-spring rice sowing stage in October.

salt water intrusion.

ers to temporarily stop sowing rice

seeds as prolonged rains are fore

Farmers can resume sowing noe seeds between November 15 and December 15, the main sowing pe-riod of the 2016-17 winter-spring rice crop, said the department. In Long An Province, pro-longed rains have caused damage to about 7,500ha of rice aged 5-00 down the second second

Besides prolonged rains, the

20 days old.

Farmers can resume sowing rice

cast to continue in coming days.

#### Prolonged rains in Mekong

CONTINUED PAGE 2

Meanwhile thousands of hectares of the 2016-17 winter-spring rice season, which were sown early in the Citu Long (Mekong) Delta, have been damaged by prolonged and heavy rains. In Hậu Giang Province, many

farmers have had to pump rain wa-ter out of paddy fields to save their

young rice. Nguyễn Văn Hơn in Hậu Giang's Vị Thuỳ District said his family used more than 100 litters of diesel oil to pump water out of two hectares of 10 day old rice. "But before all the redundant

water had been pumped out of the field, rains continue occurring. As

held, rains continue occurring. As a result, about 30 per cent of the rice has died," he raid. Rains have flooded more than 210ha of newly sown paddy fields in Håy Giang, causing 10-50 per cent of newly sown rice in the fields to die, according to the pro-vincial Danstrander of Amicrophysics

vincial Department of Agriculture and Rural Development. Under the province's plan for

delta's annual flooding is increas-ing in the Đồng Tháp Mười (Plain of Reeds) region, threatening the crop, Hậu Giang planned to sow about 30,000ha in the crop's first safety of rice areas which are not

sowing stage in October. But the province has sown about 4,000h as of ar. Lê Văn Đời, deputy director of the Hậu Giang Province Depart-ment of Agriculture and Rural De-velopment, said the 30,000h ar rice are planned to be sown early in areas which are prone to irriga-tion water the and sarety of nice areas which are not protected by dykes in Long An. The annual flooding is caused by the rining levels of the Mekong River and its tributaries between August and November. The Long An Province Depart-ment of Agriculture and Rural De-velopment in co-operation with tion water shortage near the end of the crop because of drought and

velopment in co-operation with district authorities is consolidating dykes and pumping water out of paddy fields to mitigate the salt water intrusion. However, continuing rains made the process of sowing rice slower than scheduled, he said. The Hậu Giang Province De-partment of Agriculture and Ru-ral Development has warned farmd forfar

damage for farmers. Dông Tháp Province has also sown more than 60,000ha of the 2015-16 winter-spring crop and prolonged rains have affected many paddy fields in Hông Ngt, Tân Hồng, Tam Nông and Tháp Mười districts

In Tháp Mười alone, more than In Tháp Mưới alone, more than 250ha of winter-spring rice have been inundated. Of the figure, more than 150ha have been dam-aged 70-100 per cent. Nguyễn Phú Bến in Tháp Mưới nhà havenn men thơ Tháp

Mutti, who has sown more than 7ha of glutinous rice, said prolonged and heavy rains caused the loss of sown seeds and increased extra production costs.

The extra production costs included buying pesticides to kill golden snails and hiring kill golden snalls and hiring people to transplant new rice seedlings in areas where rice seedlings died because of flood-ing, he said. Costs had increased by VND2-4 million per hectare, he said. Dông Tháp authorities have mobilized more gumps to merion

mobilised more pumps to suction water out of paddy fields and warned farmers to sow rice seeds according to schedules to mitigate damage. The delta, the country's rice

The delta, the country's rice granary, plans to grow about 1.5 million hectares of rice in the 2016-17 winter-spring crop, down nearly 5,000ha compared to the 2015-16 winter-spring crop, according to the Ministry of Agriculture and Rural Development's Plant Cultivation Department.

Under the Plant Cultivation Department's sowing schedules for the delta, the region planned to sow early about 420,000 ha of winter-spring rice last month, con-tinue sowing the rest of the areas in the following months and finish the sowing by January 10, 2017. — VNS

#### Annex A.16 Flash flooding in Central Provinces of Viet Nam, caused by Low Pressure 01 December 2016

#### Friday December 2, 2016

## VN, New Zealand agree to step up trade

WELLINGTON — Deputy Prime Minister and Foreign Minister Pham Binh Minh suggested that Việt Nam and New Zealand forge closer economic and trade ties in order to achieve their bilateral trade targets

The official made the proposal during his meetings with New Zealand's Speaker of the House of Representatives David Carter, and Deputy Prime Minister-cum-Finance Minister Bill English in Wellington yesterday. The target of US\$1.7 billion was formalised by their senior leaders for 2020.

He called on the two countries to increase co-operation between their businesses while seeking collaboration in new areas such as banking, services and renewable energy, especially wind power, which is New Zealand's strength.

Minh spoke highly of New Zealand's economic achievements, which, he said, have helped it become one of the ten economics of the Organisation for Economic Co-operation and Development (OECD) recording the fastest and most stable economic growth rate.

At the meetings, the two sides noted the strong developments in the Việt Nam-New Zealand relationship, especially after the two countries had established a comprehensive partnership in 2009, and issued a joint statement in March 2015, under which they agreed to enhance the partnership towards a strategic goal.

The regular exchange of highranking delegations, particularly in 2015, which marked the 40th anniversary of diplomatic ties (1975 to 2015), has helped intensify mutual understanding between Việt Nam and New Zealand, they said.

Two-way trade expanded by 20 per cent annually over the past five years, exceeding \$800 million in 2015, the officials said, while stressing on the effective and pragmatic bilateral collaboration in national defence and security, agriculture, labour, culture and people-to-people exchanges. The New Zealand side promised to join hands with Việt Nam in speeding up the assessment of risks to Vietnamese agricultural products, thus facilitating their penetration into the New Zealand

Talking about the latest developments relating to the Trans-Pacific Partnership (TPP) agreement to which Việt Nam and New Zealand are signatories, they described free trade and integration as "irreversible".

The two sides pledged to continue their co-ordination and mutual support at regional and international forums in which they are members, including the Asia-Pacific Economic Co-operation (APEC) forum.

(APEC) forum. The New Zealand side affirmed its backing for Việt Nam as the host of the APEC Year in 2017.

David Carter said Việt Nam is one of the priority partners with who New Zealand has earlier established a comprehensive partnership.

While expressing his delight at the thriving legislative ties and people-to-people exchanges between the two countries, the speaker said the two sides should maintain the direct air route between HCM City and Auckland in New Zealand in a bid to boost trade, tourism and delegation exchanges.

English valued Việt Nam's encouraging achievements in economic restructuring and growth model reform, saying that New Zealand wanted to co-operate with Việt Nam in economy, finance, banking and State-owned enterprise restructuring. New Zealand will continue to

New Zealand will continue to support Việt Nam's development by providing official development assistance (ODA) to the coun-

try, he said. Later that day, Deputy PM and FM Minh visited the Vietnamese embassy in New Zealand. — VNS

## 1,000 homes flooded in VN central provinces

QUÂNG NGÂI — Torrential rainfall measuring 100-200mm in Quâng Ngầi and Bình Định provinces has flooded nearly 1,000 houses and over 3,000ha of sowed rice and raised river levels.

A report yesterday by the Centre of Flood and Storm Prevention in the Central and Central Highlands regions said Bình Định was the most damaged locale by storm Tokage, with over 2,200 cubic metres of soil and 2.2kms of dyke and irrigated channels eroded and damaged.

2.2kms of dyke and irrigated channels eroded and damaged. One man, Nguyễn Đức Trọng, 33, was still missing in Quảng Ngải Province after trying to cross a stream in Ba Xa Commune in Ba Tơ District. The centre also said a ship from Navy Zone 3 had found and towed a stalled fishing boat with 11 sailors in the waters off the Hoàng Sa (Paracel) Island of Việt Nam.

A Navy ship was also called to rescue a boat from Bình Định off the coast of Đà Nẩng on Wednesday.

The central Quảng Ngài Province banned all passenger ships and fishing boats, warning of strong winds and high waves (from 1.5-3m high) in the Paracel and Trường Sa (Spratly) Archipelagos, and heavy downpours forecast to continue till the weekend.

Reservoirs in the central and Central Highlands regions were at 75 to 95 per cent of capacity. — VNS

#### Annex A.17 Flash flooding in Central Provinces of Viet Nam, caused by Low Pressure 14 December 2016

### NATIONAL

Saturday December 17, 2016

## Migration - a journey we must take together

e are almost at the end of the year, according to the Western business calendar. For many, it's the start of a journey home to see family, to be with friends. The journey to be with friends. The journey ends in reunions, togetherness, sharing. Even if we travel alone, we travel hopefully, knowing there will be a warm welcome at the end of the tiring journey. It's the time of the year when strang-ers help one another, when we smile and exchange greetings with people we don't know. Our journeys may be short, but they are long enough for us to re-flect on the millions who have set ut this year on less happy jour-

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out this year on less happy jour-neys. Asia may be one of the more neys. Asia may be one of the more peaceful continents on our planet, but is one with some of the big-gest disparities between rich and poor. Millions are on the move, seeking work and comfort for their families

#### **Op-E**D Dr Nenette Motus

Dr Nenette Motus December 18 is International Migrants Day, celebrated under the United Nations theme of to-getherness. Our welcome for mi-grants, our togetherness and soli-darity with them must extend fur-ther than simply benefiting from their contributions. We must also accept them into our society and assure them of the rights that we take for granted. take for granted.

The Aria and the Pacific re-gion hosts the largest migrant population in the world. Accord-ing to UN data, between 2000 and 2015, Azia added more interna-tional migrants than any other area of the world - 26 million in total, or 1.7 million additional migrants ner annum. or 1.7 million accesse\_ per annum. Asia's prosperity and growth is

built on a culture of migration, on the life stories and contributions of migrants. Asia can lead the world in celebrating this narrative, in realising that extending a wel-

in realizing that extending a wel-coming hand to migrant brings economic and social benefit: The migration journey will not always be smooth, but host soci-eties will never benefit if they neglect the welfare of migrant. Nothing increases the stigma that migrant face like diseases, ghettoisation and poverty. Con-versely, nothing increases the value and contribution of mi-grants than ensuring good grants than ensuring good healthcare (including mental

healthcare (including mental health) for them, housing, nutri-tica and working conditions. Very often, we send our young, talented, and educated people not only within our region but also to other regions. We expect their right to health and access to edu-cation to be ensured, as it should

be under the UN Convention on the Protection of the Rights of All Migrant Workers and Members of their Families. We need to demand that these rights be pro-

mand that these rights be pro-tected for all migrants, not just the ones to which we are connected. If we don't care for the migrants in our midst, how can we demand the same for our children overseas? The migrants' contribution is interwoven into our daily lives. Our shopping is bagged by mi-grants. Our meals atrestaurants are served by migrants. Our of-fice buildings are often built by migrant workers. The elderly in our aving societies are supported our aging societies are supported by migrants. Migrants are among the best and brightest of their

communities, and guickly rise to become doctors, lawyers, commu-nity leaders, tech innovators. Why do we stigmatize a group from which we benefit so much?

Migrants are too often perceived as "they.". They are the ones who take jobs from us or increase the crime rate or bring disease to our

crime rate or bring disease to our workplace and communities. This prejudice cannot be reconciled with the valuable role migrants play in our daily lives. Migrants sacrifice the one thing that we cherinh above all other - their homes. We need to recognise this, and ensure we value their contributions while appreciating what they have given up to be with us. Migration is a journey, not an escape. If s a quest for sanctuary, work, a sec-ond chance, a new dawn. We can walk that path together. walk that path together.

\*Dr Motus is Director of the International Organisation for Migration's Regional Officer for Asia and the Pacific, located in Bangkok, Thailand

From late November to vesterday, flooding caused by heavy rains killed 25 people and

injured 10 others in Binh

## Deputy PM urges joint response on central flooding

BINH DINH — Ministries, agen-cies and central province admin-istrations have been asked to work harder to deal with wide-spread flooding, which have heavily damaged the region. Inspecting flood response in Binh Dinh Province - one of the localities affected by the heavy flooding - waterdaw Denvin

flooding - yesterday, Deputy Prime Minister Trinh Đình Dùng Prime Minister Trinh Dình Dùng offered sympathies to flood vic-tims and asked Binh Định's au-thorities to mobiline all re-sources and have plans ready to timely deal with all situations. He stressed that local offi-cials should visit and encourage flood victims and prepare to help local residents resume their daily routines after the flood is

From late November to yes-From late November to yea-terday, flooding caused by heavy rainc killed 25 people and injured 10 others in Binh Binh. More than 57,400 houses were deep underwater, 348 collapsed, and another 398 were un-roofed—according to the province's steering board for di-sater prevention, search and rescue.

Over 13,500ha of rice and 3,500ha of other crops were de-stroyed in floods, which also washed away some 3,180 live-stock and 195,500 poultry. To-tal damage is estimated at over VND1.23 trillion (US\$54 mil-lion)

#### Mass flooding

Mass flooding More communes and villages in Thira Thién-Hué, Quáng Nam, Quáng Ngãi and Bình Định, as were flooded as the region ex-perienced average rainfaill rang-ing from 150mm to 400mm over the last two days. Further, 14 hydro-power plants and eight irrigation lakes in the central and Central High-lands region started discharging water through the soillway from

ater through the spillway from

water through the second secon



plants in Thừa Thiên-Huế, Quảng Nam and Phú Yên đis-charged a huge capacity of wa-ter, including Hrdng Điển in Huế (1,23cu, m. per seconD), Bình Điện (892), Sông Tranh 2 (2,606) and Sông Bung 4 (917) in Quảng Nam Province, as well Du Hưế (2000 - 41% Sec C as Ba Ha (2,800) and Vinh Son C (2,096)

The floods isolated and dis-

The floods isolated and dis-rupted traffic on 16 provincial roads in Thira Thiêa-Huế as main roads in the districts of Phong Điềa, Quảng Điền and Hương Trà were submerged, with water as high as 0.3m-2m. Heavy flooding also occurred in the districts of Đại Lôc, Điện Bàn, and Duy Xuyên and Hội An City in Quảng Nam, while four districts - Nghĩa Hành, Mộ Đức, Đưc Phổ and Tư Nghĩa - in guảng Ngài Trư Nghĩa - in submerged in 0.7-1.5m deep wa-ter.

ter. More than 823 households in Tư Nghĩa District in Quảng Ngãi were isolated, while some inner

ds of Quảng Ngãi City

also submerged in water as high as 0.5-0.8m. Rescue forces in the central province helped 1,579 house-holds move to safety. The Centre of Flood and Storm Prevention in the Central and Central Highlands regions warned that provinces from Thiữa Thiên-Huế to Phú Yên could get

Thiên-Huế to Phú Yên could get rainfall ranging from 200mm to 300mm until Saturday, while medium rainfall would occur in the coastal south central prov-inces from today through Sun-day. The water level also rock from 1.5m to 2.5m (over emer-gency grade 3) in ancient Hội An City and in the suburban ar-ean along the Hoài River yester-day morning

as mong the normal trivel years and as morning. In Dà Năng City, the floods isolated 420 households in Hòa Liên Commune in suburban Hòa Vang District, while 105ha of re-cently-sowed rice was inundated with water.

#### Land erosion

Meanwhile, torrential rains caused serious land erosion at Cà Pass in Phú Yên Province, lead-

Pass in Phú Yên Province, lead-ing to hours-long traffic conge-tion yesterday morning. According to Phú Yến's Steering Committee for Natural Disaster Prevention and Search and Rescue, thouzand tonnes of soil and rock fell down from the pass, which connects Phú Yên and Khánh Hða provinces, pa-ralyring the north-south traffic flow on National Highway I from around 10pm last night. At times, yehicles were seen queuing up for dozens of kilometres. Two care were damaged, but

for dozens of kilometres. Two care were damaged, but no one was injured. Colonel Nguyễs Phi Long, head of Phú Yên's Transport Po-lice Department, suid at Sam yes-terday morning, the rescue force temporarily cleared the soil and vock on two-thirds of the road where erosion had occurred. One-way traffic on National Highway 1 through this area was

Boats are used in Hội An City. Flooding has disrupted traffic ( the banks of the Hoài River. --VNA/VNS Photo Công Thành

Đinh.

restored. The provincial Department of Transport said heavy rainfall and floods also caused land de-pression in many areas of Na-tional Highway I passing through the province. The most serious incidents occurred at Km 1294 + 200 in Vt/fX Xohi Slope and in Xuán Đài Ward, Sông Cầu Towa. Cổ Mã Pass in neighbouring Khán Hào Province also report-

Cổ Mã Pass in neighbouring Khánh Hòa Province also report-edly suffered from Iand erosion. Torrential rainfall is continu-ing in both Khánh Hòa and Phá Yế n provinces. Hydropower plants in the two provinces said they would discharge water in large quantities yesterday after-noon. Households in 17 communes

in Phú Yên Province have been flooded. Water levels of the rivers in

Water levels of the rivers in Quảng Nam, Bình Định, Quảng Ngãi, Phú Yên and Gia Lai is ex-pected to rise through this week-end. — VNS

## ANNEX B List of tropical storms

### Annex B.1 List of Tropical storm in the North West Pacific

### Individual Storm Summary for the season 2016

Num.	Name	Date	Wind	Pres	Cat	Remark
1	Super Typhoon-5 NEPARTAK	03-09 JUL	150		5	
2	Tropical Depression THREE	17-17 JUL	25		-	
3	Tropical Storm LUPIT	23-24 JUL	40		-	
4	Tropical Storm MIRINAE	25-27 JUL	45		-	Effected to LMB
5	Typhoon-1 NIDA	29 JUL-02 AUG	80		1	Effected to LMB
6	Tropical Storm OMAIS	05-08 AUG	60		-	
7	Tropical Depression 08W	08-09 AUG	30		-	
8	Tropical Storm CONSON	08-14 AUG	50		-	
9	Tropical Storm CHANTHU	13-17 AUG	45		-	
10	Tropical Storm DIANMU	18-19 AUG	40		-	Effected to LMB
11	Tropical Storm TEN	17-19 AUG	40		-	
12	Tropical Storm MINDULLE	17-22 AUG	55		-	
13	Typhoon-4 LIONROCK	18-30 AUG	115		4	
14	Tropical Storm THIRTEEN	19-20 AUG	40		-	
15	Tropical Storm KOMPASU	18-21 AUG	40		-	
16	Tropical Storm 14W	23-25 AUG	35		-	
17	Typhoon-3 NAMTHEUN	31 AUG-05	100		3	
17		SEP				
18	Super Typhoon-5 MERANTI	09-14 SEP	165		5	
19	Tropical Depression SEVENT	11-11 SEP	30		-	
20	Tropical Depression RAI	12-12 SEP	30		-	Effected to LMB
21	Tropical Storm EIGHTEEN	11-12 SEP	40		-	
22	Typhoon-4 MALAKAS	11-20 SEP	115		4	
23	Typhoon-4 MEGI	23-27 SEP	115		4	
24	Typhoon-1 CHABA	05-05 OCT	75		1	
25	Tropical Storm AERE	05-13 OCT	55		-	
26	Typhoon-2 MATTHEW	07-07 OCT	95	948	2	
27	Tropical Depression 23W	08-08 OCT	25		-	
28	Super Typhoon-4 SONGDA	08-12 OCT	130		4	
29	Typhoon-3 NICOLE	13-13 OCT	100	956	3	
30	Typhoon-4 SARIKA	12-19 OCT	115		4	Effected to LMB
31	Super Typhoon-5 HAIMA	15-21 OCT	145		5	
32	Tropical Storm 25W	15-15 OCT	35		-	

Num.	Name	Date	Wind	Pres	Cat	Remark
33	Tropical Depression TWENTY	03-22 NOV	25		-	
34	Typhoon-2 MEARI	03-07 NOV	90		2	
35	Tropical Depression TWENTY	10-10 NOV	30		-	
36	Tropical Storm MA_ON	10-12 NOV	35		-	
37	Tropical Depression TWENTY	11-12 NOV	30		-	
38	Tropical Storm TOKAGE	24-28 NOV	50		-	
39	Tropical Depression OTTO	25-25 NOV			-	
40	Tropical Storm 30W	21-22 DEC	35		-	

### Saffir-Simpson Scale

The chart color codes intensity (category based on Saffir-Simpson scale):

Tuno	Category	Pressure (mb)	Winds	Winds	Line Color
Type			(knots)	(mph)	Line Color
Depression	td		< 34	< 39	Green
Tropical Storm	TS		34-63	39-73	Yellow
Hurricane	1	> 980	64-82	74-95	Red
Hurricane	2	965-980	83-95	96-110	Light Red
Hurricane	3	945-965	96-112	111-130	Magenta
Hurricane	4	920-945	113-135	131-155	Light Magenta
Hurricane	5	< 920	>135	>155	White

NOTE: Pressures are in millibars and winds are in knots where one knot is equal to 1.15 mph Source: http://weather.unisys.com/



Annex B.2 Map of the location of hydro-meteorological monitoring stations