MEMBER REPORT

ESCAP/WMO Typhoon Committee

14th IWS

SOCIALIST REPUBLIC OF VIET NAM

November 2019

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Member's area since the last Typhoon Committee Session

Since the beginning of 2019, natural disasters occurred in unpredictable and abnormal manners in all regions of the country. There were 04 storms; 04 cold spells; 49 heavy rains caused floods and inundations; 08 flash floods and landslides; 195 thunderstorms, lightning, hail, 121 river bank erosion cases; 08 heat waves, ... in which the most serious are the flash flood and landslide occured in Quan Son, Thanh Hoa province due to floods after storm No. 3. Severe flash floods and landslides devastated in Lai Chau, Thanh Hoa; serious floods and inundation in North Central and Central Highlands; drought occurred since the the water level of 02 reservoirs of Son La and Hoa Binh decreased to the lowest level in recent years; the drought lengthened in the Central region in June-July causing widespread forest fires; river bank erosion in Central coast and Mekong river delta; historic rainfall, causing floods in Phu Quoc and Kien Giang; storm surges and big waves overturned the sea dike erosion in Ca Mau province, ...

1.1. Meteorological assessment

1.1.1. Evolution and Impact of TS No.2 (MUN)

a. Evolution of TS No.2

In the afternoon of July 1st, a low pressure area in the northeast of the Paracel Islands was upgraded to a tropical depression (TD) with sustained wind force 6 and gust 8 in Beaufort scale (BFS) and kept almost stationary. In the evening of the same day, tropical depression intensified to force 7 in BFS with gust force 9 and moved slowly to the west.

In the morning of July 2nd, TD moved to the west with an increasing speed of 10 km/h. At night, this TD was upgraded to Tropical Storm No.2 (TS No.2) in the Bien Dong Sea in 2019 and named MUN internationally. TS No.2 has sustained wind force 8 and gust 11. After that, TS No.2 continued to move faster westward, with a speed of about 10-15km/h. Around 01:00 am (local time) on July 3rd, this TD hit the eastern part of Hainan Island (China) with wind force 8 and gust 11 and changed direction to the west-northwest with relatively stable speed. Around 3rd July noon, TS No.2 crossed Hainan island and entered the Bac Bo Gulf, continued to move in the west-northwestern direction, the storm gradually intensified to 9, gust 11 in BFS. Early morning of July 4th (around 04h00-05h00 local time), TS No.2 made landfall in provinces from Hai Phong - Nam Dinh, then rapidly downgraded to TD and then a low pressure area in the Northern Delta region (see Figure 1.1). The minimum pressure was recorded 989.9mb at Thai Binh station at 03h32 local time on 4th July.

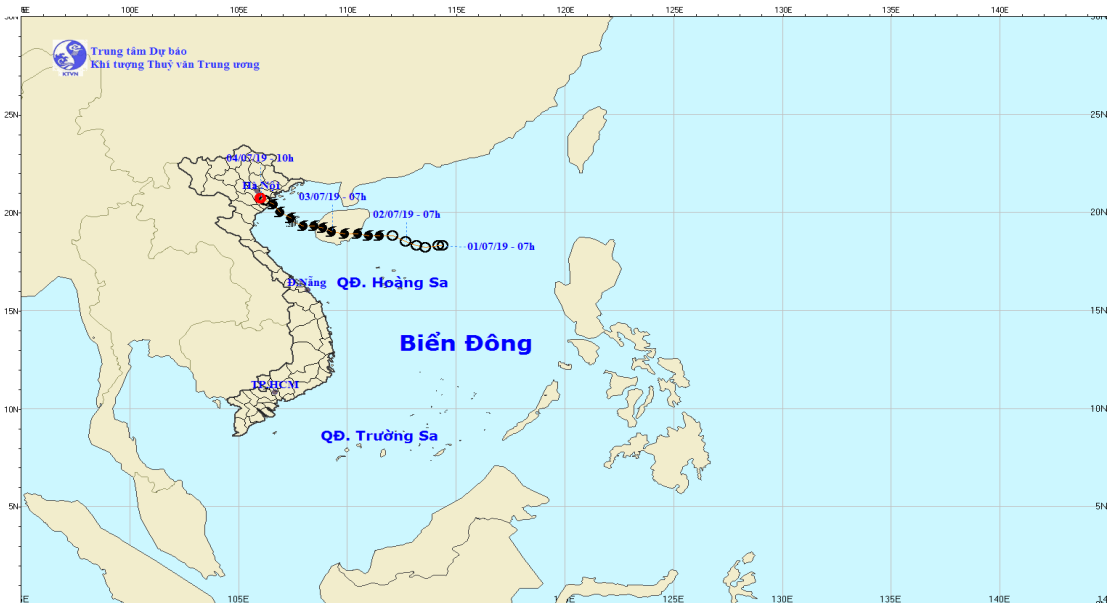


Figure 1.1 The best track of TS No.2 (MUN)

b. Strong wind impacts of TS No.2

TS No.2 had caused strong winds of level 8-9 and gust winds of level 10-11 in the Bac Bo Gulf. In the coastal area of Quang Ninh and Hai Phong provinces, there are strong winds force 6-7 and gust winds 8-9. The strongest wind observed in TS No.2 is shown in Table 1.1.

Table 1.1 The strongest wind observed of TS No.02

No	Station	Strongest wind	Time (HH/DD/MM)	Gust wind
1	Bach Long Vi Island	17m/s (BFS7)	22h55’ 03/07	25m/s (BFS 10)
2	Co To Island	16m/s (BFS 7)	00h25’ 04/07	23m/s (BFS 9)
3	Cat Hai Island	24m/s (BFS9)	04h00’ 04/07	31m/s (BFS11)
4	Mong Cai	12m/s (BFS 6)	20h42’ 03/07	15m/s (BFS 7)
5	Quang Ha	11m/s (BFS 6)	23h00’ 03/07	13m/s (BFS 6)
6	Cua Ong	16m/s (BFS 7)	00h13’ 04/07	24m/s (BFS 9)
7	Bai Chay	16m/s (BFS 7)	04h45’ 04/07	22m/s (BFS 9)
8	Uong Bi	17m/s (BFS 7)	04h06’ 04/07	20m/s (BFS 8)
9	Phu Ly	11m/s (BFS 6)	04h14’ 04/07	21m/s (BFS 9)
10	Van Ly	11m/s (BFS 6)	07h22’ 04/07	17m/s (BFS 7)
11	Phu Le	13m/s (BFS 6)	05h33’ 04/07	15m/s (BFS 7)

c. Rainfall impacts of TS No.2

Due to the impact of the monsoon trough lying along the North Central region after TS2, there was heavy to extreme rain from July 2nd to July 4th in provinces from Thanh Hoa to Thua Thien Hue. In Thanh Hoa, the popular rainfall was 80-110mm, particularly in Tinh Gia 366mm; common rainfall was 100-150mm in Nghe An, especially in Quynh Luu 282mm; Ha Tinh common rainfall was 100-150mm, particularly Huong Khe 199mm; Quang Binh was popular with 100-150mm; Quang Tri and Thua Thien Hue were popular 60-90mm. From afternoon and night of July 4th, the heavy rain was concentrated in Tay Bac and Viet Bac regions but the total rainfall is less than in north central coastal provinces.

1.1.2. Evolution and Impact of TS No.3 (WIPHA)

a. Evolution of TS No.3

In the morning of July 29th, 2019, in the East of the North Bien Dong sea, a low pressure area was formed in the Inter Tropical Convergence Zone (ITCZ) and upgraded to tropical depression (TD) in the morning of July 30th. After one day, TD intensified to Tropical Storm No. 3 (TS No.3) in 2019 with international name of Wipha.

After developing to tropical storm, TS No.3 moved stably northwestward, then westward with an averaged speed of 10-15km/h. In the morning of August 1st, TS No.3 moved northward and in the evening on the same day, this TS changed its direction to move toward the west with a lower speed, about 5-10km/h and sometime kept almost stationary.

Around 10pm on August 2nd, TS No.3 entered the northern area of Quang Ninh (the center of the storm passed closely to the north of Mong Cai station), then changed direction to move west-southwest along the coastal area of Quang Ninh - Hai Phong while moving further inland. At around 4am on August 3rd, TS No.3 downgraded into a tropical depression in the mainland of Quang Ninh - Hai Phong provinces, then weakened more into a low pressure area in the Northern Delta region in the evening of the same day (Figure 1.2).

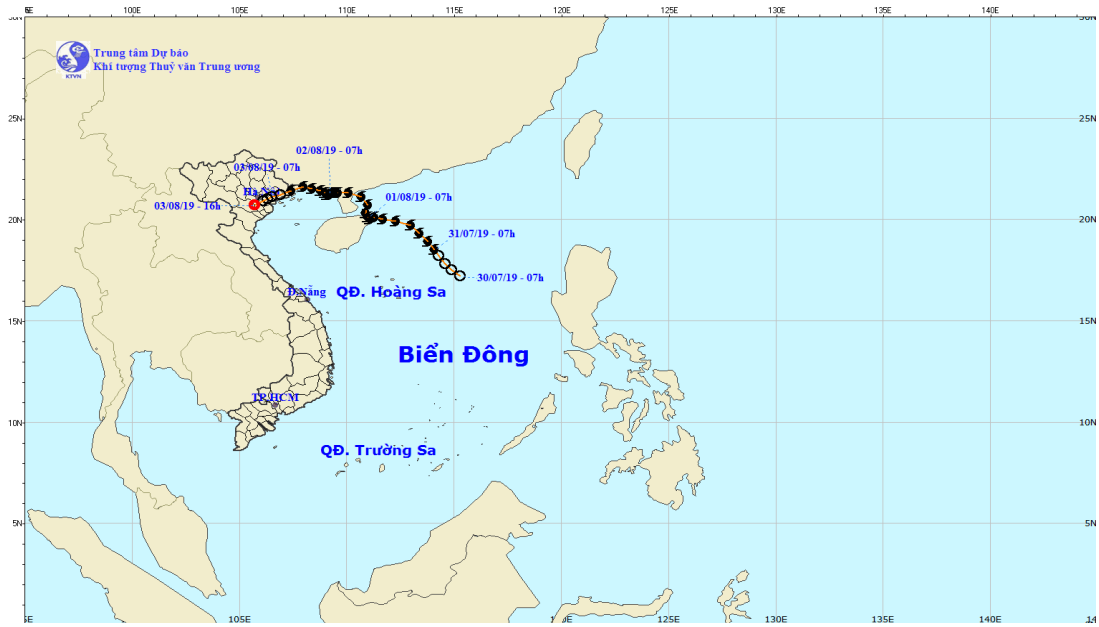


Figure 1.2: The best track of Tropical Storm No.3 (WIPHA)

b. Strong winds impacts of TS No.3

TS No.3 maintained a sustained wind of level 8-9 when it entered the northern part of the Bac Bo Gulf. When TS No.3 made landfall, it caused strong winds of level 7 with gust of level 9 in Mong Cai (Quang Ninh); strong winds force 6-7, gust force 8 in coastal Quang Ninh, Hai Phong, Hai Duong and sustained wind force 6, gust force 7 in the coastal areas of the Northern Delta (Table 1.2). The minimum pressure recorded during TS No.3 was at Mong Cai station (Quang Ninh) at 985.2mb at 21h50 on 02/8 local time.

Table 1.2. The strongest wind observed of TS No.3

No	Station	Strongest wind	Time (HH/DD/MM)	Gust wind
1	Bach Long Vi Island	16m/s (BFS7)	13h39/01/08	20m/s (BFS 8)
2	Co To Island	07m/s (BFS 4)	01h30/03/08	15m/s (BFS 7)
3	Mong Cai (Quang Ninh)	17m/s (BFS 7)	21h21/02/08	23m/s (BFS 9)
4	Quang Ha (Quang Ninh)	10m/s (BFS 5)	22h53/02/08	15m/s (BFS 7)
5	Cua Ong (Quang Ninh)	11m/s (BFS 6)	02h10/03/08	13m/s (BFS 6)
6	Bai Chay (Quang Ninh)	08m/s (BFS 5)	03h16/03/08	14m/s (BFS7)
7	Hon Dau Island (Hai Phong)	10m/s (BFS5)	11h48/03/08	14m/s (BFS 7)
8	Phu Lien (Hai Phong)	11m/s (BFS 6)	06h58/03/08	13m/s (BFS 9)

No	Station	Strongest wind	Time (HH/DD/MM)	Gust wind
9	Dong Xuyen (Hai Phong)	12m/s (BFS 6)	09h34/03/08	15m/s (BFS 7)
10	Thai Binh	10m/s (BFS 5)	09h48/03/08	13m/s (BFS 6)
11	Hai Duong	16m/s (BFS 7)	06h56/03/08	20m/s (BFS 8)
12	Mau Son* (Lang Son)	23m/s (BFS 9)	01h44/03/08	30m/s (BFS 11)

* Mau Son is at about 1600m above sea level

c. Rainfall impacts

TS No.3 caused heavy and extreme rainfall in the Northern Vietnam with the total amount of rainfall recorded from August 1st to August 4th was popularly 50-150mm in Quang Ninh, Thanh Hoa and Red River Delta (including Hanoi) were 200-300mm (Table 1.3). Some stations observed the amount of over 300mm as follows:

Table 1.3. The total rainfall of TS No.3

Province	Station Name	Total rainfall (mm)
Son La	Moc Chau	363
	Km 46	406
Hoa Binh	Hung Thi	371
	Mai Chau	307
Vinh Phuc	Tam Dao	317
Lang Son	Mau Son	445
Quang Ninh	Mong Cai	361
Ha Noi	Ha Dong	251
	Lang	288
Hung Yen	Hung Yen	325
Ha Nam	Phu Ly	456
Thanh Hoa	Tam Trung	484
	Muong Lat	415

1.1.3. Evolution and Impact of TS No.4 (PODUL)

a. Evolution of TS No.4

In the morning of August 27th, a tropicald depression on the East of the Central Philippines sea became a tropical storm, named Podul, with wind force 8 and gust force 10 grade in BFS. After intensitification to tropical storm, TS Podul moved quickly to the northwest at about 30-35km/h. In the early morning of August 28th, Podul crossed the Luzon island (Philippines) and entered Bien Dong Sea, became the TS No.4 in 2019.

When entered the Bien Dong Sea, TS No.4 maintained the intensity of 8, gust 11 in BFS and moved westward with an averaged speed of 30km/h. At night, TS No.4 traveled on the Paracel Islands, with wind force 9, gust force 11 then moved slower than before at about 25km/h.

In the early morning of August 30th, TS No.4 made landfall in Ha Tinh - Quang Binh area, weakened rapidly into tropical depression and then low pressure area in central Laos. (Figure 1.3).

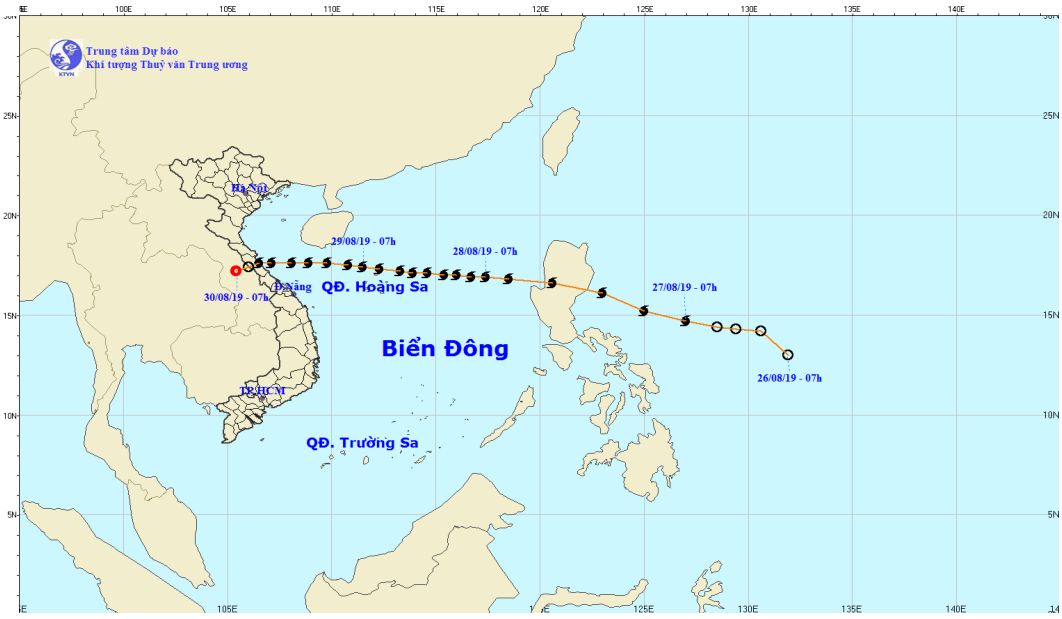


Figure 1.3. The best track of TS No.4 (PODUL) (NCHMF of Viet Nam).

c. Strong wind impacts

TS No.4 has wind force 8-9, gust force 10-11 when entered the sea of provinces from Nghe An - Quang Tri and strong wind force 6-8, gust force 9 when it made landfall in Thanh Hoa – Quang Tri area, some places has observed gale wind such as: Dong Hoi force 6, gust 8; Con Co reached force 9 and gust force10; Dong Ha wind force 6 and gust 7, Cam Nhuong wind force 7 and gust 9; Cua Hoi recorded wind force 7 and gust 9; Hon Ngu wind force 8 and gust 9 …

d. Rainfall impacts

From the night of August 28th to the morning of August 30th in Thanh Hoa - Thua Thien Hue provinces, there has extreme rainfall with common

total rainfall of 100-250mm, some exception such as: Ly Nhan (Thanh Hoa) 358mm, Sao Vang (Thanh Hoa) 295mm, Cam Ly (Quang Binh) 263mm, Vinh O (Quang Tri 276mm) ... And delta region, such as: Hoa Binh, Son La, Yen Bai and Phu Tho has moderate and heavy rain, popularly 70-150mm, in the Northern Central Highlands has popularly rainfall of 100-150mm.

1.1.4. Tropical depresion Kajiki

In the evening of August 31st, a tropical depression passed over the northern of Luzon island (Philippines), and entered the northeastern part of Bien Dong Sea with strong wind force 6, gust force 8. After that, tropical depression moved mainly westward with speed about 20-25km/h and enhanced intensity force 7, gust 9. In the morning of Sep 2nd, tropical depresion changed direction in westsouthwest with speedabout 15-20km/h. At night, tropical depresion approached the coastal areas of Ha Tinh – Thua Thien Hue provinces with strong wind force 7, gust 9. At around 01:00 (Local time) on September 3rd, tropical depression made landfall in region from Quang Tri - Thua Thien Hue with force 6-7, gust force 9. After that the tropical depression moved slowly to the southwest. At noon, tropical depression changed the direction and moved back to the east and back to ocean region of provinces from Thua Thien Hue - Quang Nam with a maximum windspeed of force 6, gust 8 in BFS. Then, the tropical depression turned to the northeast with a speed of about 5-10 km/h. In the evening of September 4th, the tropical depression weakened to a low pressure area in offshore of provinces from Quang Tri - Quang Ngai (see Figure 1.4).

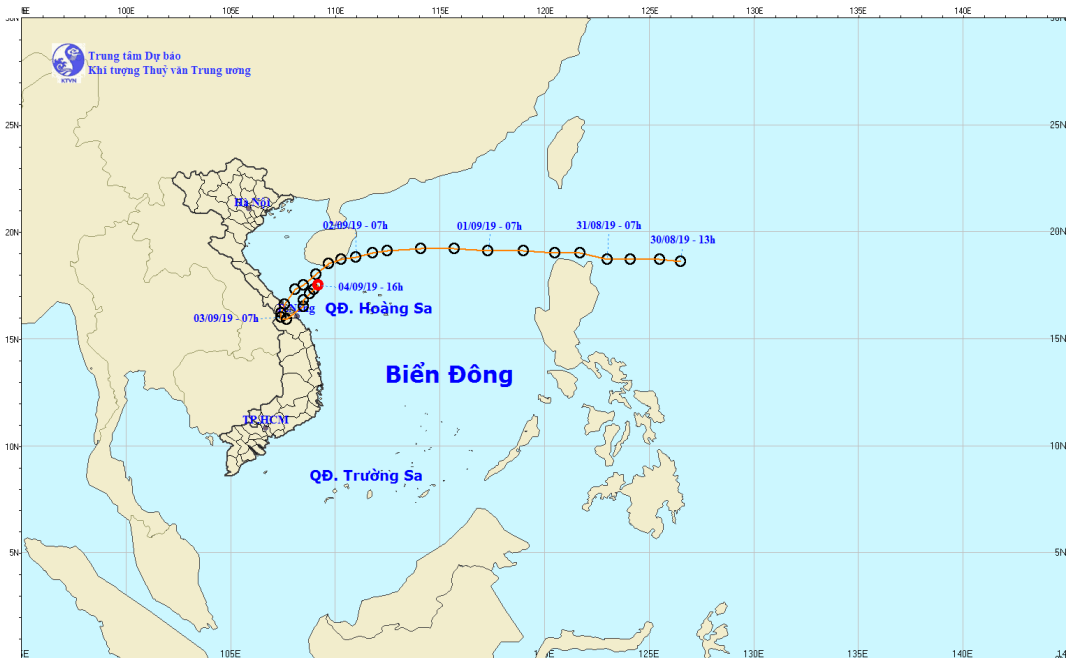


Figure 1.4. The best track of Tropical Depresion

b. Strong wind impacts

This TD caused strong winds of force 6-8, gust 9 in the Bac Bo Gulf and on the coastal area of Quang Tri - Quang Nam. Stations from Ha Tinh to

Quang Tri has observed wind force 6 and gust 8, some places has recorded stronger wind such as: Bach Long Vi island (Hai Phong) has wind force 8 and gust 9; Cam Nhuong (Ha Tinh) wind force 6 and gust 8; Con Co island (Quang Tri) has observed wind force 9 and gust 9; Dong Ha (Quang Tri) wind force 6 and gust 7; Ky Anh (Ha Tinh) has recorded wind force 6 and gust 8, Ly Son island (Quang Ngai) wind force 6, gust 7.

c. Rainfall impacts

From September 1st night to September 5th, there was heavy and extreme rainfall in the area from south of Nghe An to northern of Thua Thien Hue, with common total rainfall of 400-700mm. In the North of Nghe An, South of Thua Thien Hue, Da Nang, Quang Nam and Central Highlands regions had common total rainfall of 70-150mm, some places over 200mm. The maximum total rainfall at some stations has observed such as: Vinh (Nghe An) 875mm; Ha Tinh 937mm; Huong Khe (Ha Tinh) 926mm; Ky Anh (Ha Tinh) 812mm; Chu Le (Ha Tinh) 862mm; Dong Tam (Quang Binh) 828mm; Mai Hoa (Quang Binh) 1000mm; Minh Hoa (Quang Binh) 931mm; Khe Sanh (Quang Tri) 781mm.

1.2. Hydrological Assessment

1.2.1. Hydrological Assessment in the North of Viet Nam

An abnormal flood event had appeared on the Thao, Da and Gam rivers with flood amplitude of 1.5 – 4.5m during the 8th and the 10th January, 2019. During the time of dry season, flooding on the main rivers provided precious water resource for agriculture and hydro-power generation.

In 2019, flood season started more or less the same previous flood years, and a general picture of the whole flood season is quite peaceful with 3 small and medium flood events appearance in June and August. However, flood peak in a small mountainous river was recorded over historical statistic in the mid of June because of appearance of low pressure trough lying through Northern part combination with wind convergence of 5000m height.

Due to TS WIPHA and TS PODUL, in the beginning and the end of August, high floods at Hung Thi station in Boi river was recorded the peak over alarm level (AL)3; most of peak flood on the main rivers as Thao, Hoang Long, Luc Nam, Ky Cung were recorded from AL1 to AL2.

Table 1.4 summarized information of flood characteristics on the river systems in the North of Viet Nam during flood season 2019, the figure 1 and figure 2 shows the information about the floods on the Boi river at Hung Thi anh on the Thao river at Yen Bai where the flood peaks were over AL3 and AL2 respectively.

Table 1.4 The characteristics of flood events for main stations and reservoirs on rivers in the North of Viet Nam from June to September, 2018

No	Duration	Weather patterns	Stations	Rivers	Flood peaks m/m^3/s	Time of flood peaks	Compared with AL
1	23-24/6	low pressure trough with axis through Northern part combination with wind convergence of 5000m height	Na Hu	Nam Bun	340.48 m	7h20'/24/6	>Historical flood (HF) 1979:340.46m
2	3-5 /8	WIPHA TS circulation	Inflow to Hoa Binh reservoir	Da	7730 m^3/s	21h/03/8	<AL1: 270m^3/s
			Yen Bai	Thao	30.99 m	2h/05/8	~AL2
			Ben De	Hoang Long	3.34 m	8h/04/8	<AL2: 0.16 m
			Hung Thi	Boi	13.84 m	1h/04/8	>AL3: 0.84 m
			Lam Son	Bui	22.6 m	21h/03/8	>AL2: 0.6 m
			Luc Nam	Luc Nam	4.69 m	21h/03/8	>AL1: 0.39 m
3	3 - 8/8	PODUL TS circulation	Yen Bai	Thao	31.36 m	23h/31/8	>AL2: 0.36m
			Lang Son	Ky Cung	253.72 m	23h/30/8	>AL1: 1.72 m

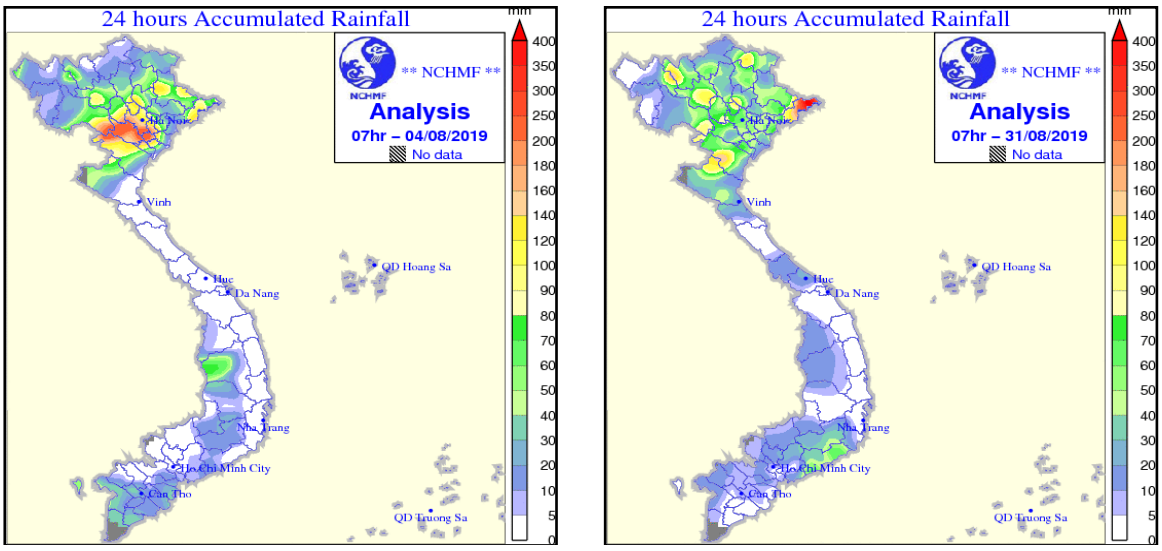


Figure 1.5 The 24h accumulated rainfall in the 4th August and the 31st August as a result of TS WIPHA and PODUL's circulation

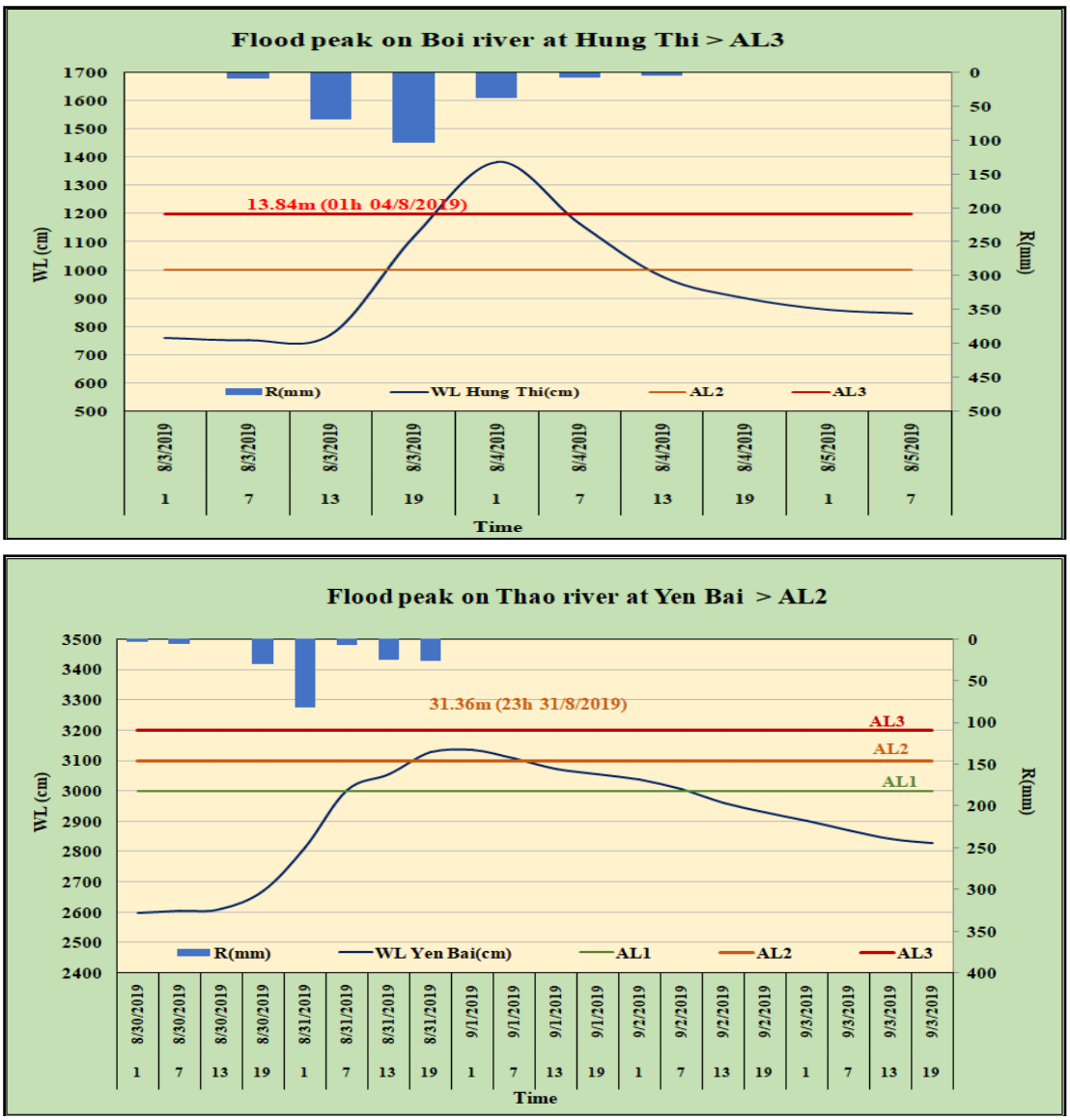


Figure 1.6. Flood peaks on Boi river at Hung Thi and Thao river at Yen Bai over AL3 and AL2.

1.2.2. Hydrological Assessment in the Central, Highland and Southern areas

a. Hydrological Assessment in the Central and Highland areas

During the dry season in 2019, water level in some rivers in the Central Vietnam reached the lowest level compared to the historical records in the same period, i.e. -0.65m (10h 15th July) at the Nam Dan station in Ca river; 1.73m (07h 22nd April) at the Ai Nghia station in the Vu Gia river; -0.09m (19h 01st July) at the Tra Khuc station in the Tra Khuc river; 12.74m (13h 20th September) at the Binh Nghi station in Kon river, 2.42m (07h 20th August) at the Dong Trang station in the Cai Nha Trang river.

Until the middle of October, the number of floods were less than those of annual mean. Only two flood events occurred from 1st to 8th August and from 2nd to 5th September in the north of Central and Highland. Details are as follows:

- The first flood event occurred in rivers in Thanh Hoa province (north of Central) and the south of Highland. Amplitudes of water level during flood in upstream and downstream were 5-7m and 1-4m respectively. Flood peaks were between AL2 and AL3, especially 0.25m greater than that of historical record at the ThanhBinh station in the Cam Ly river.

- The second flood event caused by heavy rainfall occurring in a long period occurred in rivers that are in provinces from Thanh Hoa to Thua Thien Hue. Amplitudes of water level during flood were commonly between 5 and 9m at upstream. Flood peaks were in a range of AL2 and AL3.

Table 1.5. Flood characteristics on main rivers in the Central and Highland areas from 01 to 08, August

No	River	Station	Time of flood peaks	Flood peaks (m)	Compared with AL
1	**Buoi**	Thach Quang	7h/04/8	14.56	
2	-	Kim Tan	18h/04/8	11.04	>AL2 0.04m
4	**Ma**	Hoi Xuan	04h/04/8	63.31	<AL3 0.69m
5	-	Cam Thuy	12h/04/8	20.60	>AL3 0.40m
6	-	Ly Nhan	18h/04/8	10.87	<AL2 0.13m
7	-	Giang	21h/04/8	3.71	<AL1 0.29m
8	**Srepok**	Ban Don	16h/07/8	176.56	>AL3 1.56m
9	**Cam Ly**	Thanh Binh	18h/08/8	834.25	>AL3 1.25m

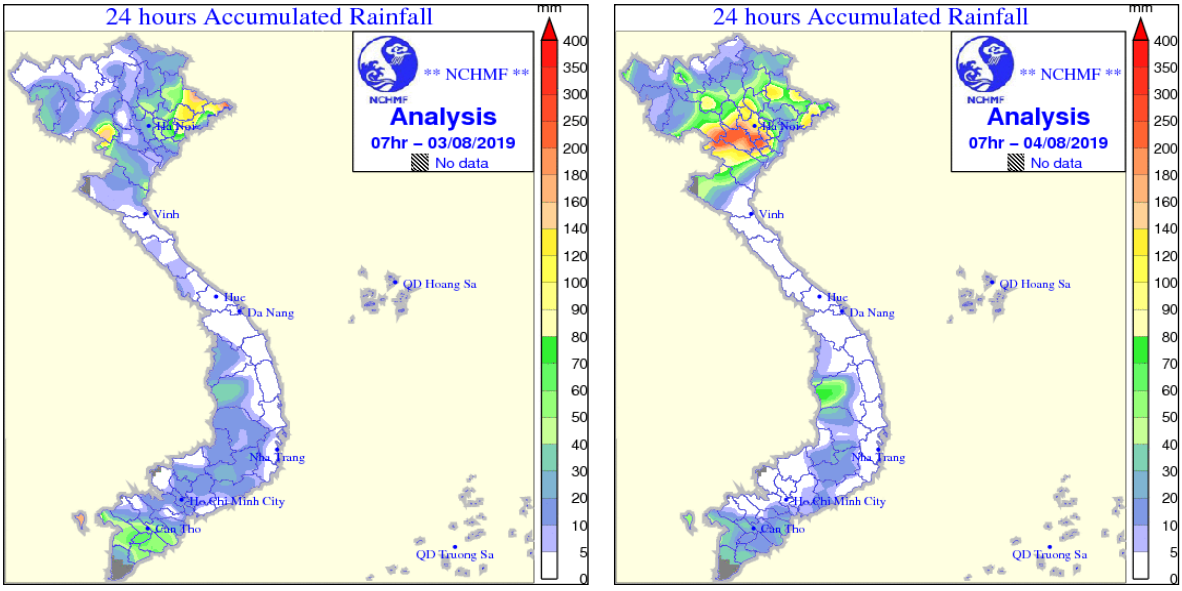
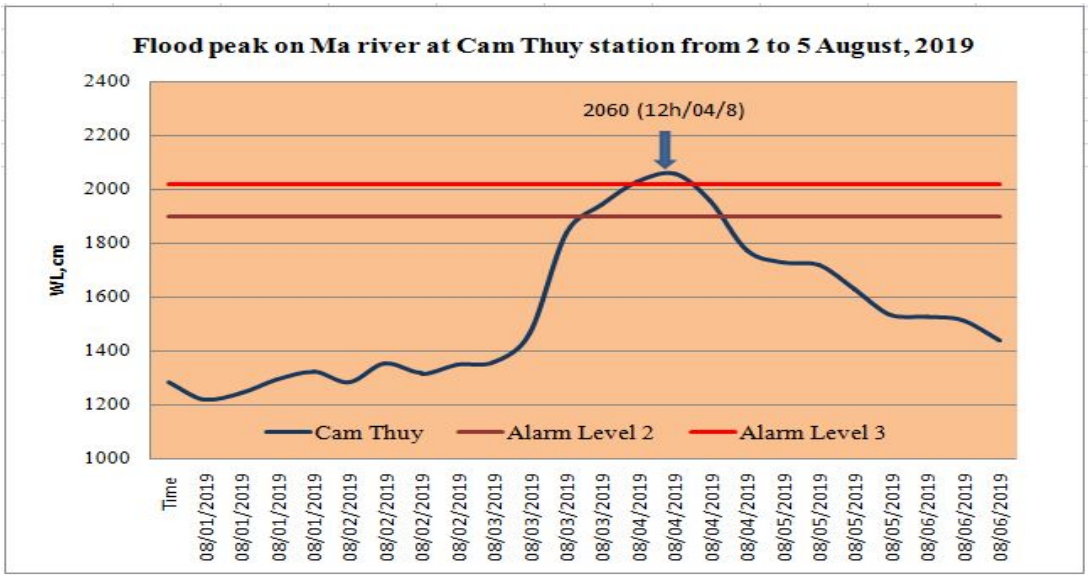
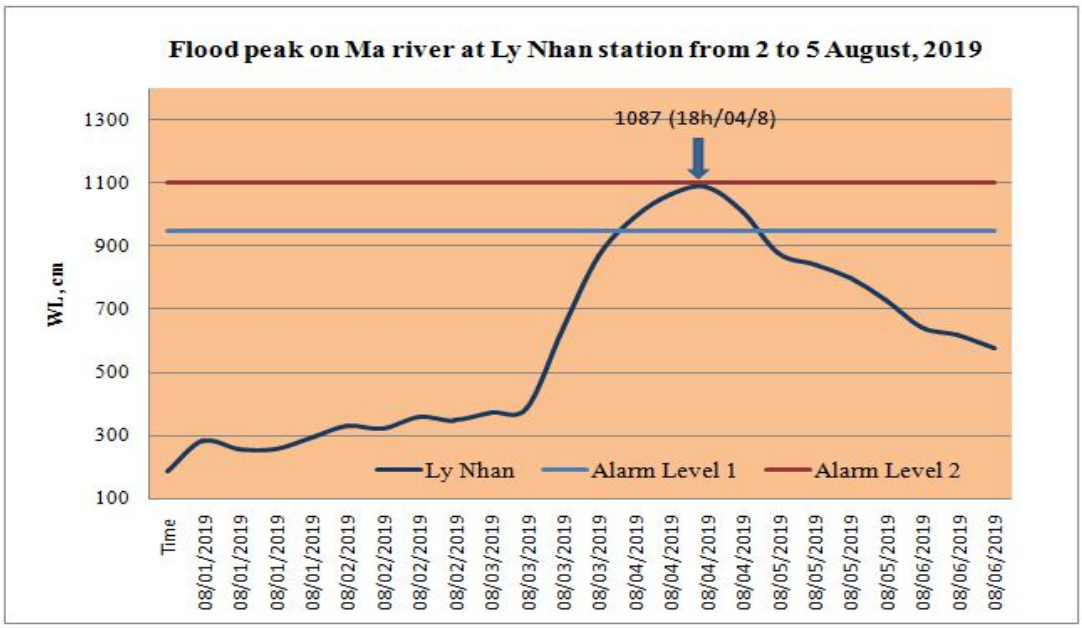


Figure 1.7. 24h accumulated rainfall in the 03th August and the 04th August





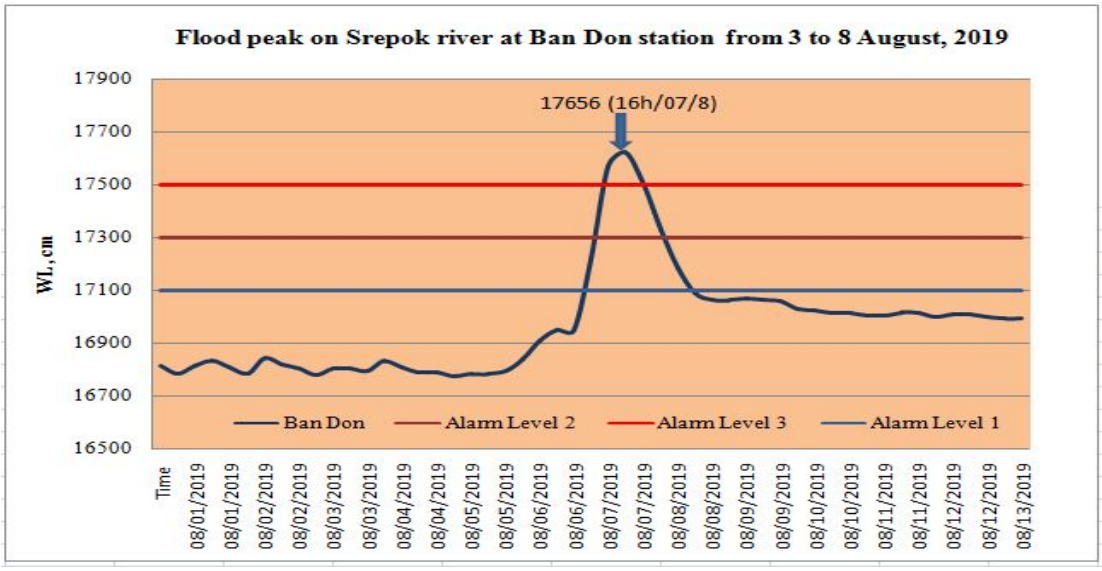


Figure 1.8. Flood peaks on the Ma river at Cam Thuy andLy Nhan and Srepok river at Ban Don from 2st to 8th August

Table 1.6. Flood characteristics on main rivers in the Central and Highland areas from 2 to 5 September

No	River	Station	Time of flood peaks	Flood peaks (m)	Compared with AL
1	Ngan Sau	Chu Le	8h/05/9	14.45	>AL3 0.95m
2		HoaDuyet	23h/05/9	10.43	<AL3 0.07m
3	Ngan Pho	Son Diem	16h/03/9	11.05	<AL3 0.45m
4	La	Linh Cam	19h/05/9	3.71	<AL1 0.79m
5	Gianh	Mai Hoa	7h/05/9	6.87	>AL3 0.37m
6	KienGiang	Le Thuy	5h/05/9	2.57	<AL3 0.13m
7	Thach Han	Thach Han	11h/04/9	5.24	<AL3 0.26m
8	Huong	Kim Long	4h/03/9	1.05	>AL1 0.05m

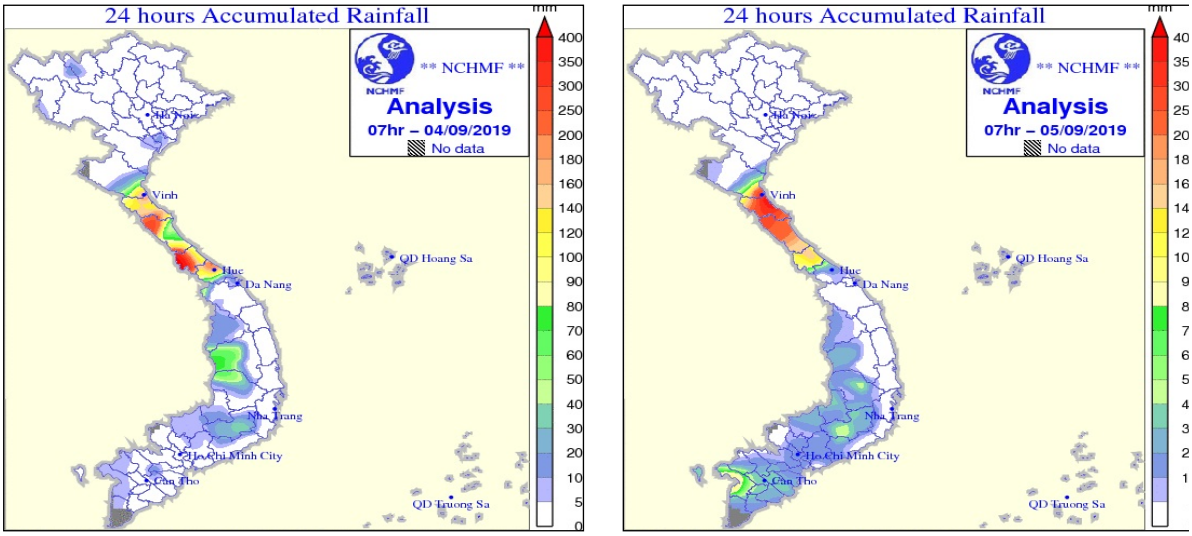
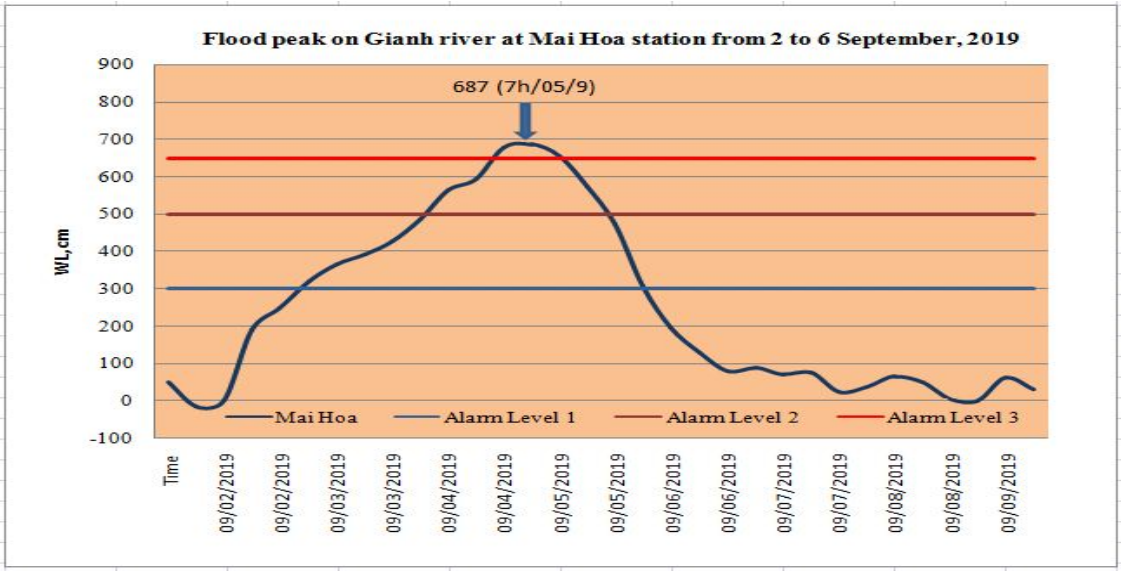


Figure 1.9.The 24h accumulated rainfall in the 03th and the 04th September



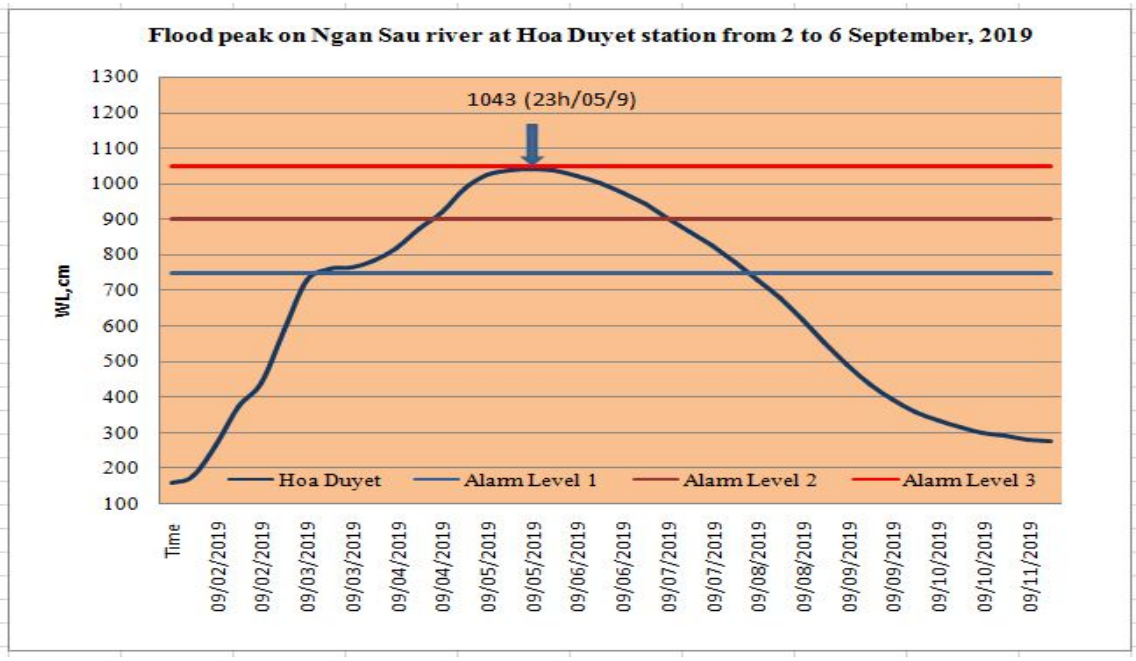


Figure 1.10. Flood peaks on the Ngan Sau river at Hoa Duyet and Gianh river at Mai Hoa from 2st to 6th September

b. Hydrological Assessment in the Southern area

From January to August, water levels at upstream and mid-stream of the Mekong river basin were always 1.5-3.0m higher than their means at the same period; water level at the upstream of the Cuu Long river (downstream of the Mekong river) was always 0.05-0.65m higher than that of annual mean.

In September, flood from upstream combining with high tide led to the rapidly increase of water level in the Cuu Long river and reached the peak in this year. The highest water level at the Tan Chau station in Tien river was 3.63m (17 September), 0.16m greater than AL1; higher than AL3 and historical records at areas outside of bank and the Sai Gon river. The seriously inundation occured in the low areas in An Giang, Dong Thap, Can Tho, Vinh Long, Binh Duong provinces and downtown of Ho Chi Minh city.

1.2.3. Flash flood situation

Severe flash flood, landslide occurances in mountainous areas were significant disaster in the North of Viet Nam during flood season 2019 causing many losses of human, properties, infracstrutures and agricuture production as well. The largest flash flood and landslide situation occurred in the beggining of August in the Dien Bien and Thanh Hoa province's mountainous areas. Table 1.7 is summarized flash flood and landslide locations and appearance times as well in 2019.

Table 1.7. Flash flood events and landslide occurences in 2019

No	Appearance Time	Flash flood and landslide location
1	24/6	Ban Ho commune, Sa Pa district, Lao Cai province;

No	Appearance Time	Flash flood and landslide location
		Hua Bum commune – Nam Nhun district and Pa Ve Su commune-Muong Te district, Lai Chau province;
2	03/8	Dien Bien Dong, Dien Bien, Muong Cha, Muong Nhe, Nam Po districts, Dien Bien province; Sa Na village, Na Meo commune, Quan Son district, Thanh Hoa province;
3	04/8	Landslide in Cho Moi district, Bac Can province
4	02-04/9	Landslide occurances in Ho Chi Minh main road throught Ha Tinh, Quang Binh, Quang Tri provinces

In flood season 2019, flash flood is mostly occurred in the North of Viet Nam and several districts in the Northern part of Central provinces as Thanh Hoa and Nghe An.

Figure 1.11. Flash flood at Sa Pa district, Lao Cai province durinh 23-24/6 and Quan Son district, Thanh Hoa province in 03/8/2019

Figure 1.12. Landslide in ho Chi Minh road, Ha Tinh province 3/9/2019

1.2.4. Flooding situation

During the end of June and August, serious flooding and inundation were appeared in the many cities and low-land areas as a result of extreme heavy rainfall, sharp rising of water level on stream and river. The names of cities and provinces faced inundation, flooding was listed below:

-The seriously inundation occurred in Phu Quoc island due to heavy rainfall occurring during the 2nd and the 9th , August.

- The deep and large innundation occurred in several regions in Ha Tinh, Quang Binh and Quang Tri provinces as a result of heavy rainfall during TS PODUL circulation affect from 02 to 06, September.

- Severe flooding in Thai Nguyen city as downtown of Thai Nguyen province caused by heavy rainfall from 09 – 11, September.

Figure 1.13. Innudation in Phu Quoc island (09/08/2019)

Figure 1.14. Flooding in Minh Hoa district, Quang Binh province and innudation in Lao Bao district, Quang Tri province (05/09/2019)

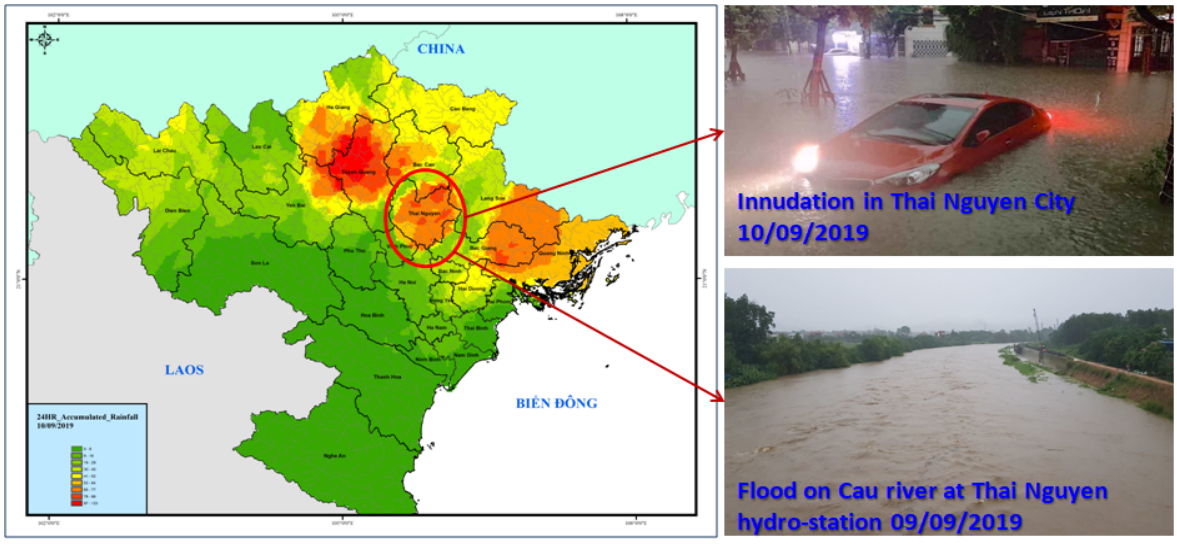


Figure 1.14. Innudation in Thai Nguyen city (09-11/9/2019).

1.3. Socio-Economic Assessment

Damages caused by natural disasters in 2018 have been reduced compared to the average in many years and in recent years.

Table 1.8. Statistics of damages caused by natural disasters in 2018

Human damage	224 deaths and missing, including: 92 deaths and missing due to rainfall and floods (41%); 82 deaths and missing due to flash flood and landslides (37%); 50 deaths and missing due to other natural disasters (22%)
House damages	1,967 houses collapsed or swept away; 31,335 houses flooded, damaged and urgently relocated;
Agriculture production damages	261,377 ha of rice and subsidiary crops inundated and damaged; 43,159 ha of cash crops, fruit trees collapsed and broken; 29,400 cattle and 774,427 poultry died; 11,900 ha of aquaculture ponds damaged;
Other damages	884 km of dykes, revetments, canals and embankments were eroded and collapsed; more than 86 km of river banks and coastline eroded; over 8.4 million m^3 of rock and soil of national highways, provincial roads and rural roads were slid; 107 boats were sunk

In 2019, The Prime Minister and Chairman of Central Committee for natural disaster prevention and control issued 17 urgent telegraphs; dispatching missions to the localities, especially the implementation of disaster recovery work in Quan Son district, Thanh Hoa province, Ha Tinh; requested Quang Tri provinces to deal with floods in early September; provided instructions to enhance the safety of downstream reservoirs...

The Central Committee submitted the official report No. 120/ TWPCTT dated September 13, 2019 to the Prime Minister to support VND 450 billion for 13 provinces and cities damaged by natural disasters from June to August 2019.

Issued nearly 150 bulletins in the television, 335 messages on Viber, 2050 posts on Facebook and 320 posts on website.

Local authorities at all levels to drastically response and recover from major natural disasters.

Mobilized 262,426 officers, soldiers of the army, police, self-defence forces and other forces: handled over 800 cases, saved 1,560 people, ensured safety for 88 vehicles; informed over 804,000 vehicles / 3,680,000 people on

the developments of storms and tropical depression; helped local people reinforce 265,000 houses; evacuated 137,734 households / 681,265 people in the disaster area to safe places.

In the first 9 months of 2019, natural disaster was blamed for 117 deaths and missing; 148 injuries; 1,102 collapsed houses, 30,124 damaged–lost roof houses and thousands of emergency relocated households; 63,000ha of rice and 14,000ha of crops flooded and damaged; 18,000 hectares of crops damaged; 137km of embankments eroded; 122km of roads eroded and nearly 880,000 m3 of soil and stone eroded, etc. Total economic losses were nearly 10,000 billion VND (equivalent to 4,545 million USD).

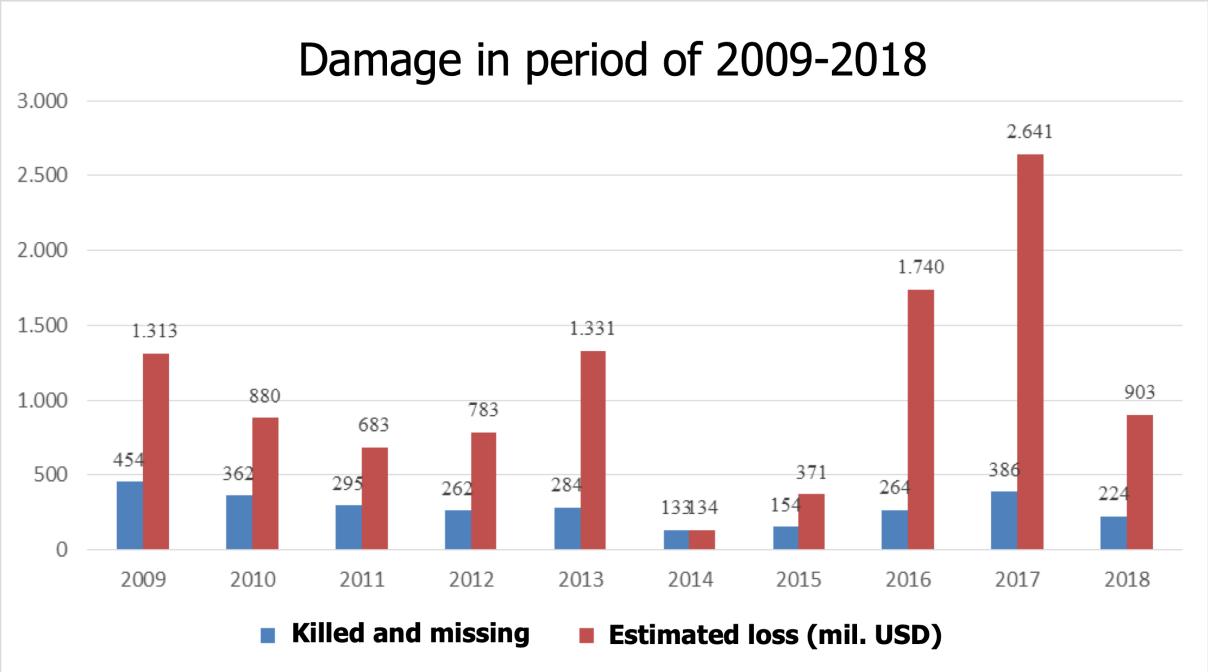


Fig 1.15: Losses due to natural disasters in Vietnam by years

1.4. Regional Cooperation Assessment (highlighting regional cooperation success and challenges.

1.4.1 Hanoi Regional Forecasting Support Centre (RFSC) of the Severe Weather Forecasting Demonstration Project (SWFDP)

As recommended by the Regional Subproject Management Team (RSMT) of SWFDP-Southeast Asia in the meeting in 2015 (Ha Noi, Viet Nam, August 2015) and agreed during its meeting in November 2017 in Ha Noi, Viet Nam, a two-week training desk had been organized at RFSC Ha Noi from 7 to 18 May 2018 with attachment of two experts from NMHSs of Philippines and Thailand and forecasters from Viet Nam Meteorological and Hydrological Administration (VMHA). Two expert lecturers from Hong Kong Observatory (HKO), Hong Kong, China joined and gave lecturesat the training desk.

Experts and forecasters from VNMHA hasattended the Regional Training Workshop on Severe Weather and Impact based Forecasting and

Warning Services in Vientiane, Lao PDR form 19 February - 1 March 2019. VNMHA experts have shared the current status of warning and information delivery, current challenges in impact-based forecasting and risk-based forecasting as well as exchanging these solutions to enhance the forecasting, alerting activities of Viet Nam.

For future plan,with the acceptation for Project Proposal "Training workshop based on the Severe weather Forecasting Demonstration Project (SWFDP) for the Southeast Asian Region" from ASEAN Committee on Science and Technology (COST), there will be a second two-week Training Desk organized at RFSC Ha Noi in December 2019.

1.4.2. Severe weather consultation with CMA

Following the cooperative agreement between the Viet Nam Meteorology, Hydrology Administration (VNMHA) of Socialist Republic of Viet Nam and the China Meteorological Administration (CMA) in Meteorological Science and Technology. One of the cooperation focusing on China-Viet Nam conssultations workshop on severe weather events such as typhoons, rainstorms, cold air, drought and other extreme weather-related events. In 2019, the National Centre for Hydro-Meteorological Forecasting of Viet Nam, VNHMA conducted some consultations with National Meteorological Center of CMA on TC. Mun and TC. Wipha by telephone call and through webchat platform. Through these severe weather consultations, experts from both sides have discussed thoroughly the major characteristics of the tropical cyclones and their related severe weather. The forecasters from both sides also shared the observation information of the two sides on those tropical cyclones which then contributed to the analysis and assessment of the actual situation (location and intensity) of the severe weather events.

1.4.3. Other collaborations

International and regional cooperation in natural disaster prevention and control have been promoted; responsibility of SENDAI action framework has been realized, AHA Center Agreement is signed, regional maneuverson disaster responses took place in Indonesia; the participation of Vietnam in APEC, ARF, International Storm Committee etc. has been maintained;

- Bilateral cooperation with developed countries and regional countries have been promoted both in in-depth and practical manner, including Japan, Korea, Germany, Netherlands, United States, China, Taiwan, Cambodia, etc.;

- Close coordination with multilateral organizations such as the World Bank, Asian Development Bank, UN agencies, JICA, GIZ, etc. has been promoted to seek for technical assistances and financial supports as well as high quality human resources of disaster prevention and control;

- International conferences with the participation of leading experts from the World Bank, Japan, Germany, Netherlands, Taiwan have been held to find solutions to problems faced in disaster prevention and control in

Vietnam, especially solutions to flash flood, landslides, river bank and coastline erosions prevention and control and drought management in the Mekong Delta etc.

- Disaster relief goods have been received and distributed to affected people from overseas partners (44 tons of goods from Belarus, 10,000 tons of rice from Korea etc.)

II. Summary of Progress in Priorities supporting Key Result Areas

2.1. Central Data Hub and new information integration and forecast supporting system

Central Data Hub (CDH) is a part of the information integration system that provides the forecasting sub-systems access to all required data sources. The CDH will support and provide each separate forecasting sub-system the access to different data sources such as synoptic manual observation, automatic weather station, automatic raingauge, water level and sea level data, radar and satellite data will be also stored in CDH. The require ment for the CDH is that it must be integrated to the forecasting sub-systems (e.g weather, hydrology, marine forecast sub-system) in a good manner so that all inputs to the systems are read from the CDH and all the outputs of the sub-forecast systems are stored in the CDH.

The CDH is responsible for collecting and distributing operational data, such as observations and forecasts, between all components. The CDH and the forecasting sub-systems are independent systems but they are closely linked, with the CDH has a key role in collecting (near) real-time data from all required sources, so latest available data is always available from CDH, and for providing forecast data to the services, provided by VNMHA.

The forecast supporting system can integrate most of meteorological, hydrological and wave models where as the meteorological and wave model are installed and run in High Performance Computer (HPC) and hydrological models run in window servers. The wave forecasting using the SWAN model with resolution 8km, input wind from GFS. The running time for 3 days forecasting is about 10 minutes. For future, the resolution is reduced to 1-2km (nesting) and running in the new HPC.

VNMHA is running the ROMS 2D model with resolution 2km, input wind and pressure from GFS in our new HPC. The running time for 3 days forecasting is about 10 minutes. For future, the model resolution is increased to 1km, input wind and pressure from WRF, running in HPC which can provide daily forecast for all regions in Vietnam. Besidesrunning VNMHA own numerical wave models, VNMHA also used numerical results of storm surge and storm waves from RSMC Tokyo-Typhoon Center as a references for warning and forecasting when tropical cyclones approaching the coastal area of Vietnam.

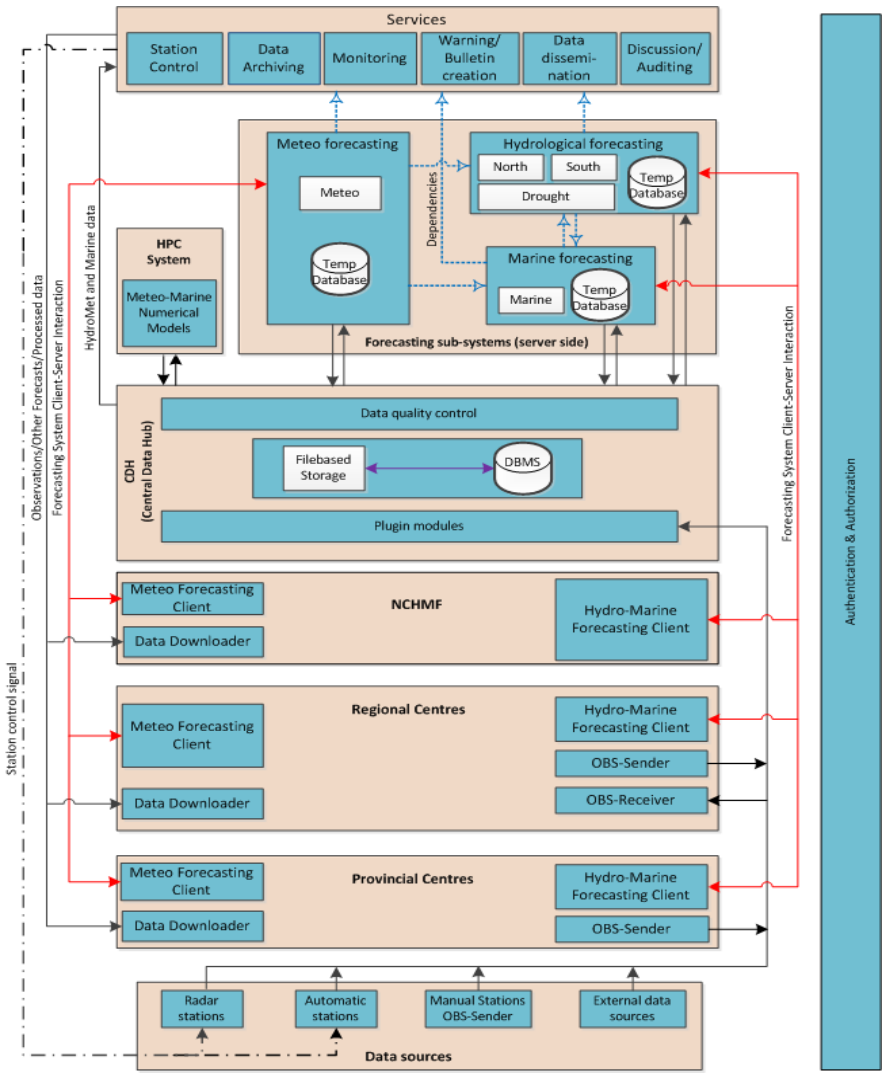


Figure 2.1. Conceptual Design data integration and weather forecasting support system

Identified opportunities/challenges, if any, for further development or collaboration:

The system is under testing phase and some of the data is still needed to be ingested in the system for a complete automatic system.

Priority Areas Addressed:

KRA 4: To enhance capacity to generate and provide accurate, timely and understandable information on typhoon-related threats

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2.2 Impact-based forecast in Viet Nam

Viet Nam Meteorology, Hydrology Administration (VNMHA) is moving toward an impact-based forecast and risk-based warning for meteorological and hydrological phenomena. Since 2017, VNMHA has been changing the way of information design and delivery to the disaster risk management section, local government and the public through tradiational media (TV, printed papers) as well as social media and online papers. The target of impact-based forecast and impact-based warning is to warn the risk of natural hazards for different regions, different users. It requires the VNMHA an extra effort in understanding the possible impacts of severe weather phenemona, especially tropical cyclones. The most obvious change is the questions from the disaster risk section and public for tropical cyclone cases, they are now more care about the time of the strongest wind, the most intense rainfall and possibility of inundation, flash flood and the wind damage instead of tropical cyclone information itself (such as location and intensity).

Identified opportunities/challenges, if any, for further development or collaboration:

VNMHA understands that to have a complete impact-based forecast system, VNMHA need to cooperate with different stakeholders in disaster risk management to have a common agreement on the possible impacts of severe weather in Viet Nam as well as the international cooperation and support with developed countries. Recently, VNMHA and Finland Meteorology Institute (FMI) and UK Met Office are cooperating to support Viet Nam to set up an impact-based forecast in near future. The cooperation projects PROMOSERV3 with FMI and WCSSP with UK Met Office are two ongoing projects that will support Viet Nam in those area. The PROMOSERV3 will provide a toolkit to produce and distribute the impact forecast of meteorological phenomena such as heavy rain, strong wind… and part of WCSSP project will guide VNMHA forecasters and staffs on how to build an impact matrix and step by step to get an impact-based forecast system.

Priority Areas Addressed:

KRA 1: To mitigate against the damaging impacts of typhoons and enhance the beneficial typhoon related effects for the betterment of quality of life through scientific research, technological development and operational enhancement.

KRA 2: To strengthen typhoon related disaster risk management in various sectors, including hydrological and aviation sectors, through strategic partnerships and collaboration.

KRA 3: To strengthen the resilience of communities to extreme weather and typhoon related disasters through the intelligent use of data, information and communication technology.

KRA 4: To enhance capacity to generate and provide accurate, timely and understandable information on typhoon-related threats

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2.3 Short-rangeRegional Ensemble Prediction System (SREP-32)

With the new HPC system, in 2019, the regional NWP products have been significantly upgraded, especially of very high resolution of deterministic forecast (3km, Southeast Asia domain) with boundary conditions (from ECMWF). The following figures shows examples of the new NWP products:

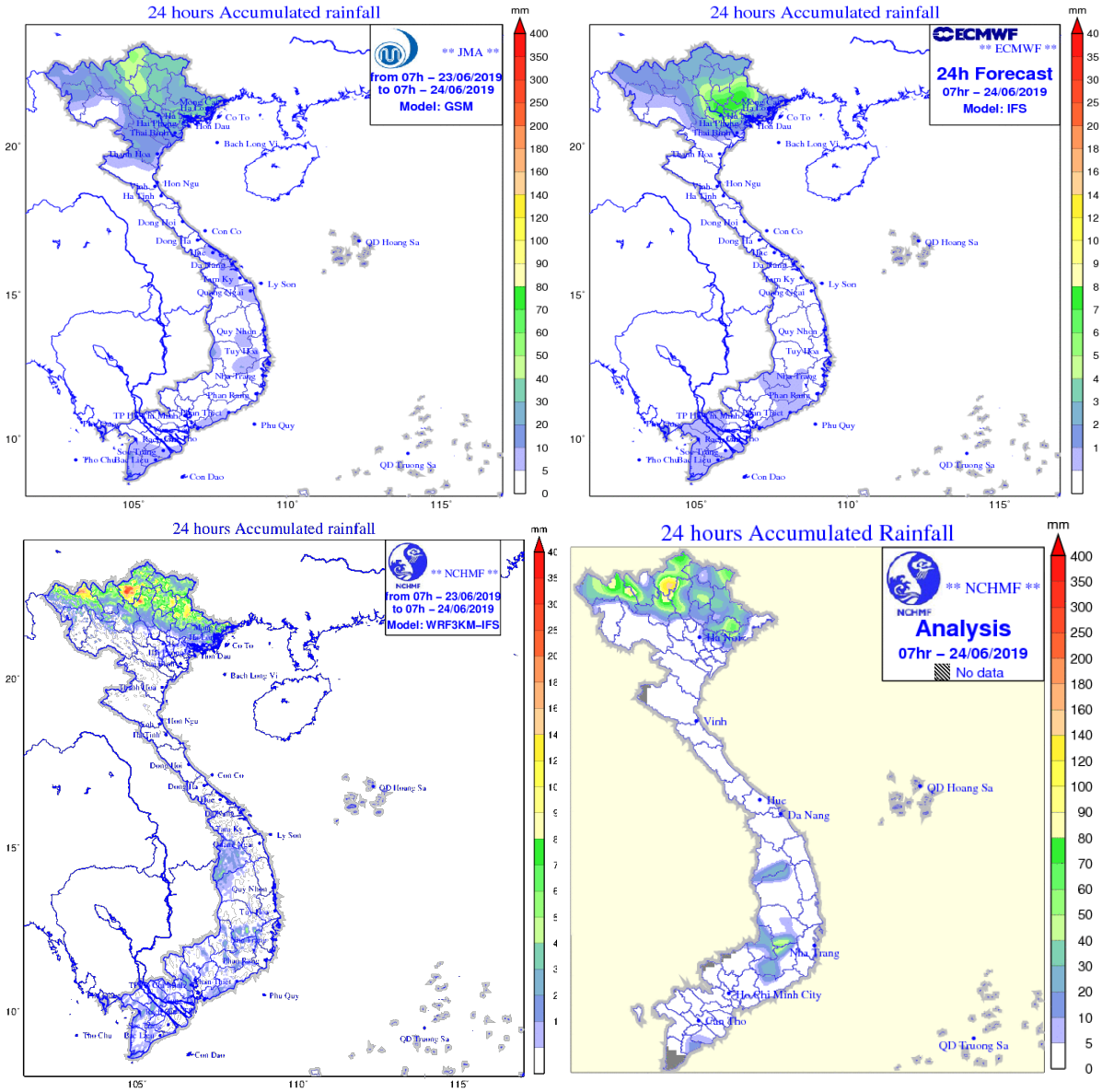

Figure 2.2. Comparison of IFS-ECMWF, GSM and WRF3kmIFS for

heavy rainfall over the northern Vietnam on 24/6/2019

The regional ensemble forecast was upgraded by using the Weather Research and Forecasting Model with Advanced Research with ARW dynamical core (WRF-ARW) with various physical model configurations (generated from different typical cumulus, shortwave radiation, boundary layer and from simple to complex cloud micro-physic schemes). The resolution of 32 ensemble members is 10km and using GFS-NCEP as boundary conditions. Examples of 32-member SREPS are as follows:

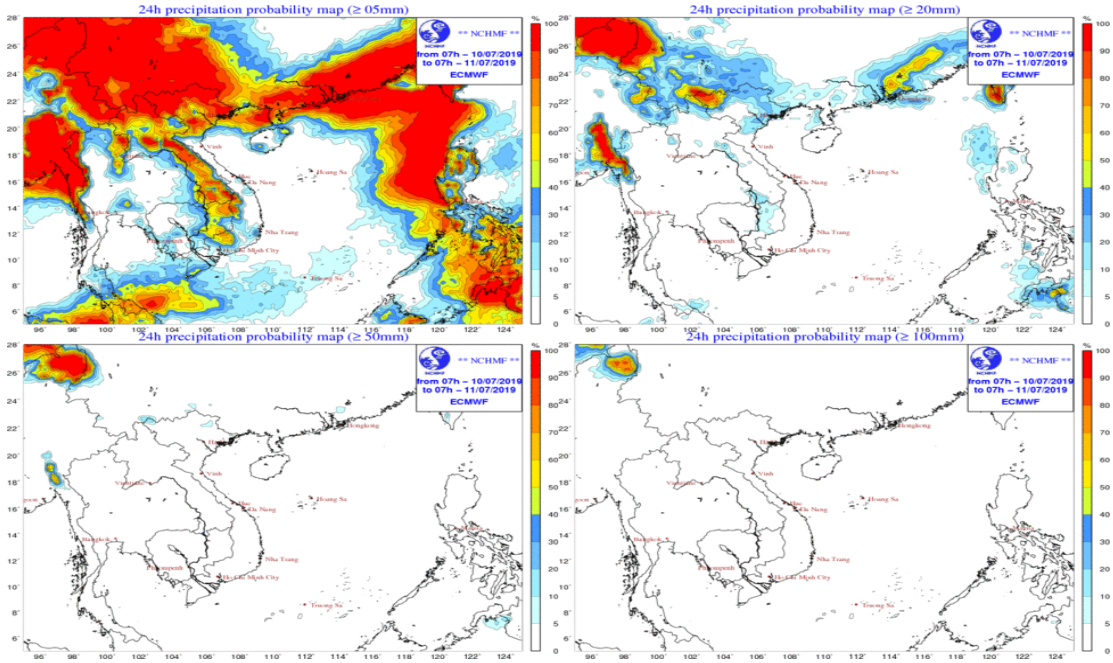

Figure 2.3. 24-hour rainfall ensemble forecast from ECMWF (51 members) at 00 UTC (07 LT) of 11 July 2019

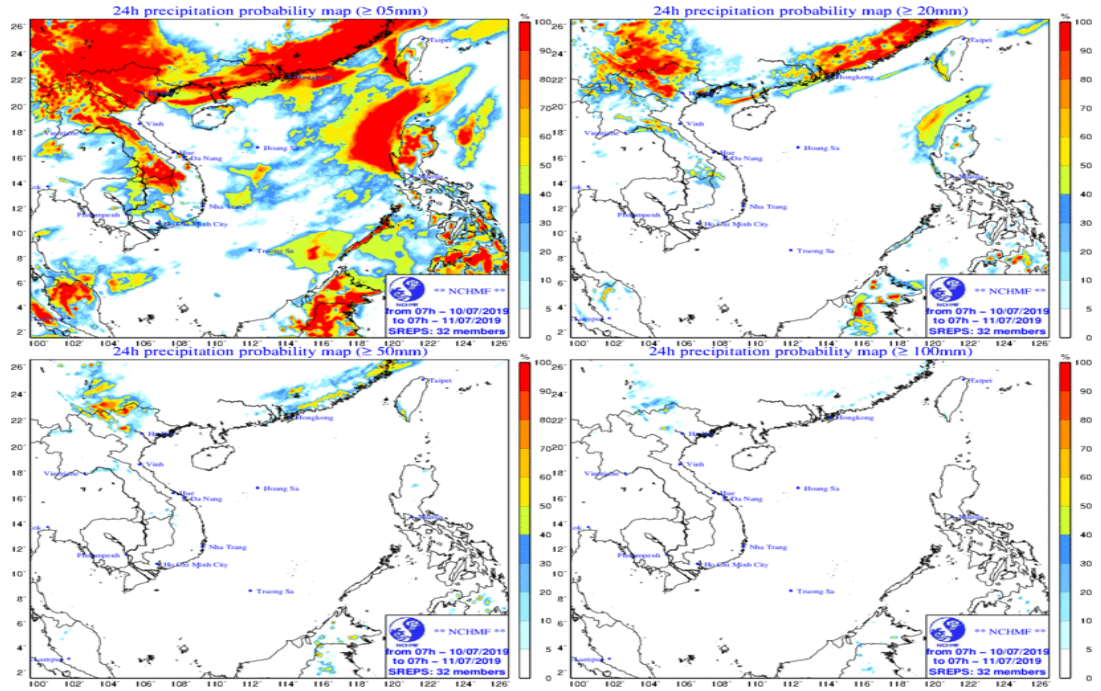

Figure 2.4. 24-hour rainfall ensemble forecast from SREP-32 at 00 UTC (07 LT) of 11 July 2019

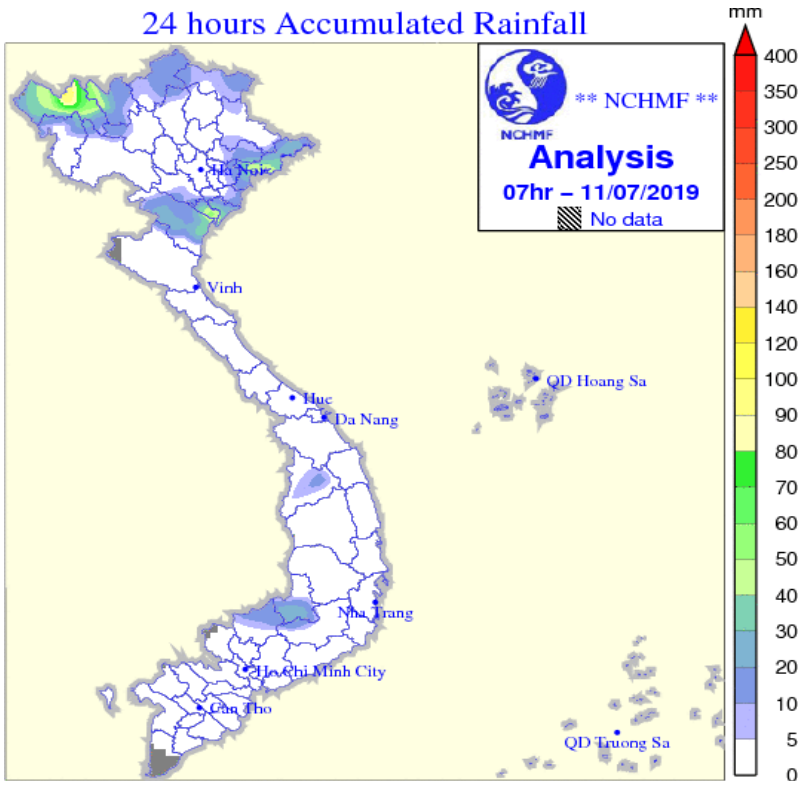

Figure 2.5. 24-hour Observation rainfall at 00 UTC (07 LT) of 11 July 2019

Identified opportunities/challenges, if any, for further development or collaboration:

VNMHA is providing the SREP-32 products on SWFDP-SeA website for member countries to use in daily severe weather forecast and warning. Feedbacks and suggestions from members are welcome for a better information design and delivery.

Priority Areas Addressed:

KRA 1: To mitigate against the damaging impacts of typhoons and enhance the beneficial typhoon related effects for the betterment of quality of life through scientific research, technological development and operational enhancement.

KRA 4: To enhance capacity to generate and provide accurate, timely and understandable information on typhoon-related threats

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2.4 Consultation workshop on SSOP in VietNam

In scope of the Project for Implementation of Synergized Standard Operating Procedures for Coastal Multi-Hazards Early Warning System,

Phase two (SSOP-II). From 26-27 September 2019, the Viet Nam Meteorological and Hydrological Administration (VMHA) has collaborated with Typhoon Committee (TC) to organize the consultation workshop under entitled “Preparing synergized standard operating procedures for multi-hazards early warning systems”.

The main purposes of this workshop are discuss on how to VietNam can write effective SSOPs to manage and operate its early hydro-meteorological warning system to protect life and property. The subjects have mainly been discussion in the consultation workshop to preparing SSOPs to include: Overview of SSOP-II Processes and Advantages; Developing multi-hazard SSOPs; Discover hazards that may allow SOPs to be combined for more streamlined SSOPs; Revising current SOPs to include multiple agencies and multiple levels leading to synergized SOPs; using current SOPs for tropical cyclone forecast, flood and flash flood, apply SSOP concepts to revise the plans to be synergized with multi-agencies across multi-levels; Establishing a process for sustaining improvements of SSOPs; using SSOP principles and concepts, develop a process for sustaining improvement of SSOPs. Discussion on how to incorporate the ideas from this workshop into current SOPs.

There were 40 experts from different fields and organizations attending in the workshop, including: Meteorological services, Hydrological services, Oceanographical services, Disaster risk management, Red Cross/Red Crescent partners, Tsunami/Seismic services, General Administration, Water resources services, Public health services, Social science representatives, Community leaders, Transportation managers, Utilities partners, Telecommunications partners, and broadcast and print media partners.

Objective assessment, the workshop has been successful and achieved positive results. The experts of SSOP-II will continue to improve and incorporate with relevant ministries and agencies of Vietnam to finalize the current SOPs.

Identified opportunities/challenges, if any, for further development or collaboration:

The main challenge on the implementation of the SSOP is the involvement of different agencies in VietNam.

Priority Areas Addressed:

KRA 3: To strengthen the resilience of communities to extreme weather and typhoon related disasters through the intelligent use of data, information and communication technology.

KRA 4: To enhance capacity to generate and provide accurate, timely and understandable information on typhoon-related threats.

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