MEMBER REPORT

SOCIALIST REPUBLIC OF VIET NAM

ESCAP/WMO Typhoon Committee

19th Integrated Workshop

October 2024

CONTENTS

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

Since January 2024, among 04 tropical cyclones (TCs) and 01 tropical depressions (TD) active in the Bien Dong Sea, there were 03 TCs making landfall to the Vietnam region, in which the third tropical cyclone (TC) (numbered by the National Center for Hydro-Meteorological Forecasting, Vietnam Meteorology Hydrology Administration) or storm with international name Yagi broke many records of intensity over the 50-year tropical cyclone historical database of Vietnam.

According to the report of the Viet Nam Disaster and Dyke Management Authority, Ministry of Agriculture and Rural Development of the Socialist Republic of Vietnam, since the beginning of 2024, natural disasters have continued to evolve over the countrywide. After prolonged periods of extreme heat, drought, and saltwater intrusion in the south, there have recently been continuous occurrences of heavy rainfall, landslides, and flooding in the northern and central provinces. Notably, the typhoon (TY) Yagi has caused severe damage in the northern region, even breaking many previous records for destruction. The TYYagi and its subsequent floods have claimed the lives of 329 people and caused significant damage to agricultural production, impacting the economic growth targets for the year.

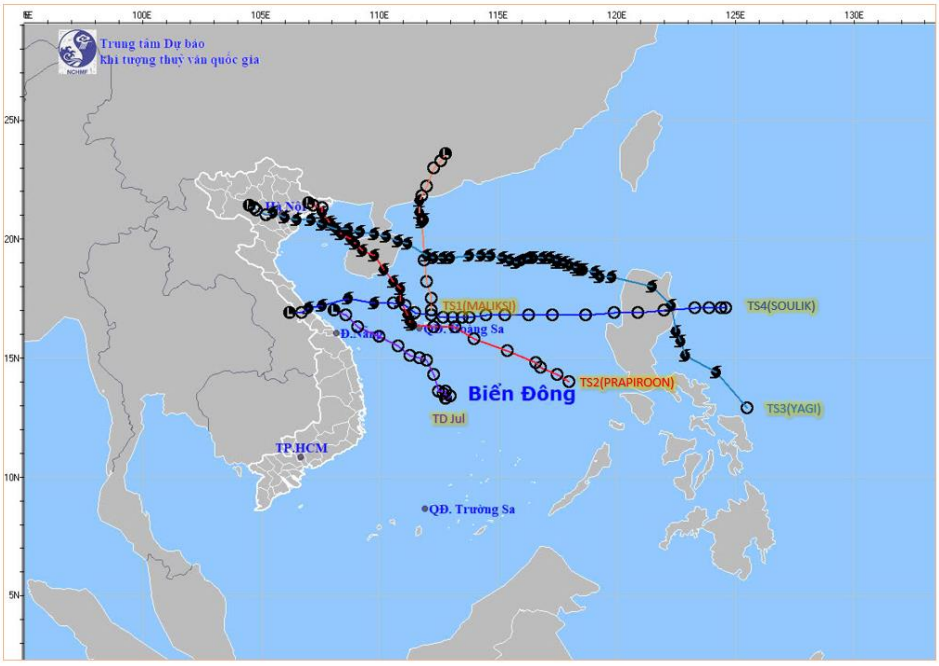


Figure 1.1. Tropical cyclone tracks in the Bien Dong Sea from January – September 2024.

1.1. Meteorological assessment

Tracks of 05 tropical cyclones (TCs) including 02 Tropical Storms (TS), 01 Severe Tropical Storm (STS), 01 Typhoon (TY) and 01 Tropical Depressions (TD) active in the Bien Dong are shown in Fig. 1.1.

Details of durations, affected areas and landfall locations deduced by 5 TCs are presented in Table 1.1

Table 1.1. Statistics on tropical cyclones since January 2024 affecting the Viet Nam region.

TC Name (International Name)	Duration	Affected Areas	Landfall Location
MALIKSI	30 May – 1 June	North Bien Dong Sea	Guangdong, China
Tropical Depression – July	13 – 16 July	The western Center Bien Dong Sea, southwestern North Bien Dong Sea, offshore Quang Tri – Quang Ngai Sea	
PRAPIROON	19 – 23 July	North and Center Bien Dong Sea, Gulf of Tonkin, Northern Vietnam provinces	Quang Ninh – Hai Phong, Vietnam
YAGI	3 – 8 September	North Bien Dong Sea, Gulf of Tonkin, Northern and North-central Vietnam provinces	Quang Ninh – Hai Phong, Vietnam
SOULIK	17 – 19 September	North Bien Dong Sea, offshore Nghe An – Thua Thien Hue Sea, Thanh Hoa – Quang Ngai provinces	Quang Binh – Quang Tri, Vietnam

* STS PRAPIROON TC PRAPIROON:

The STS PRAPIROON started as a low system over the eastern Center Bien Dong Sea in the morning of 19th July, gradually intensified then reached the peak intensity of level 10 Beaufort scale with the gust wind of level 12 in the Gulf of Tonkin 3 days later. When approaching the Quang Ninh – Hai Phong coastal region on the early morning of July 23, it downgraded to the level 8 – 9, gust level 11 then level 7, gust level 9. It made landfall in the Quang Ninh – Hai Phong region and continued to reduce its intensity to the low pressure area over Lang Son – Quang Ninh provinces.

On the mainland of Quang Ninh-Hai Phong, there were strong winds of level 6–7, with areas near the center of the TS PRAPIROON experiencing wind levels of 8–9, and gust wind reaching level 10. The central pressure recorded at Co To station (Quang Ninh) was 986.8 mb at 3:30 AM on July 23, while at Cua Ong station (Quang Ninh), it was 990.8 mb at 4:00 AM on July 23.

The STS PRAPIROON caused high waves in the Gulf of Tonkin. According to observation at the Bach Long Vi station, the waves reached heights of 1.75 – 3.25 meters, while ship observation and satellite data measured wave heights of 2.0 – 3.5 meters. Additionally, due to the influence of strong southwest winds combined with the circulation of the STS PRAPIROON, the wave heights in the northern part of the Bien Dong Sea fluctuated between 2.5 – 5.0 meters.

The STS PRAPIROON actually did not cause high storm surges (about ~ 0.2 – 0.3 meters in fact). However, due to the storm coinciding with high tides along the northern coastline, the combination of storm surges and tidal effects resulted in flooding in several low-lying coastal areas and riverbanks in Quang Ninh and Hai Phong on the afternoons of July 21 and 23.

Due to the impact of the STS PRAPIROON, from the night of July 22 to July 24, the midland and lowland areas, the Northwestern Vietnam and Thanh Hoa province experienced moderate to heavy rainfall, with some areas receiving very heavy rainfall. The average rainfall ranged from 100 – 200mm, with some places exceeding 250mm.

* TY YAGI:

In the morning of 3rd September, TY YAGI entered the Bien Dong Sea with the intensity of level 8, gust level 11, movement velocity of 15 – 20 km. After that, the TY YAGI slowed down and suffered a rapid intensification to the super typhoon classification with the maximum sustained wind speed of level 16, gust over level 17 in the morning of Sep 5, then increased its movement again.

On the afternoon of 6th September, the TY YAGI made landfall in the northern region of Hainan Island (China), with its intensity decreasing to level 15 and gusts exceeding level 17. By the night of September 6, the typhoon entered the eastern waters of the northern Gulf of Tonkin, weakening to level 14, with gusts at level 17, moving west-northwest at a speed of 15–20 km/h.

By the evening of 7th September, the TY YAGI made landfall in the Quang Ninh–Hai Phong area with strong winds at levels 12–14, near the TC's center reaching level 14, with gusts exceeding level 17. Afterward, the TY YAGI moved further inland, rapidly weakening to levels 8–9, with gusts at level 11. By the early morning of 8th September, it weakened to TD intensity, with it's intensity at levels 6–7 and gusts at level 9, moving westward at 10–15

km/h, then it continued to downgrade to a low-pressure area over the northwestern region of Vietnam.

The TY YAGI is the strongest TC making landfall and the longest TC remaining the TS intensity classification after making landfall in Vietnam during the last 30 years (more than 6 hours) based on the historical tropical cyclone database of Vietnam.

Due to the impact of the TY YAGI, the Gulf of Tonkin experienced strong winds at levels 12–13, with areas near the central of the TC reaching levels 14, and gusts at levels 16–17. On land, in Quang Ninh, Hai Phong, and Hai Duong provinces, wind speeds ranged from levels 10–13, with areas near the TC's center at levels 14 and gusts exceeding level 17. Further inland, winds were at levels 7–8, with gusts at levels 9–10. The central pressure recorded at Bai Chay station (Quang Ninh) was 955.2 mb at 1:30 PM on September 7 (as shown in the Table 1.2). TY YAGI induced the peak storm surge of 1.2m at Hon Dau station in Da Nang Province and 1.9m at Mui Ngoc station in Da Nang Province. The waves height were observed up to 6-8m Gulf of Tonkin, and 3-5m near the coast from Quang Ninh to Hai Phong. Fortunately, the typhoon landed at low tide so it did not cause serious coastal flooding.

Table 1.2. The maximum wind speed observed due to the TY YAGI

No.	**Province**	**Station**	**The maximum windspeed**	**Time (HHhMM/DD/M)**	**Gust wind**
1	Hải Phòng	Bạch Long vĩ	38.3m/s (level 13)	07h30/07/9	47.2m/s (level 15)
2		Hon Dau	25m/s (level 10)	15h10/07/9	35m/s (level 12)
3		Phu Lien	29m/s (level 11)	15h30/07/9	50m/s (level 15)
4		Cat Hai	34,2m/s (level 12)	16h00/07/9	42.8m/s (level 14)
5	Quảng Ninh	Co To	40m/s (level 13)	09h44/07/9	56m/s (level 16)
6		Mong Cai	13m/s (level 6)	09h50/07/9	22m/s (level 9)
7		Tien Yen			
8		Quang Ha	18m/s (level 8)	10h45/07/9	30m/s (level 11)
9		Dam Ha	30.4m/s (level 11)	11h10/07/9	40m/s (level 13)
10		Cua Ong	33m/s (level 12)	07h42/07/9	44m/s (level 14)

11		Bai Chay	45m/s (level 14)	13h00/07/9	62m/s (beyond level 17)
12		Uong Bi	30m/s (level 11)	14h55/07/9	45m/s (level 14)
13	Thai Binh	Thai Binh	20m/s (level 8)	12h00/07/9	28m/s (level 10)
14	Nam Dinh	Nam Dinh	15m/s (level 7)	13h39/07/9	22m/s (level 9)
15		Van Ly	16m/s (level 7)	20h47/07/9	21m/s (level 9)
16	Ninh Binh	Nho Quan	19m/s (level 8)	14h27/07/9	19m/s (level 8)
17	Tuyen Quang	Ham Yen	18m/s (level 8)	11h58/07/9	20m/s (level 8)
18	Bac Can	Bac Can	11m/s (level 6)	18h40/07/9	16m/s (level 7)
19	Phu Tho	Minh Dai	16m/s (level 7)	00h10/08/9	16 (level 14)
20		Phu Ho	14m/s (level 7)	21h25/07/9	15m/s (level 7)
21	Lanh Son	Mau Son	31m/s (level 11)	09h52/07/9	38m/s (level 13)
22		Huu Lung	16m/s (level 7)	15h10/07/9	18m/s (cấp 8)
23	Thai Nguyen	Thai Nguyen	11m/s (level 6)	16h20/07/9	15m/s (level 7)
24		Dinh Hoa	14m/s (level 7)	19h40/07/9	20m/s (level 8)
25	Vinh Phuc	Vinh Yen	15m/s (level 7)	20h40/07/9	20m/s (level 8)
26		Tam Dao	23m/s (level 9)	19h22/07/9	23m/s (level 9)
27	Bac Giang	Hiep Hoa	16m/s (level 7)	15h52/07/9	21m/s (level 9)
28		Luc Ngan	19m/s (level 8)	14h50/07/9	27m/s (level 10)
29		Son Dong	19m/s (level 8)	14h45/07/9	27m/s (level 10)
30		Bac Giang	17m/s (level 7)	18h55/07/9	24m/s (level 9)
31	Bac Ninh	Bac Ninh	20m/s (level 8)	19h30/07/9	27m/s (level 10)
32	Ha Noi	Lang	12m/s (level 6)	17h45/07/9	18m/s (level 8)
33		Hoai Duc	14m/s (level 7)	21h30/07/9	22m/s (level 9)
34	Ha Nam	Phu Ly	15m/s (level 7)	15h05/07/9	22m/s (level 9)
35	Hai Huong	Chi Linh	40m/s (level 13)	16h25/07/9	40m/s (level 13)

36		Hai Duong	26m/s (level 10)	15h17/07/9	35m/s (level 12)
37	Hung Yen	Hung Yen	19m/s (level 8)	15h22/07/9	29m/s (level 11)

Satellite-based observation of wave heights were about 6–8 meters in the offshore waters of Quang Ninh–Hai Phong between 2:00 PM and 4:00 PM on 7th September 2024. According to reports from observation at Bach Long Vi station, waves reached heights of 5–7 meters at 7:00 AM on 7th September. At Co To, wave heights were recorded at 3.5–4.5 meters at 10:00 AM, at Bai Chay 2.5–3.5 meters at 1:00 PM, and at Hon Dau 2.5–3.5 meters at 10:00 AM on the same day. The TY Yagi caused storm surges of approximately 1.4 meters at Cua Ong and 1.2 meters at Hon Dau. However, since the storm made landfall during low tide, flooding occurred only in some low-lying coastal areas of Quang Ninh and Hai Phong.

Due to the impact of the TY Yagi, followed by the influence of the inter-tropical convergence zone (ITCZ) connected to the circulation of the low-pressure area weakened from the TY Yagi, extremely heavy rainfall occurred in the Northern region, Thanh Hoa, and Nghe An provinces from the night of 6th September to 12th September. The average rainfall ranged from 200 – 450mm, with some areas receiving over 550mm (Table 1.3).

Table 1.3. The Maximum Accumulated Rainfall at several stations

No.	**Province**	**Station**	**Rainfall Amount (mm)**
1	Ha Giang	Nam Dan 2	781
2	Yen Bai	An Phu	706
3		Phuc Loi	692
4		Tan Phuong 1	680
5	Hoa Binh	Dong Tam	694
6		Dan Ha	669
7		Chi Ne	669
8	Son La	Pu Danh	635
9		To Mua	620
10	Thai Nguyen	Yen Do	662
11		Market town Chu	666
12		Trung Hoi	562
13	Lao Cai	O Quy Ho	647
14		TT Sa Pa	649
15	Ha Noi	Thuong Tin	622
16		Huong Son	623

17		Quan Hoa	591
18	Thai Binh	Phu Duc	607
19		Thai Ninh	579
20	Nam Dinh	Xuan Thuy	598

* TS TC SOULIK:

In the morning of 17th September, a tropical depression (TD) intensity over the eastern waters of Luzon Island (Philippines) entered the eastern waters of the North Bien Dong Sea with an intensity of level 7 and gusts at level 9. After entering the Bien Dong Sea, the TD moved westward at a fast pace of approximately 25–30 km/h. In the early morning of September 19, after entering the northeastern waters of the Hoang Sa (Paracel) Islands, the TD strengthened into a tropical storm (TS) intensity, internationally named TS SOULIK, becoming the fourth tropical storm in the Bien Dong Sea in 2024. The TS SOULIK had an intensity of level 8, with gusts at level 10. By the morning of 19th September, the TS SOULIK moved southward at a speed of about 25 km/h, strengthening to level 9 with gusts at level 11. By the afternoon, the TS SOULIK made landfall along the coast from Quang Binh to Thua Thien Hue, weakening to level 8, with gusts at level 10, then continued to move further inland over Quang Binh and Quang Tri provinces, and weakened to TD intensity and later to a low-pressure area over central Laos.

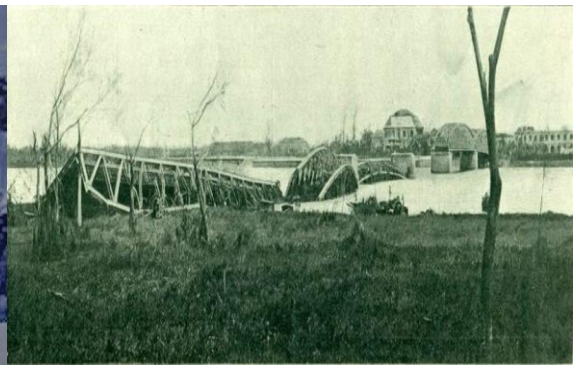
Due to the impact of the TS SOULIK, strong winds of levels 6–7 were recorded in the coastal waters from Nghe An to Thua Thien Hue, with areas near the center of the TC experiencing winds of levels 8–9 and gusts at levels 10–11. On land, in the coastal regions from Ha Tinh to Quang Tri, wind speeds were also at levels 6–7, with gusts at level 8. The central pressure recorded at Con Co station (Quang Tri) was 992.9 mb at 10:30 AM on September 19; at Dong Ha station (Quang Tri), it was 992.8 mb at 12:30 PM on September 19; and at Hai An station (Quang Tri), it was 992.0 mb at 11:40 AM on September 19.

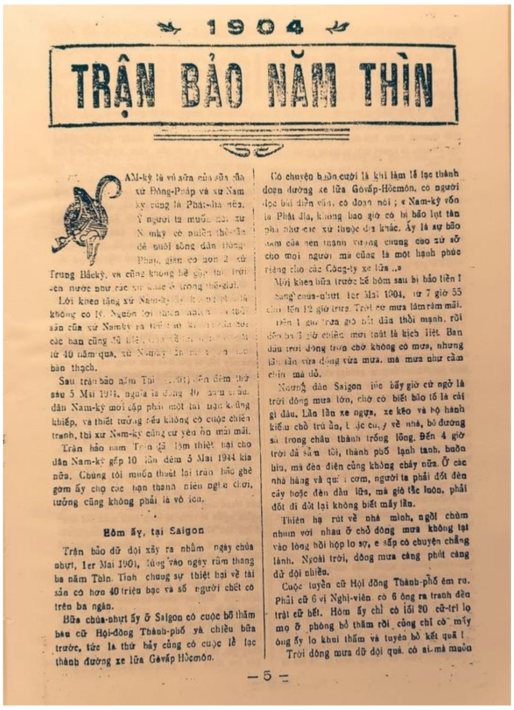
Satellite data recorded wave heights of 3–5 meters in the offshore waters from Thanh Hoa to Da Nang between 10:00 AM and 1:00 PM on September 19. At the Con Co marine station, wave heights were recorded at 2.5–3.5 meters at 10:00 AM on 19th September. The TS SOULIK caused storm surges of approximately 0.4 meters at Son Tra and 0.6 meters at Hon Ngu. However, since the storm surge was not significant, flooding occurred only in some low-lying coastal areas from Ha Tinh to Da Nang.

From 13th -19th September, due to the strong southwesterly monsoon, the Central Highlands and Southern regions experienced moderate to heavy rainfall and thunderstorms. Rainfall ranged from 70–150mm, with some areas receiving over 250mm. From the early morning of September 17 to the night of September 20, due to the influence of the ITCZ extending through the Middle-Central Vietnam region connecting with the TS SOULIK (then weakened into a low-pressure area over central Laos), Thanh Hoa and Quang Ngai provinces experienced moderate to heavy rainfall, with some areas receiving very heavy rainfall. Rainfall in these regions generally ranged from 100–200mm, with some areas exceeding 250mm. In the area from Nghe An to Quang Nam, rainfall was higher, ranging from 200–350mm, with some places receiving over 400mm. Specifically, in the region from Quang Tri to Quang Nam, notably rainfall occurred from the early morning of 17th -19th September.

1.2. Hydrological Assessment

With a return period of 60 years, in the year of the "dragon" according to the lunar calendar, catastrophic natural disasters as storm, flood appearances cause great damage to Viet Nam. Historically, in the years 1844, 1904 and 1964, storms, large floods, even great deluges caused terrible disasters in terms of human lives and property in the Central and Southern parts of Vietnam. By this year 2024, a year of the dragon following the 60-year return period, great floods have appeared in the North of Viet Nam.





1904

TRẬN BẢO NĂM THÌN

NAM-kỳ là vú sữa của sữa của xứ Đông-Pháp và xứ Nam kỳ cũng là Phật-địa nữa. Ý người ta muốn nói: xứ Nam-kỳ có nguồn [illegible] để nuôi sống dân Đông-Pháp, [illegible] có hơn 2 xứ Trung Bắckỳ, và cũng không hề gặp tai trời [illegible] nước như các xứ khác ở trong thế-giới.

Lời khen tặng xứ Nam-kỳ [illegible] không có lý. Nguồn lợi [illegible] sản của xứ Namkỳ ra thế nào [illegible] các bạn cũng đã biết [illegible] từ 40 năm qua, xứ Namkỳ [illegible] bàn thạch.

Sau trận bão năm Thìn [illegible] đến đêm thứ sáu 5 Mai 1944, nghĩa là đúng 40 năm [illegible] dân Nam-kỳ mới gặp phải một tai nạn kinh khiếp, và thiết tưởng nếu không có cuộc chiến tranh, thì xứ Nam-kỳ cũng cứ yên ổn mãi mãi.

Trận bão năm Thìn đã làm thiệt hại cho dân Nam-kỳ gấp 10 lần đêm 5 Mai 1944 kia nữa. Chúng tôi muốn thuật lại trận bão ghê gớm ấy cho các bạn thanh niên nghe chơi, tưởng cũng không phải là vô ích.

Hôm ấy, tại Saigon

Trận bão dữ dội xảy ra nhằm ngày chúa nhựt, 1er Mai 1904, nhằm vào ngày rằm tháng ba năm Thìn. Tính chung sự thiệt hại về tài sản có hơn 40 triệu bạc và số người chết có trên ba ngàn.

Bữa chúa-nhựt ấy ở Saigon có cuộc bỏ thăm bầu cử Hội-đồng Thành-phố và chiều bữa trước, tức là thứ bảy cũng có cuộc lễ lạc thành đường xe lửa Gòvấp Hốcmôn.

Có chuyện buồn cười là khi làm lễ lạc thành đoạn đường xe lửa Gòvấp-Hốcmôn, có người đọc bài diễn văn, có đoạn nói: « Nam-kỳ vốn là Phật địa, không bao giờ có bị bão lụt tàn phá như các xứ thuộc địa khác. Ấy là sự bảo đảm của nền thạnh vượng chung cho xứ sở cho mọi người mà cũng là một hạnh phúc riêng cho các Công-ty xe lửa ..»

Mới khen bữa trước kế hôm sau bị bão liền!

Sáng chúa-nhựt 1er Mai 1904, từ 7 giờ 55 cho lến 12 giờ trưa. Trời cứ mưa lâm râm mãi.

Đến 1 giờ trưa gió bắt đầu thổi mạnh, rồi đến ba 3 giờ chiều mới thật là kịch liệt. Ban đầu trời dông trơn chớ không có mưa, nhưng lần lần vừa dông vừa mưa, mà mưa như cầm chĩnh mà đổ.

Nhưng dân Saigon lúc bấy giờ cứ ngỡ là trời dông mưa lớn, chớ có biết bão tố là cái gì đâu. Lần lần xe ngựa, xe kéo và bộ hành kiếm chỗ trú ẩn, hoặc cuốn về nhà, bỏ đường sá trong châu thành trống lõng. Đến 4 giờ trời đã sầm tối, thành phố lạnh tanh, buồn bíu, mà đèn điện cũng không cháy nữa. Ở các nhà hàng và quán cơm, người ta phải đốt đèn cây hoặc đèn dầu lửa, mà gió tắc luôn, phải đốt đi đốt lại không biết mấy lần.

Thiên hạ rút về nhà mình, ngồi chùm nhum với nhau ở chỗ dông mưa không lọt vào lòng hồi hộp lo sợ, e sắp có chuyện chẳng lành. Ngoài trời, dông mưa càng phút càng dữ dội nhiều.

Cuộc tuyển cử Hội đồng Thành-phố êm ru. Phải cử 6 vị Nghị-viên có 6 ông ra tranh đều trật cử hết. Hôm ấy chỉ có lối 20 cử-tri lọ mọ ở phòng bỏ thăm rồi cũng chỉ có mấy ông ấy lo khui thăm và tuyên bố kết quả!

Trời dông mưa dữ dội quá, có ai mà muốn

— 5 —

Figure 1.2. Devastation in Go Cong after storm - Southern Vietnam, May 1904 and destroyed bridge Thanh Thai in Hue - Central of Viet Nam, Sep 1904

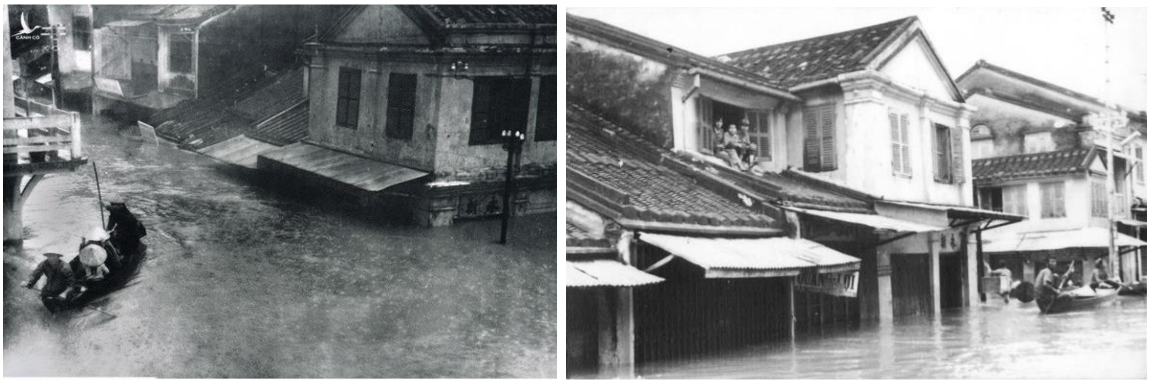


Figure 1.3. Great flood in Quang Nam – Central of Viet Nam, Nov 1964

In 2024, the prominent disaster situation related hydrology in Vietnam can be mentioned as:

- In the Northern part, severe flooding occurred in the most of Northern Viet Nam's provinces as results of Typhoon Yagi, in which, flood peaks were recorded in several rivers over historical flood. Flash floods and landslides are dangerous hydrological phenomena that have taken place in the northern mountainous areas.

- In the Central and Highland areas of Viet Nam, as a result of long time lacking of rainfall, drought and water shortage situation occurred during the months of 2024 dry season. However, when the flood season in the Central

region has come, the first flood event in the Central of Vietnam is a major flood with the flood peak on many rivers were reached or over the AL3. This is the result of the TS SOULIK appearance from the 17th to the 23th, September.

- In the Southern part, saline intrusion in the Mekong delta area always occurs in every dry season. The severity of saline intrusion will depend on the situation of the upstream Mekong flow.

1.2.1. Flood, flash flood and landslide in the North of Viet Nam

a) Flood situation

After landfalling in Hai Phong - Quang Ninh provinces from the 7th September, the typhoon TY YAGI caused a large amount of rainfall covering almost the entire Northern part of Vietnam until the 13th Sep, in which, total rainfall were recorded at many rain gauges over 500mm. As a result of this situation, large flood occurred on many river systems in the North of Viet Nam. Flood peak on the both main stream and small tributaries were recorded over Alarm Level 3 – AL3 (flood stage) and historical flood (HF) peaks. Especially, water levels at downstream of two main rives as Red and Thai Binh reached approximately and over AL3, the highest situation since 2003. As the consequence of the great flood, many provinces, cities in the Red and Thai Binh Delta areas, coastal areas were under flooding for next 2 weeks. Table 1.4 summarized information of flood characteristics on the main river systems in the North of Viet Nam from 09th to 13th September.

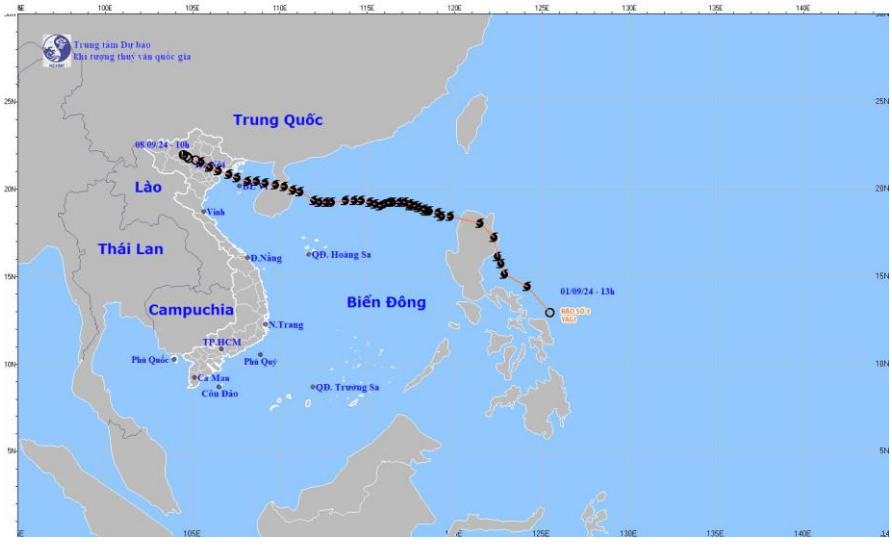


Figure 1.4. The track of the TY Yagi

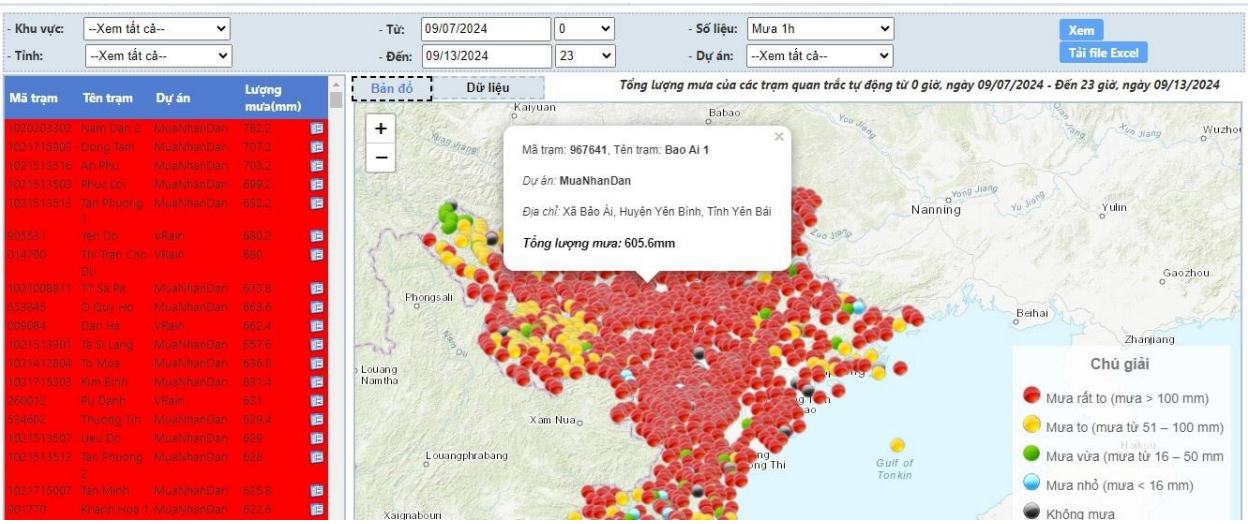
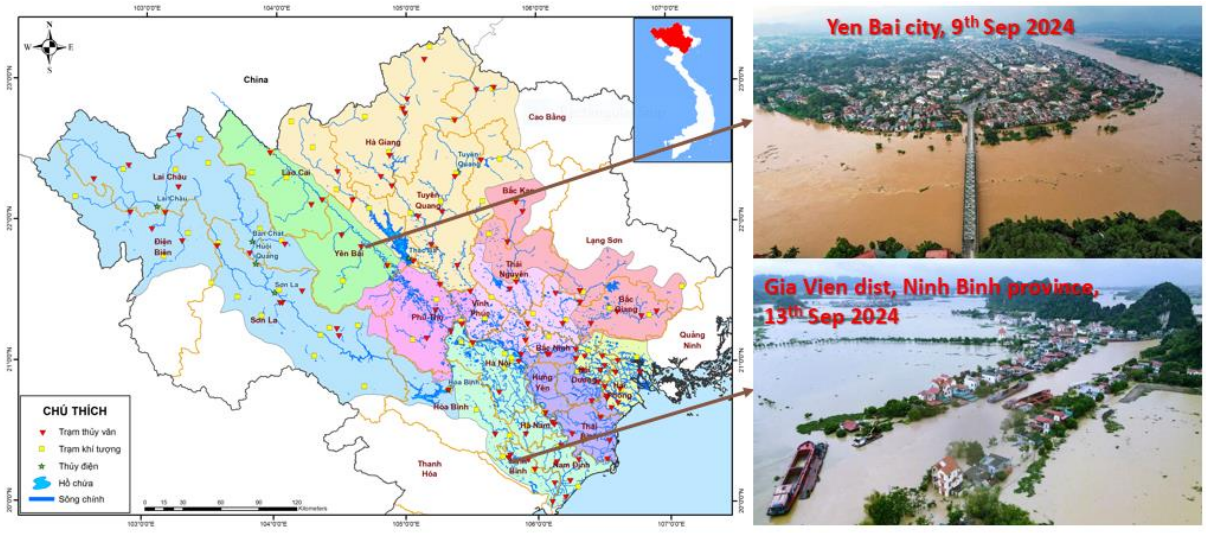


Figure 1.5. Total rainfall from 07th to 13th September 2024 in the North of Viet Nam during TY YAGI landing



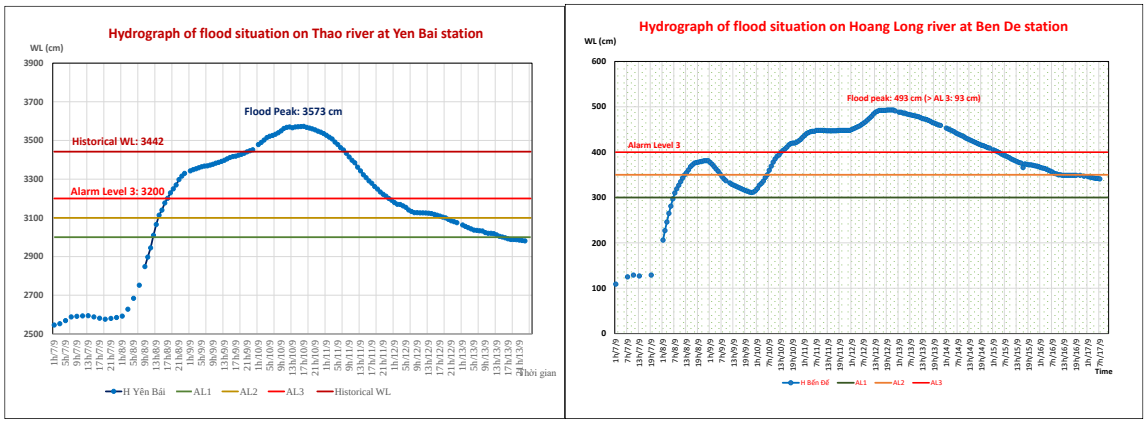


Figure 1.6. Flood peaks on Thao river at Yen Bai over historical flood, on Hoang Long river at Ben De over AL3.

Table 1.4. Flood characteristics on main rivers in the North of Viet Nam caused by the TY YAGI

No	Province	River	Station	Time of flood peaks	Flood peaks (m)	Compared with AL	Compared with HF
1	Lao Cai	Thao	Lao Cai	21h/11/9	**86.97**	**> AL3: 3.47m**	**< HF: 0.23m**
2		Thao	Bao Ha	7h/10/9	**61.95**	**>AL3: 4.95m**	**> HF: 1.02m**
3	Yen Bai	Thao	Yen Bai	17h/10/9	**35.73**	**>AL3: 3.73m**	**> HF: 1.31m**
4		Chay	Thac Ba	19h/11/9	**29.05**	**>AL3: 7.05m**	
5	Tuyen Quang	Gam	Chiem Hoa	10h/10/9	**44.37**	**>AL3: 5.87m**	
6		Lo	Tuyen Quang	05h/11/9	**27.73**	**>AL3: 1.73m**	
7	Phu Tho	Lo	Vu Quang	17h/11/9	**2121**	**>AL3: 0.71m**	**< HF: 0.69m**
8	Thai Nguyen	Cau	Gia Bay	01h/10/9	**28.81**	**>AL3: 1.81m**	**> HF: 0.67m**
9		Cau	Cha	23h/11/9	**10.90**	**>AL3: 0.9m**	**< HF: 0.12m**
10	Bac Ninh	Cau	Dap Cau	20h/12/9	**7.79**	**>AL3: 1.49m**	**< HF: 0.05m**
11	Bac Giang	Thuong	P. Lang Thuong	23h/11/9	**7.23**	**>AL3: 0.93m**	**< HF: 0.29m**
12		Lục Nam	Luc Nam	10h/9/9	**6.72**	**>AL3: 0.42m**	
13	Hai Duong	Thai Binh	Pha Lai	17h/12/9	**6.25**	**>AL3: 0.25m**	
14	Ha Noi	Hong	Ha Noi	02h/12/9	**11.30**	**>AL2: 0.80m**	
15	Ninh Binh	Hoang Long	Ben De	19h/12/9	**4.93**	**>AL3: 0.93m**	
16	Nam Dinh	Dao	Nam Dinh	14h/12/9	**5.32**	**>AL3: 1.02m**	**< HF: 0.14m**
17		Ninh Co	Truc Phuong	14h/12/9	**3.84**	**>AL3: 1.24m**	**> HF: 0.14m**
18	Ha Nam	Day	Phu Ly	02h/13/9	**5.22**	**>AL3: 1.22m**	**> HF: 0.29m**

Note: Alarm Level 2 – AL2: defined as warning stage

Alarm Level 3 – AL3: defined as flood stage

b) Flash flood and landslide

Due to heavy rainfall as result of the TY YAGI circulation, flash floods and landslides have occurred in many mountainous and midland provinces, leading to a series of devastating losses of human life and property, especially in Lang Nu village, Phuc Khanh commune, Bao Yen district, Lao Cai province, the palace that suffered the most catastrophic destruction. According to

statistics in mid-September, a large damages of human life, losing of houses in Lang Nu village was listed as below:

- People: 52 death, 14 missing, 15 injured;
- Houses: 40 swept away

Figure 1.7. Lang Nu village, Phuc Khanh District, Lao Cai province before and after flash flood & landslide occurrence

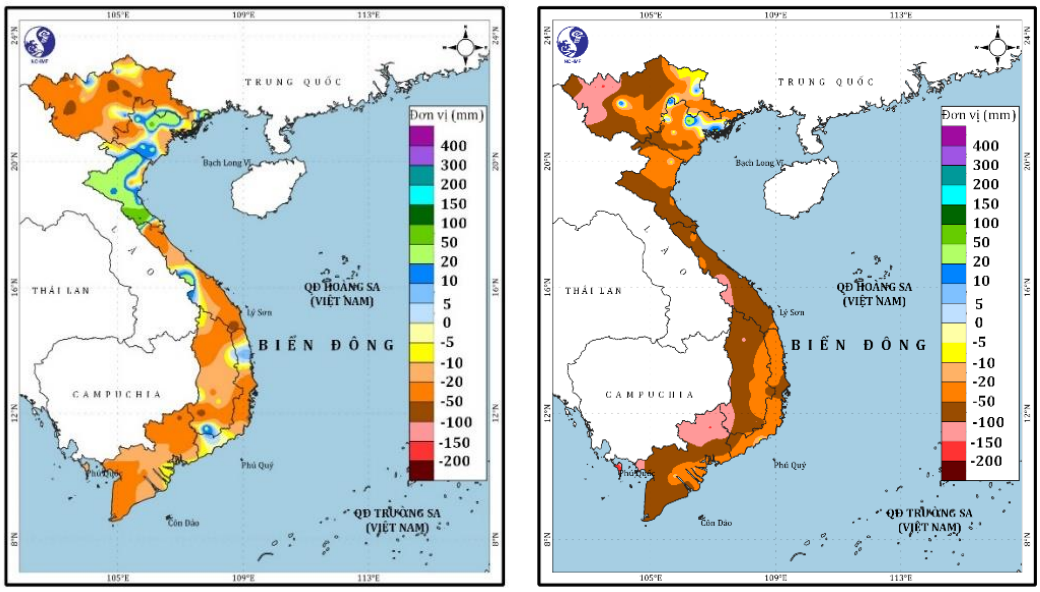
The main reason is a long time rainy in the northern mountainous region for the past 3 months, which is 40-60% higher than normal. In August alone, the number of rainy days in Lao Cai and Yen Bai provinces were 22/31 and 21/31 which is a rare occurrence. In the mountainous provinces in Northern part, after days of prolonged heavy rain, the soil and rocks were saturated, the floods on the rivers had receded but it is still faced a high risk of landslide when it was not raining.

1.2.2. Drought, water shortage situation and the first flood event during flood season in Central of Viet Nam

a) Drought, water shortage situation

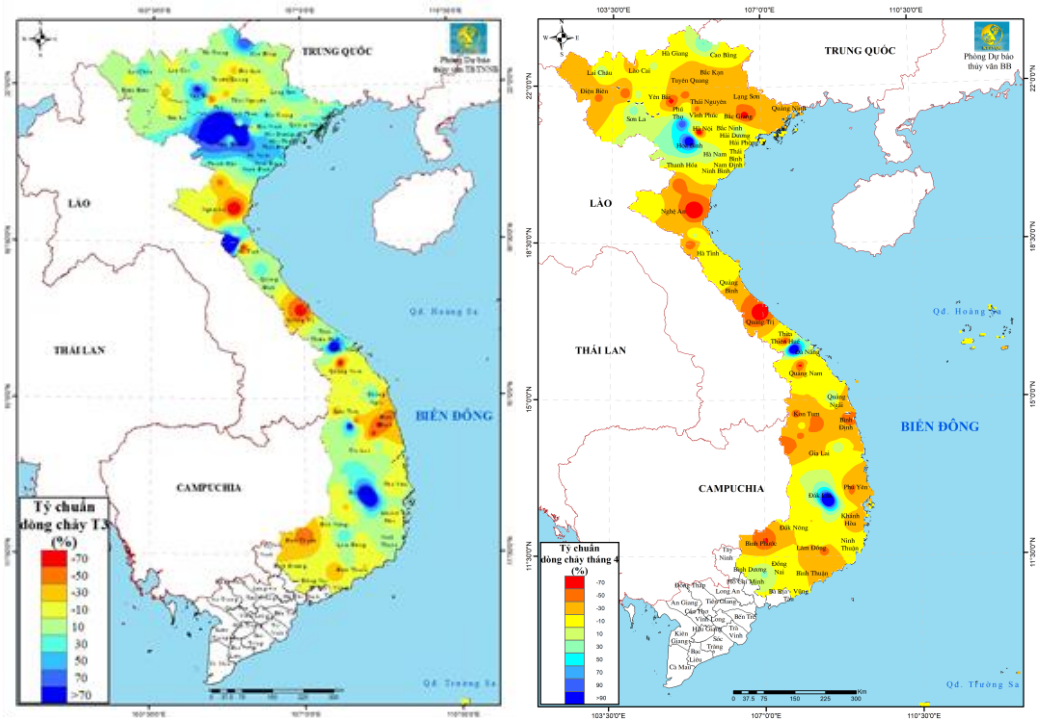
During dry season, due to a long-term lack of rainfall (from February to June), drought conditions and water shortages occurred in many provinces in the Central and Highland of Vietnam.

The figure 1.8 illustrating the Error Standard in March and April 2024, shortage of rainfall in April has increased. The amount of rainfall in the whole country is lower than that of long-term average (LTA) from 30mm to 60mm, of which, the North-Western of the North, Central and Central Highlands were lower 50-100mm in comparation with the long-term average. Together with the lack of rainfall for many consecutive months compared to the LTA, the river flow in the many provinces also faced a shortage situation, of which, the most severe affect places were Gia Lai province (Highland area) from March to April, Quang Tri and Quang Nam provinces (Central area) from April to June.



(a) (b)

Figure 1.8. Monthly rainfall error standard for March (a) and April (b) 2024



(a) (b)

Figure 1.9. Monthly flow standard deviation (%) for March (a) and April (b) 2024

b) The first flood event during flood season in Central of Viet Nam

The flood season in central Vietnam in 2024 came late with the first major flood concentrated from 17th to 24th September. The main cause of the flood was the TS SOULIK combining with other severe weather patterns causing heavy rain such as the activity of the southwest monsoon, the movement of cold mass air.

From early morning of September 17 to the night of September 20, due to the influence of the tropical convergence zone with its axis through the Central of Viet Nam with the activity of the TS SOULIK after weakening to a low pressure over the Central of Laos, total of rainfall was recorded a common of 100-200mm in the Thanh Hoa, Quang Ngai provinces, some places over 250mm; from 200 to 350mm in provinces from Nghe An to Quang Nam.

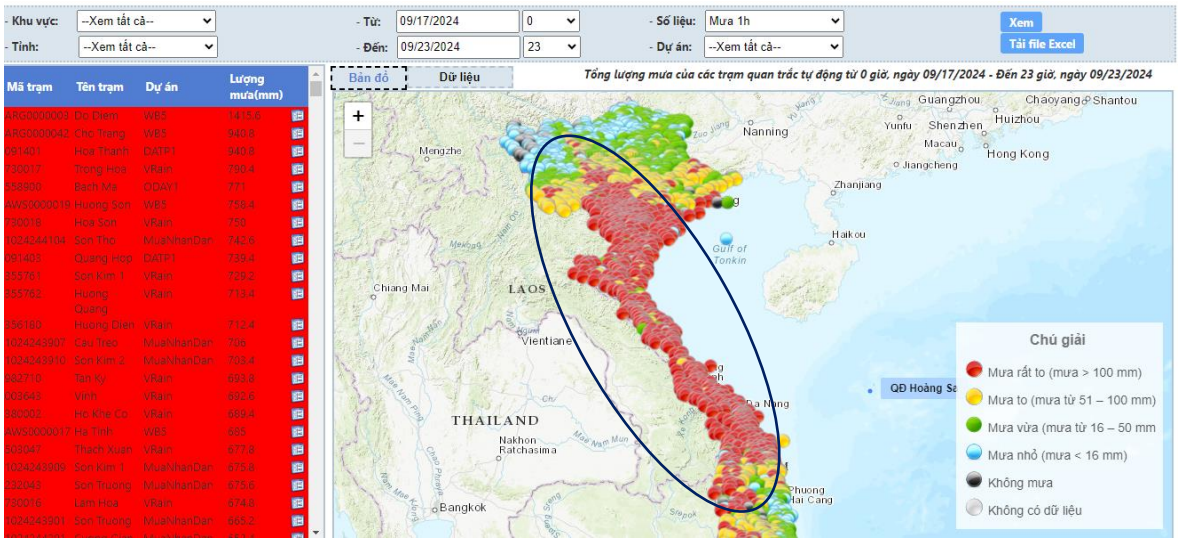


Figure 1.10. Total rainfall from 17th to 23th September 2024 in the Central of Viet Nam due to TS SOULIK circulation

As a result of TS SOULIK, heavy rainfall occurred in provinces in the North and Central of Viet Nam, from Hoa Binh to Quang Nam. The major flood appeared in many river systems in Thanh Hoa, Nghe An, Ha Tinh and Quang Binh provinces, in which, flood peaks reached AL2 – AL3, some places over AL3.

Table 1.5. Flood characteristics on main rivers in the Central of Viet Nam during TS SOULIK circulation affected

No	Province	River	Station	Time of flood peaks	Flood peaks (m)	Compared with AL
1	Thanh Hoa	Buoi	Kim Tan	08h/24/9	**12.19**	**> AL3: 0.19m**
2		Ma	Cam Thuy	04h/23/9	**20.30**	**>AL3: 0.1m**
3		Chu	Cua Dat	04h/23/9	**32.10**	**>AL3: 1.1m**
4			Bai Thuong	03h/23/9	**28.50**	**>AL3: 0.5m**
5	Nghe An	Ca	Con Cuong	01h/21/9	**30.33**	**<AL3: 0.17m**
6	Ha Tinh	Ngan Pho	Son Diem	17h/20/9	**12.38**	**<AL3: 0.62m**
7	Quang Binh	Gianh	Dong Tam	08h/20/9	**14.80**	**>AL3: 1.8m**

2.3. Saline intrusion in the Mekong delta area

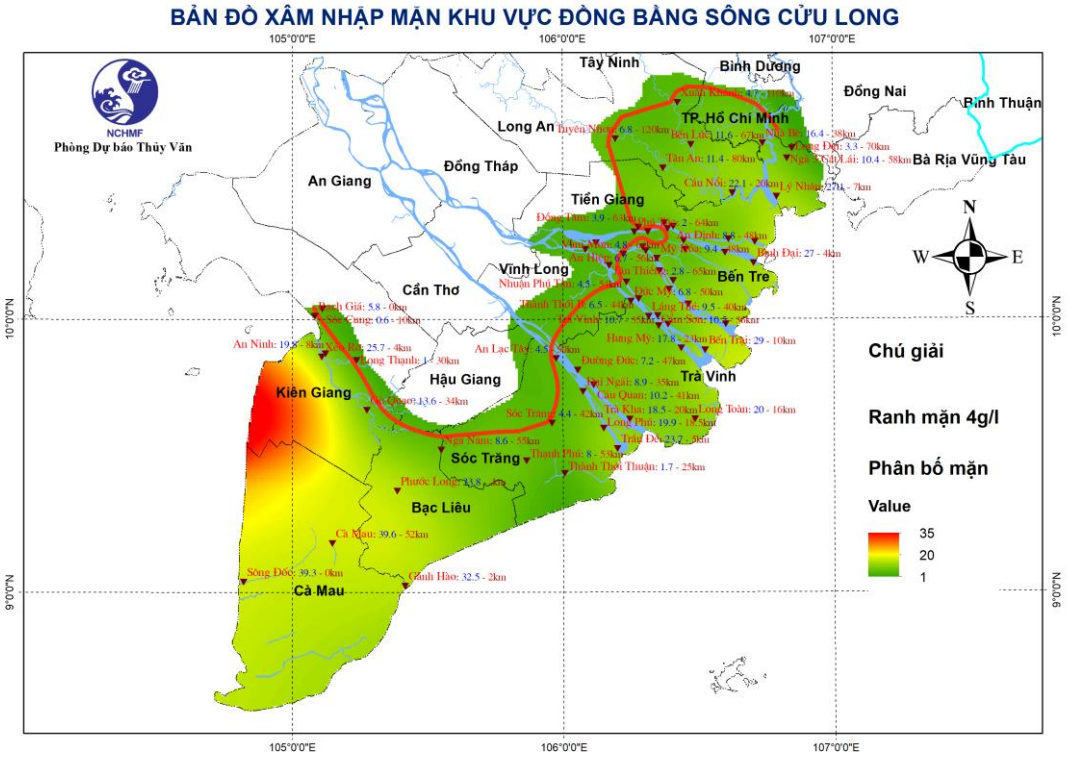


Figure 1.11. Saline intrusion map for dry season 2024 (from January to May) in the Mekong delta

Saline intrusion in the Mekong Delta in the 2023-2024 dry season had come earlier and was higher than the LTA and last year 2022-2023. The increasing saline intrusion had started to affect agriculture and people's lives since the end of January 2024. From February to April 2024, there were 03 highest saline intrusion periods, saline intrusion depth of 4g/l was recorded on several main river mouths as: on the Vam Co river from 90-122km, on the Mekong river mouths from 45-70km, on the Cai Lon river from 45-55km.

1.3. Damage Assessment

From the beginning of the year 2024 so far, due to the affects of 04 TCs and 01 TD, 185 heavy rain events, inundation, flash floods, landslides, 249 severe thunderstorms, some of the major damages listed include:

- Casualties and injuries: 453 people died and 38 missing, 2,080 people injured.

- Housing: 5,884 houses collapsed, 315,822 houses damaged or roofs blown off.

- Agriculture and livestock: 398,593 ha of rice and upland crops and 290,331 ha of other crops were flooded and damaged; 47,139 cattle and 5,481,000 poultry died and are washed away.

- Aquaculture: 219 boats and ship sunk or damaged; 39,920 ha of aquaculture area and 11,876 aquaculture cages, pens and rafts damaged.

- Irrigation: 199,419 km of dykes, embankments and canals eroded and damaged.

- Transport: 982 bridges were damaged or swept away; 232,102 km of transport roads are damaged or eroded, i.e., a total of 14 million m3 of soil, stone and concrete are eroded.

- Damaged cost was estimated at about 85,075 billion VND (about 3.4 billion US$).

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 Program (SWFP)

In 2011, Viet Nam Meteorological and Hydrological Administration (VNMHA) was chosen to be a Regional Forecasting Support Center under the WMO - Severe Weather Forecasting Demonstration Project for Southeast Asia (SWFDP-SeA), now as Severe Weather Forecasting Program (SWFP-SeA). In 2016, Hanoi Regional Forecasting Support Centre (RFSC) started the demonstration phase of the project and move to operational phase 3 years later.

Main purposes of RFSC Hanoi are: shares global model forecasts from international centers (NCEP, JMA) and regional forecast model running at Viet Nam and provides guidance for short range (1-2 days) and medium range (3-5 days) warnings for strong wind and heavy rainfall. National Hydro-Meteorological Services -NHMs (Laos, Cambodia, Thailand, Philippine, Vietnam) in the SWFP-SeA program can use RFSC’s guidance for their reference in severe weather warning.

RFSC Hanoi has collaborated with WMO to organize main training activities includes:

a) Training desk by RFSC and WMO:

- SWFP-SeA RFSC Training Desk (7-9 December 2020) (ORGANIZED REMOTELY ONLINE)

- SWFP-SeA RFSC Training Desk (Ha Noi, 9-20 December 2019)

- SWFDP-SeA RFSC Training Desk (Ha Noi, 7-18 May 2018)

b) Severe and IBFs training:

- CREWS / SWFP-Southeast Asia - In-country Training on Severe Weather and Impact-based Forecast and Warning Services (IBFWS) (Phnom Penh, Cambodia, 23 October - 3 November 2023)

- CREWS / SWFP-Southeast Asia - Introductory Training on Nowcasting of Severe Weather (for Cambodia and Lao People's Democratic Republic) (14-16 November 2022) (ORGANIZED REMOTELY ONLINE)

- SWFP – South Asia and Southeast Asia - Training Workshop on Severe Weather and Impact Based Forecasting and Warning Services (28 February - 10 March 2022) (ORGANIZED REMOTELY ONLINE)

- SWFP – South Asia and Southeast Asia - Training Workshop on Severe Weather and Impact Based Forecasting and Warning Services (1-12 February) (ORGANIZED REMOTELY ONLINE)

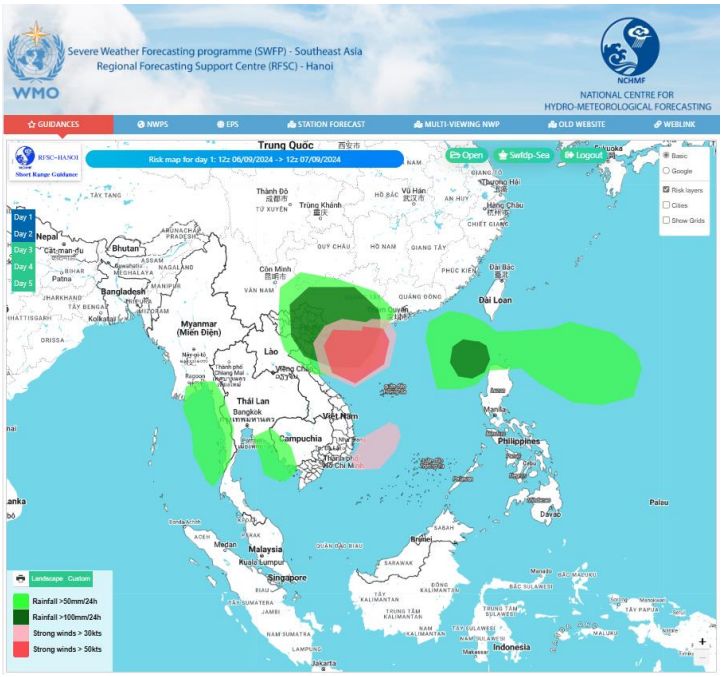


Figure 1.12. The guidance for heavy rainfall and strong win over the southeast Asian region on 06/Sep/2024 on the SWFP's portal of RFSC Hanoi

c) Annual training by WMO:

- Two-week SWFDP-SeA Training Workshop (Vientiane,19 February - 1 March 2019)

- Two-week SWFDP-SeA Training Workshop (Ha Noi, 9-30 March 2018)

- Two-week SWFDP Training Workshop (Bangkok, 14-25 September 2015) jointly organized for both Southeast Asia and the Bay of Bengal (South Asia) sub-regions

- Two-week SWFDP-SeA Training Workshop (Quezon City, 2-13 June 2014)

- Two-week SWFDP Training Workshop (Macao, 8-19 April 2013) jointly organized for both Southeast Asia and the Bay of Bengal (South Asia) sub-regions (Bhutan, Nepal, Pakistan, Indonesia and Macao also participated)

- Two-week SWFDP-SeA Training Workshop (GDPFS & PWS) (Hong Kong, 4-15 July, 2011)

1.4.2. Development of Southeast Asian Flash Flood Guidance System (SeAFFGS)

The SeAFFGS is a system under Global Flash Flood Guidance System of WMO which have been developed by Hydrologic Research Center – the USA. The purpose of the SeAFFGS project is the development and implementation of FFGS specifically for Cambodia, Lao PDR, Thailand, Viet Nam.

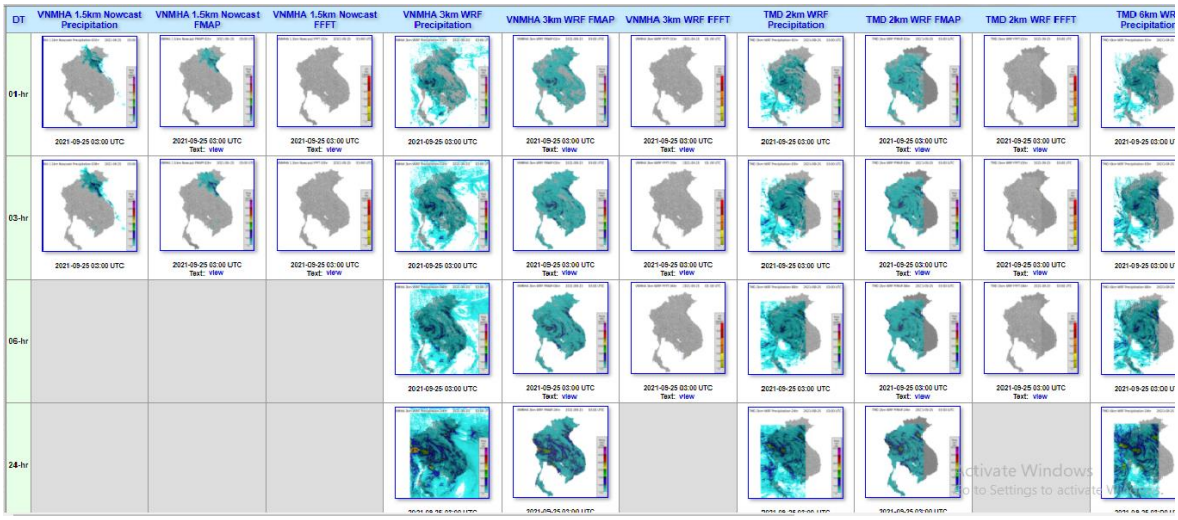


Figure 1.13. The SeAFFGS –flash flood supporting warning system

The system is integrated with many rainfall data sources with high quality such as:

+ Radar and the WRF-ARW mode provided rainfall forecast upto 24hrs: WRF3km-IFS (VNMHA), WRF-ARW 2km (TMD), WRF-6km (TMD), WRF-4km (MRC);

+ Integrating automatically rain gauges;

+ Administration information.

1.4.3. Other collaborations

In 2021, VNMHA keeps posting our discussion and questions on tropical cyclone analysis and forecast in RSMC Tokyo forum at https://my.redmine.jp/tc_communication/login

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 maneuvers on 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. In late 2019 and 2020, Vietnam has signed new Collaboration Agreement with International Research Institute for Climate and Society (IRI) on developing climate services in Vietnam, including but not limited to building up the National Framework for Climate Service in Vietnam.

Vietnam has also joined The Weather and Climate Science for Service Partnership (WCSSP) Southeast Asia which currently involving four partner countries: the Philippines, Malaysia, Indonesia and Vietnam. This project aims to jointly develop and improve underpinning capability in global and regional forecasting systems, and advance the understanding of high-impact weather events in order to provide better advice and mitigate their socio-economic impacts. This cooperation has been renewed in late 2021.

- Vietnam has been keeping 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;

II. Summary of Progress in Priorities supporting Key Result Areas

2.1. Central Data Hub, HPC 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 rain-gauge, water level and sea level data, radar and satellite data will be also stored in CDH. 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.

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

VNMHA is providing severe weather warning for short-range and medium range everyday and NWPs 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

2.2 Impact-based forecast and warning services in Viet Nam

VNMHA has been implementing the impact-based warning services (IBFWS) with more potential impact information deliveried to the disaster risk management section, local governments in the official warnings, especially with tropical cyclone situations. VNMHA also cooperates efficiently with traditional media (TV, printed papers) as well as social media and online papers to communicate with the public and different stakeholders, regions, users. The interactions helps VNMHA in understanding the possible impacts of severe weather phenomena, especially tropical cyclones, especially with landfall severe typhoon (i.e typhoon Yagi, 9/2024).

VNMHA uses our own studio and different media channels (i.e TV national channels and VNMHA's social media channels) to produce and update our forecast and warning every three hours, and even hourly when typhoon making landfall in the next 24 hours.

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. With this additional support from foreign partners (WMO, Finland Meteorology Institute (FMI), UK Met Office), Viet Nam has been improving our impact-based forecast system. The cooperation projects with UK Met Office and other ASEAN countries (i.e WCSSP Southeast Asia) is focusing on improving the transition from science to services, especially in impact forecast of meteorological phenomena such as heavy rain, strong wind…

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 High resolution system and Short-range Regional Ensemble Prediction System (SREPS-32)

With the CrayXC40 system at VNMHA, the regional NWP products have been significantly upgraded, especially of very high resolution of deterministic forecast (3km, Southeast Asia domain, named as WRF3km-IFS) with boundary conditions (from ECMWF) and the regional ensemble forecast (named as SREPS-32) was also 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).

VNMHA has been applying the data assimilation for WRF-ARW at 3km horizontal resolution using almost quality controlled observation data from NCEP and Vietnam's local observation since 2020. This new data assimilation products, named as WRF3km-IFS-DA, has been sharing via SWFP for SeA portal for all members of the project. An example of high resolution products for improving short range forecast of tropical cyclone and heavy rain over the Southeast Asia is shown in Figure 2.1.

In 2021, the radar data (10 radar stations of Vietnam) was also assimilated experimentally for improving the short-range heavy rainfall forecast (up to 24h). The rainfall forecast from NWP from 0-6 hours will be blending with nowcasting products of SWIRLS system of Hong Kong Observatory.

Regarding the regional ensemble system, the resolution of 32 ensemble members is 9km and using GFS-NCEP as boundary conditions. Figure 2.2 to are examples of 32-member SREPS and ECMWF's ensemble forecast for a strong wind of TC Yagi in 2024 with probability map products at different thresholds.

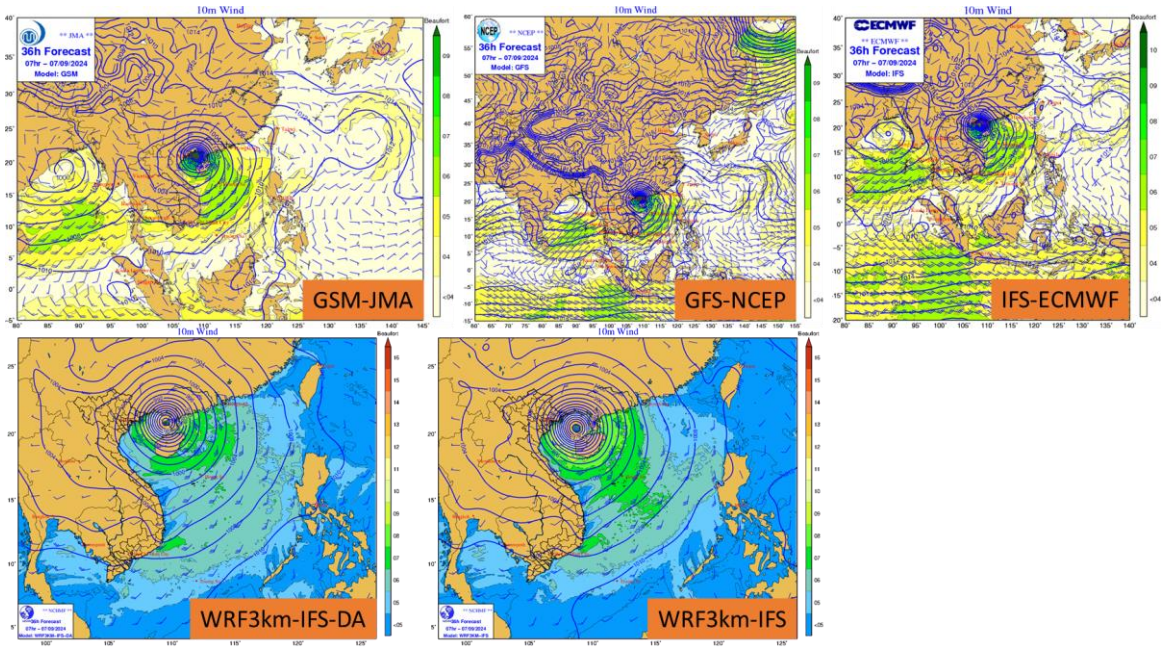

Figure 2.1. An example of enhance strong wind forecast for TY Yagi at 12UTC of 5 September 2024 from high resolution products (WRF3kmIFS and WRF3kmIFS-DA) compared to IFS-ECMWF, GFS-NCEP, GSM-JMA

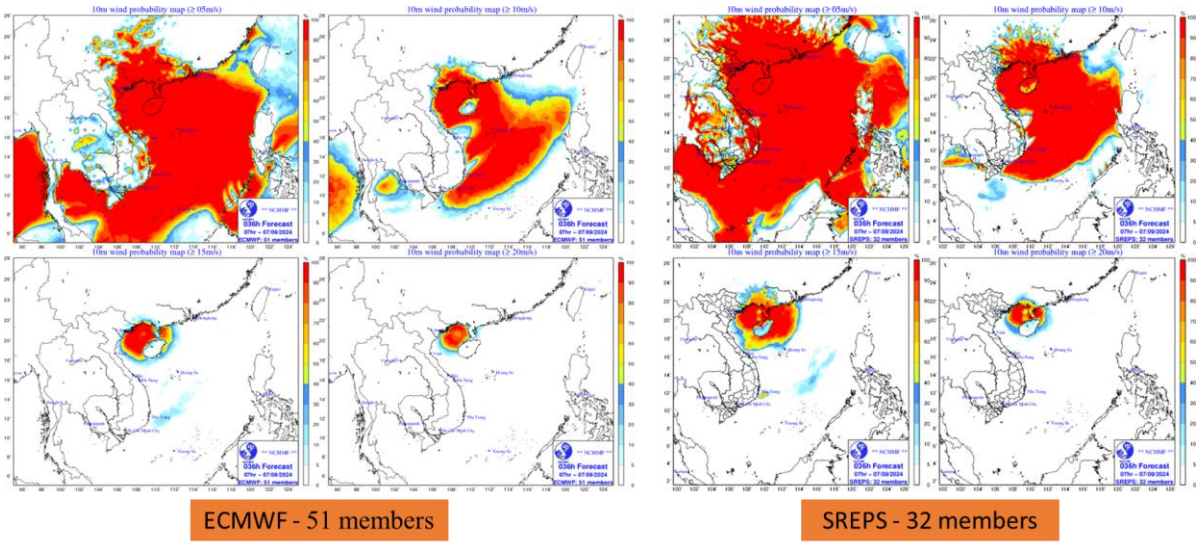

Figure 2.2. The products of 10m wind probability ensemble forecast from ECMWF ensemble system (51 member, left) and SREPS-32 (right) for TC Yagi forecast at 12UTC of 5th September 2024

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

VNMHA is providing high resolution NWPs (WRF3kmIFS, WRF3kmIFS-DA) and the regional ensemble SREPS-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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