MEMBER REPORT
THAILAND

ESCAP/WMO Typhoon Committee
19th Integrated Workshop
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19 - 22 November 2024

CONTENTS

I. Overview of tropical cyclones which have affected/impacted Thailand since the last Committee Session

1. Meteorological Assessment

1.1 Summary of tropical cyclones affecting Thailand between 1 November 2023 to 31 October 2024

For the period of 1 November 2023 to 31 October 2024, only one tropical cyclone, named 'SOULIK' (2415), entered Thailand. It originated from a low-pressure area east of the Philippines and made landfall in Vietnam before entering Thailand through the Northeastern region in September 2024. Additionally, four other tropical cyclones in the South China Sea and western North Pacific affected rainfall in Thailand: 'MALIKSI' (2402) from May to June 2024, 'PRAPIROON' (2404) in July 2024, 'YAGI' (2411) in September 2024, and 'TRAMI' (2420) in October 2024.

1.2 Brief descriptions of the tropical cyclones entering Thailand between 1 November 2023 to 31 October 2024

In 2024, tropical cyclone 'SOULIK' (2415) formed as a tropical depression from a low-pressure cell east of the Philippines on 16 September, then moved westward across the Philippines and gradually intensified into a tropical storm off the coast of upper Vietnam over the next three days, as shown in Figure 1. Soulik made landfall in Quảng Trị, central Vietnam, in the afternoon of 19 September. It then moved into Laos, where it was downgraded to a tropical depression before entering northeastern Thailand at Nakhon Phanom province the following morning. Subsequently, it weakened into an active low-pressure cell over upper northeastern Thailand on the same day. Its remnant low-pressure cell continued moving slightly westward, covering upper northeastern and lower northern Thailand between 21 and 22 September. This tropical cyclone caused plentiful rainfall, resulting in widespread and heavy rainfall in numerous areas of northern and northeastern Thailand from 19 to 20 September, as illustrated in Figure 2. According to daily reports from the Department of Disaster Prevention and Mitigation (DDPM) of Thailand, flooding occurred in Tak, Phetchabun, and Ubon Ratchathani provinces during this period. Moreover, the combined effects of Soulik, the southwest monsoon, and the monsoon trough led to prolonged flooding in Chiang Rai, Phitsanulok, Nong Khai, and Nakhon Phanom provinces.

1.3 Brief descriptions of the tropical cyclones that affected Thailand between 1 November 2023 to 31 October 2024

Since 1 November 2023, Thailand has been affected by four tropical cyclones: 'MALIKSI' (2402), 'PRAPIROON' (2404), 'YAGI' (2411), and 'TRAMI' (2420). Figure 3 shows the track map, indicating that the first cyclone, Maliksi, formed near the end of May 2024 and dissipated at the beginning of June 2024. The second tropical cyclone, Prapiroon, developed over the South China Sea

in late July 2024 and made landfall in upper Vietnam four days later. Meanwhile, the third cyclone, Yagi, formed as a low-pressure cell east of the Philippines in early September 2024, gradually intensifying into a typhoon three days later before reaching mainland Vietnam. The last cyclone, Trami, initially developed over the Northwest Pacific Ocean and made landfall in Vietnam in late October 2024. Despite not entering Thailand directly, these cyclones had an impact on the country's weather, as explained below.

1.3.1 Tropical cyclone 'MALIKSI' (2402)

At the end of May 2024, tropical cyclone 'MALIKSI' (2402) initially developed from an active low-pressure cell into a tropical depression over the central South China Sea on 30 May, before intensifying into a tropical storm the next day. After slowly moving northward, it made landfall in Guangdong, China, on 1 June, before weakening into a tropical depression and subsequently an active low-pressure cell. As a result of Maliksi, rainfall increased in upper Thailand, leading to flooding in Phayao, Nan, Chiang Rai, Mae Hong Son, and Chanthaburi provinces from 30 May to 1 June, as reported by the DDPM. Figure 4 shows the accumulated rainfall from 30 May to 1 June.

1.3.2 Tropical cyclone 'PRAPIROON' (2404)

In the second half of July 2024, a tropical depression formed from a disturbance over the upper South China Sea on 19 July, which was gradually upgraded to tropical storm 'PRAPIROON' (2404) in the morning of 21 July. The storm then moved northwestward, passing over Hainan Island into the Gulf of Tonkin before reaching mainland Quang Ninh, northern Vietnam, on 23 July. By that evening, it was downgraded to a tropical depression, and then followed by an active low-pressure cell over northern Vietnam. Under the influence of Prapiroon and its remnant low-pressure cell caused heavy to very heavy rainfall in some areas between 20 and 23 July, with fairly widespread rain from 22 to 23 July, especially in northern and northeastern Thailand. Figure 5 shows the cumulative rainfall from 20 to 23 July. According to DDPM's daily reports, flooding occurred in Chiang Rai and Roi Et provinces from 20 to 21 July, Chanthaburi province on from 20 to 23 July, Ubon Ratchathani province on 21 July, Phetchabun province from 21 to 22 July, Trat province from 21 to 23 July, and Kanchanaburi and Tak provinces on 25 July. Gusty winds were also reported in Loei province on 20 July.

1.3.3 Tropical cyclone 'YAGI' (2411)

In early September 2024, an active low-pressure cell formed a tropical depression east of the Philippines, which rapidly intensified into the tropical storm 'YAGI' (2411) on 1 September. Yagi moved northwestward across the Philippines before strengthening into a typhoon over the upper South China Sea in the morning of 4 September. Three days later, the tropical cyclone made landfall in Hải Phòng, Vietnam, in the afternoon of 7 September. It was downgraded to tropical storm and later a tropical depression, which became an active low-pressure cell the next day.

Its remnant low-pressure cell moved slightly westward and covered Myanmar and upper Laos from 9 to 10 September. Yagi brought heavy to very heavy rainfall to many areas, primarily in upper Thailand, from 8 to 10 September, causing flooding in Ang Thong province from 9 to 12 September, Tak province from 10 to 12 September, Phetchabun province on 11 September, and Loei province from 11 to 12 September, along with a landslide in Chiang Mai on 10 September. Figure 6 shows the cumulative amount of rainfall from 6 to 10 September.

1.3.4 Tropical cyclone 'TRAMI' (2420)

In late October 2024, tropical cyclone 'TRAMI' (2420) originated on 20 October, as a tropical depression from a low-pressure cell over the Northwest Pacific Ocean, then moved westward and intensified into a tropical storm on 22 October. Trami moved northwestward, passing the northern Philippines two days later before crossing the South China Sea and making landfall in Hue, Vietnam on the morning of 27 October. It subsequently reversed direction and returned to Vietnam's coastal regions on the same day. By 28 October, it had weakened to a tropical depression and finally dissipated east of Vietnam. This tropical cyclone brought rain to the northeastern, eastern and central parts of Thailand from 26 to 28 October, as shown in Figure 7.

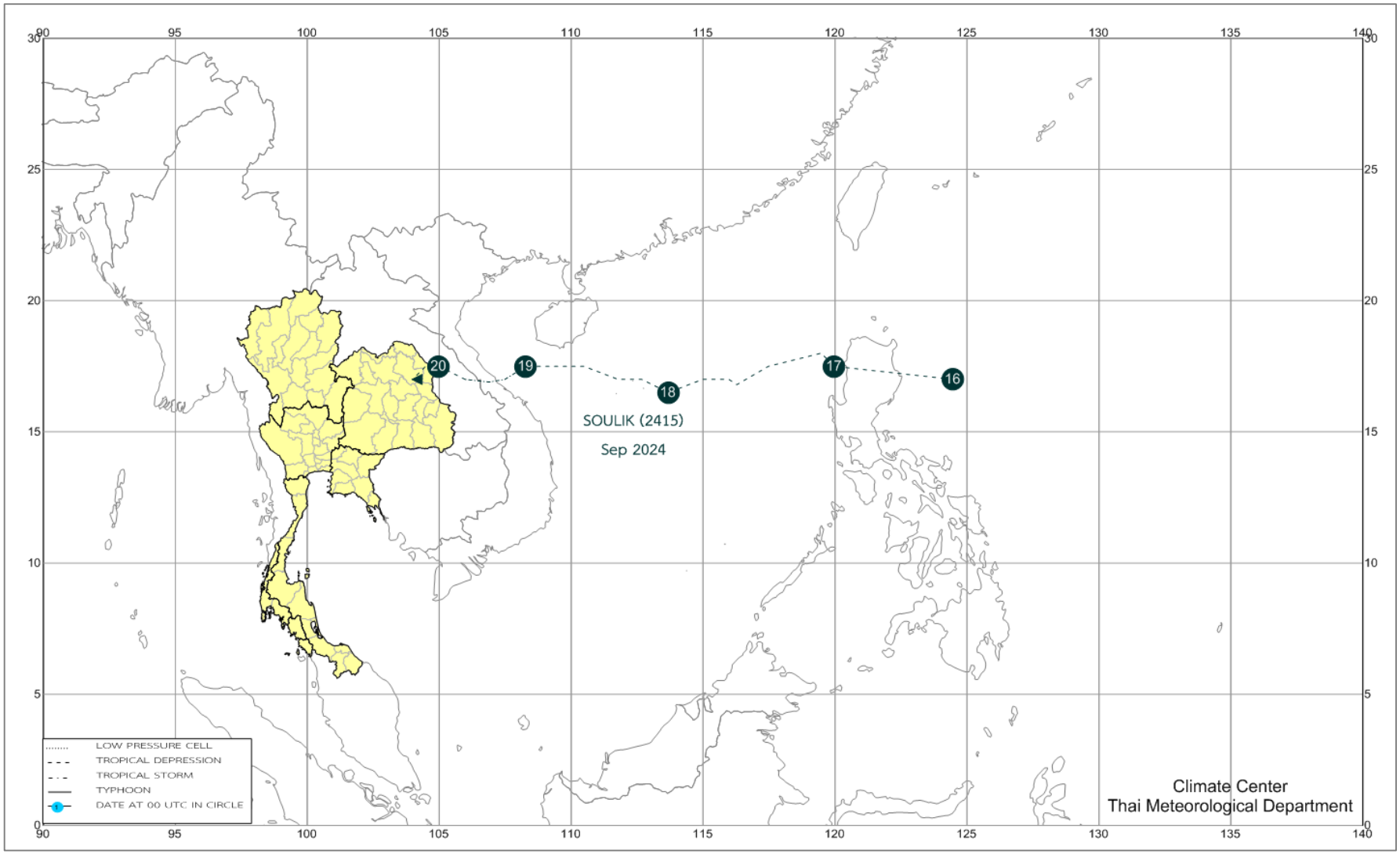


Figure 1: The track of tropical cyclone forming over the South China Sea and the western North Pacific and entering Thailand from 1 November 2023 to 31 October 2024

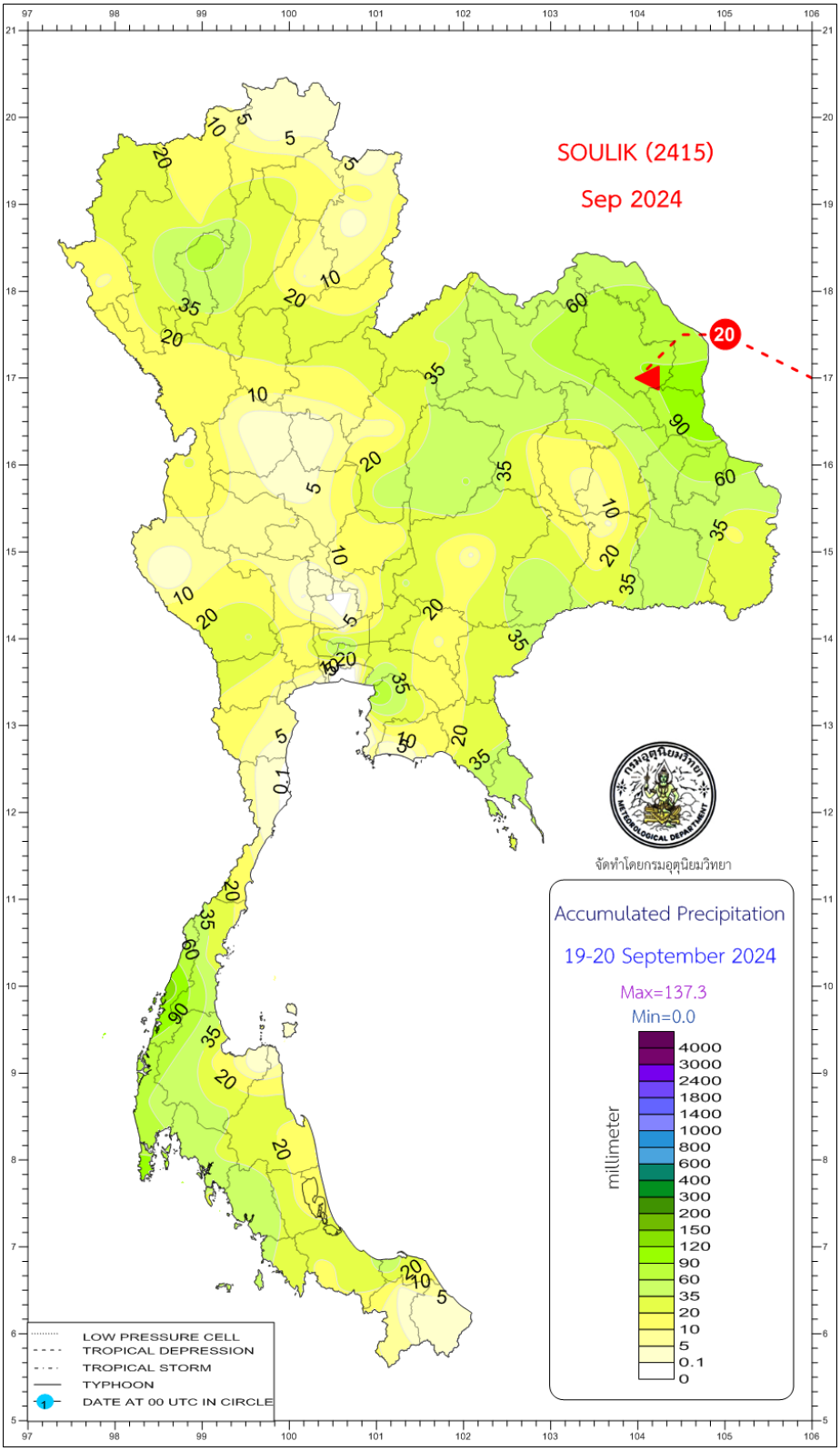


Figure 2: The accumulated rainfall from 19 to 20 September 2024 under the influence of Soulik (2415).

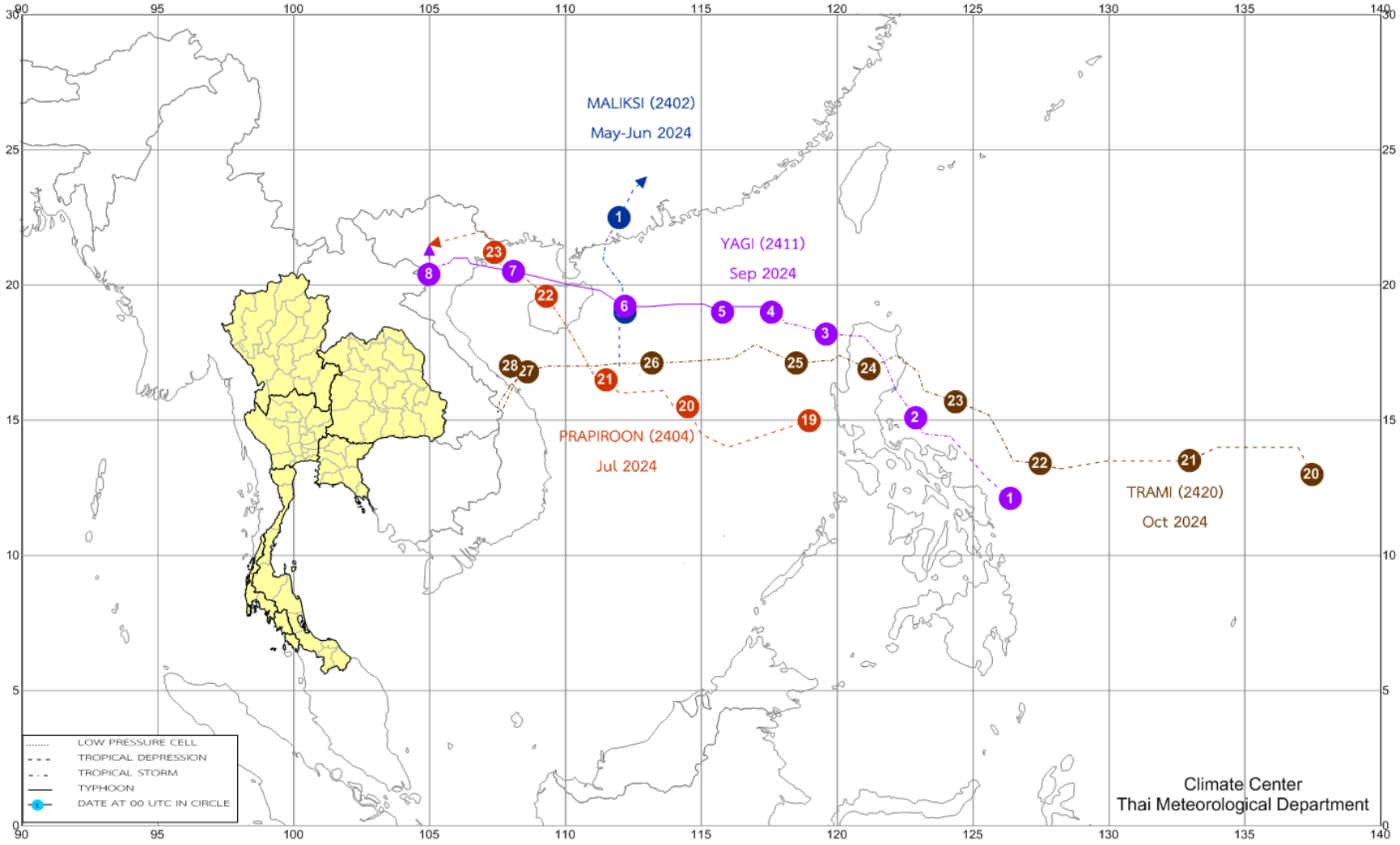


Figure 3: The tracks of tropical cyclones originating over the South China Sea and the western North Pacific and partially affecting Thailand weather from 1 November 2023 to 31 October 2024

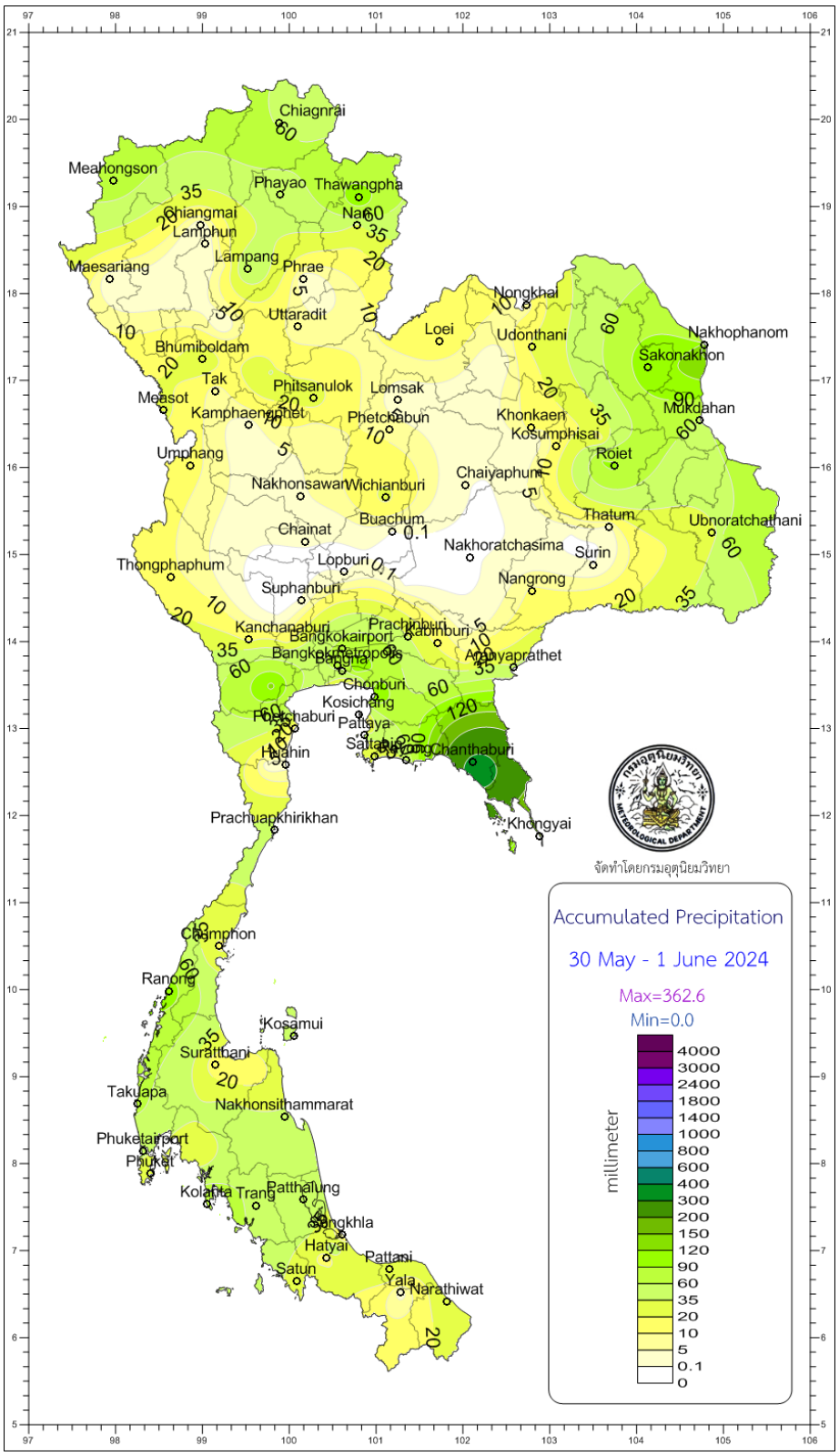


Figure 4: The accumulated rainfall from 30 May to 1 June 2024 under the influence of Maliksi (2402).

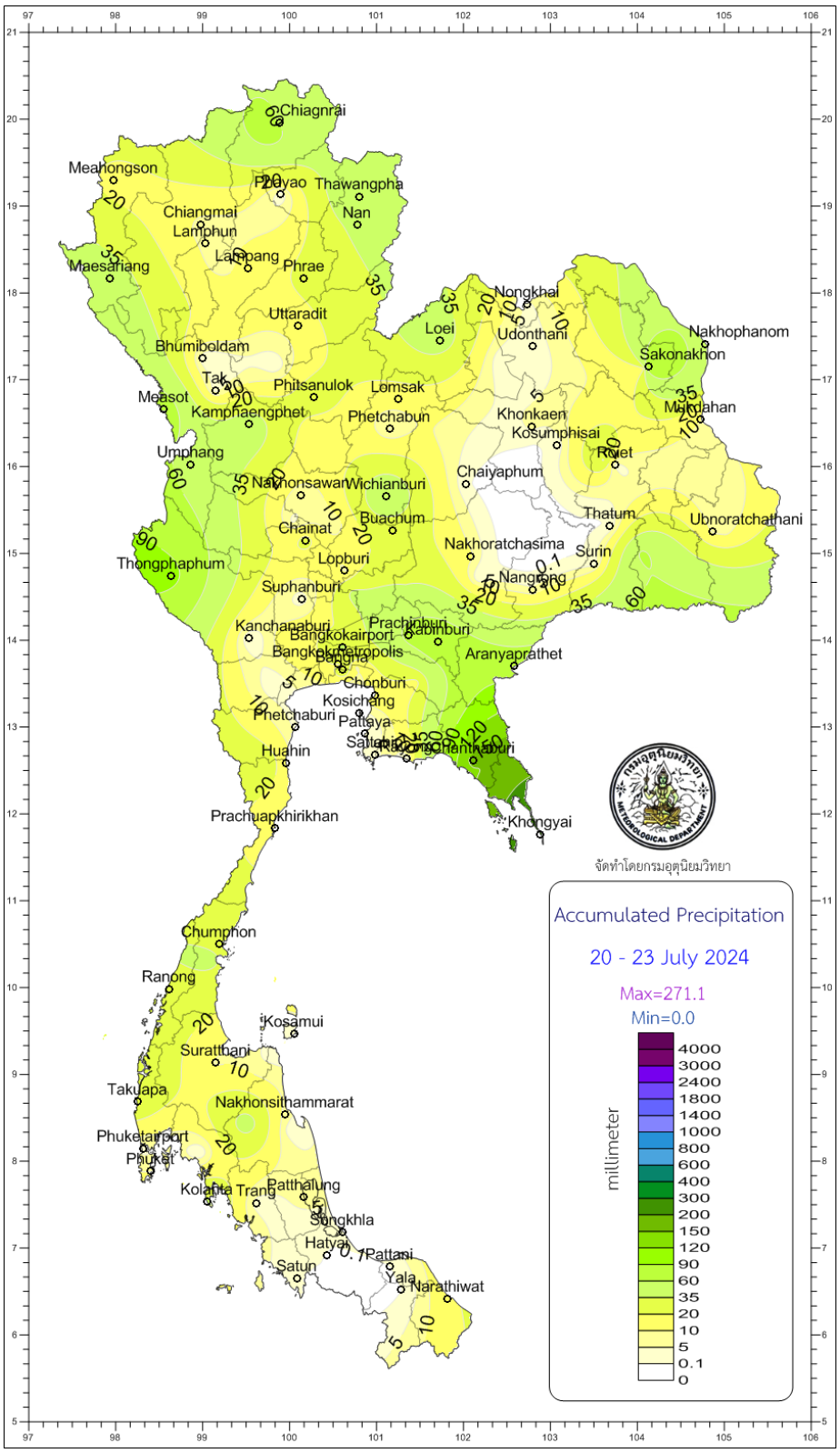


Figure 5: The accumulated rainfall from 20 to 23 July 2024 under the influence of Prapiroon (2404).

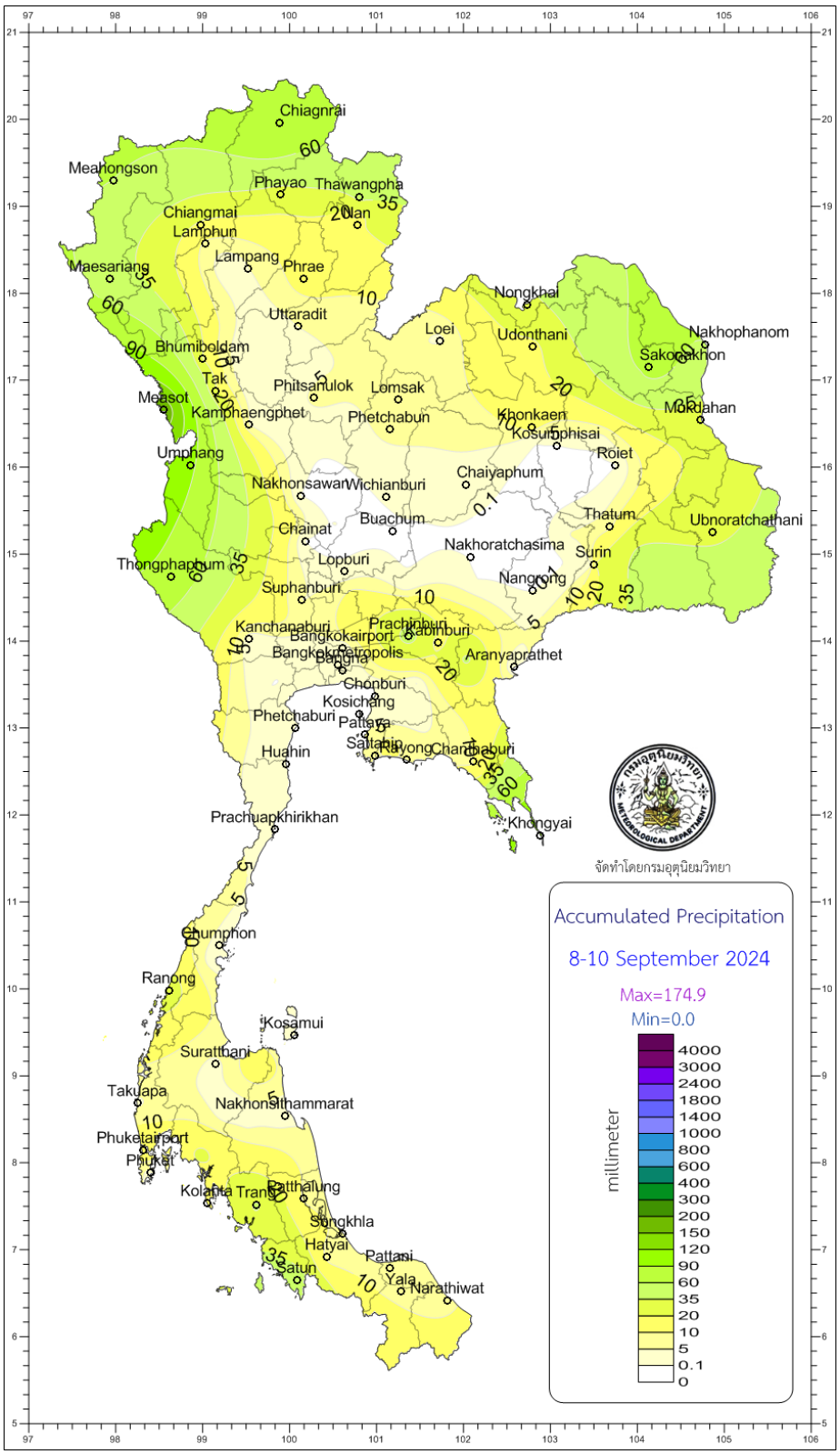


Figure 6: The accumulated rainfall from 8 to 10 September 2024 under the influence of Yagi (2411).

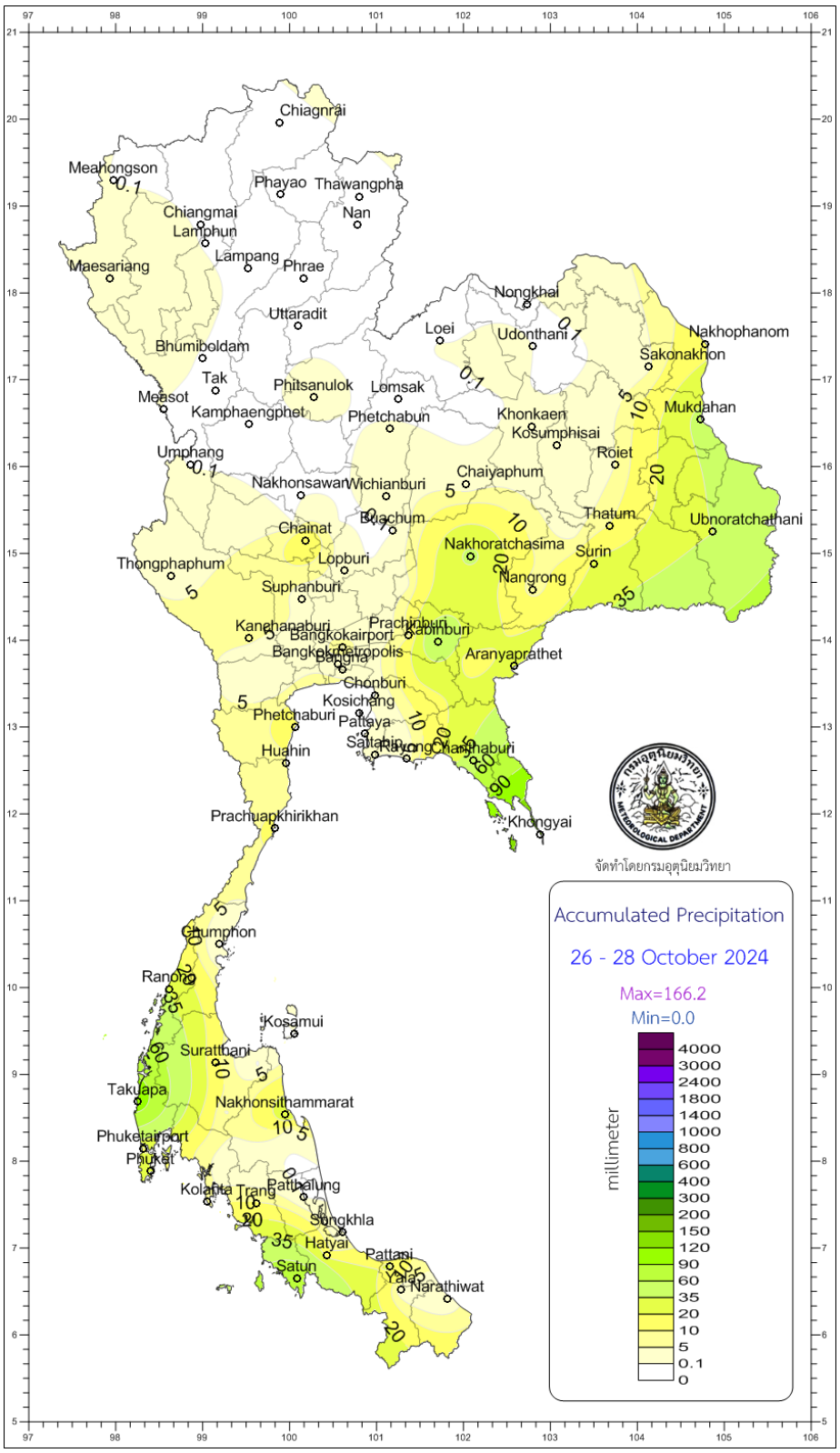


Figure 7: The accumulated rainfall from 26 to 28 October 2024 under the influence of Trami (2420).

2. Hydrological Assessment

2.1 Hydrological Assessment from the Office of the National Water Resources (ONWR), Thailand

Overview of tropical cyclones which had affected/ impacted Thailand from 1 November 2023 to 31 October 2024 by the Office of the National Water Resources (ONWR), Thailand.

2.1.1 Tropical storms

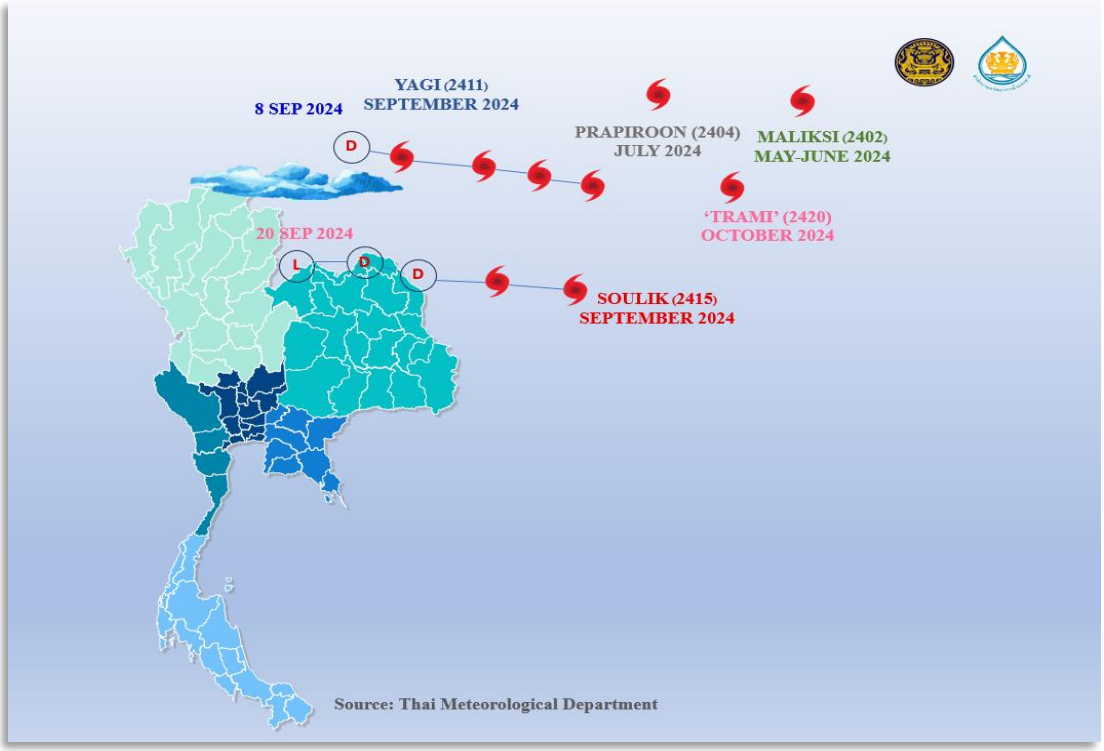


Figure 8: The tropical storms which had impacted to Thailand

For the period of 1 November 2023 to 31 October 2024, only one tropical cyclone, named 'SOULIK' (2415), entered Thailand. It originated from a low-pressure area east of the Philippines and made landfall in Vietnam before entering Thailand through the Northeastern region in September 2024. Additionally, three other tropical cyclones in the South China Sea and western North Pacific affected rainfall in Thailand: 'MALIKS' (2402) from May to June 2024, 'PRAPIROON' (2404) in July 2024, and 'YAGI' (2411) in September 2024.

- **Tropical cyclone 'MALIKS' (2402)** initially developed from an active low-pressure cell into a tropical depression over the central South China Sea on 30 May, before intensifying into a tropical storm the next day. After slowly moving northward, it made landfall in Guangdong, China, on 1 June, before weakening into a tropical depression and subsequently an active low-pressure cell. As a result of Maliksi, rainfall increased in upper Thailand, leading to flooding in Phayao, Nan, Chiang Rai, Mae

Hong Son, and Chanthaburi provinces, as reported by the Department of Disaster Prevention and Mitigation (DDPM).

- **Tropical storm 'PRAPIROON' (2404)** a tropical depression formed from a disturbance over the upper South China Sea on 19 July, which was gradually upgraded to tropical storm 'PRAPIROON' (2404) in the morning of 21 July. The storm then moved northwestward, passing over Hainan Island into the Gulf of Tonkin before reaching mainland Quang Ninh, northern Vietnam, on 23 July. By that evening, it was downgraded to a tropical depression, and then followed by an active low-pressure cell over northern Vietnam. Under the influence of Prapiroon and its remnant low-pressure cell caused heavy to very heavy rainfall in some areas, especially in northern and northeastern Thailand. According to DDPM's daily reports, flooding occurred in Chiang Rai Roi Et Chanthaburi Ubon Ratchathani Phetchabun Trat Kanchanaburi and Tak provinces.

- Tropical storm 'YAGI' (2411)

In early September 2024, an active low-pressure cell formed a tropical depression east of the Philippines, which rapidly intensified into the tropical storm 'YAGI' (2411) on 1 September. Yagi moved northwestward across the Philippines before strengthening into a typhoon over the upper South China Sea in the morning of 4 September. Three days later, the tropical cyclone made landfall in Hải Phòng, Vietnam, in the afternoon of 7 September. It was downgraded to tropical storm and later a tropical depression, which became an active low-pressure cell the next day. Its remnant low-pressure cell moved slightly westward and covered Myanmar and upper Laos from 9 to 10 September. Yagi brought heavy to very heavy rainfall to many areas, primarily in upper Thailand, from 8 to 10 September, causing flooding in Ang Thong Tak Phetchabun and Loei province, along with a landslide in Chiang Mai.

- **Tropical cyclone 'SOULIK' (2415)** formed as a tropical depression from a low-pressure cell east of the Philippines on 16 September, then moved westward across the Philippines and gradually intensified into a tropical storm off the coast of upper Vietnam over the next three days. It then moved into Laos, where it was downgraded to a tropical depression before entering northeastern Thailand at Nakhon Phanom province the following morning. Subsequently, it weakened into an active low-pressure cell over upper northeastern Thailand on the same day. Its remnant low-pressure cell continued moving slightly westward, covering upper northeastern and lower northern Thailand between 21 and 22 September. This tropical cyclone caused plentiful rainfall, resulting in widespread and heavy rainfall in numerous areas of northern and northeastern Thailand from 19 to 20 September. According to daily reports from the DDPM, flooding occurred in Tak, Phetchabun, and Ubon Ratchathani provinces during this period. Moreover, the combined effects of Soulik, the southwest monsoon, and the monsoon trough led to prolonged flooding in Chiang Rai, Phitsanulok, Nong Khai, and Nakhon Phanom provinces.

- **Tropical cyclone ‘TRAMI’ (2420)**

In late October 2024, tropical cyclone ‘TRAMI’ (2420) originated on 20 October, as a tropical depression from a low-pressure cell over the Northwest Pacific Ocean, then moved westward and intensified into a tropical storm on 22 October. Trami moved northwestward, passing the northern Philippines two days later before crossing the South China Sea and making landfall in Hue, Vietnam on the morning of 27 October. It subsequently reversed direction and returned to Vietnam’s coastal regions on the same day. By 28 October, it had weakened to a tropical depression and finally dissipated east of Vietnam. This tropical cyclone brought rain to the northeastern, eastern and central parts of Thailand from 26 to 28 October

2.2 Hydrological Assessment from the Royal Irrigation Department (RID), Thailand

In 2024, there are only one tropical cyclone named “SOULIK” directly attack Thailand in September 2024 causing heavy rain in the northeastern region of Thailand. Additionally, three other tropical cyclones (‘MALIKSI’ from May to June 2024, ‘PRAPIROON’ in July 2024, and ‘YAGI’ in September 2024) in the South China Sea and western North Pacific affected rainfall in Thailand is strengthening caused the flood occurred in 58 provinces in Thailand. There are more than 120 hydrological observation stations was affected.

2.2.1 Tropical cyclone “SOULIK” 19-20 September 2024

On September 18, 2024, a monsoon trough extended across the northern and northeastern regions of Thailand, causing heavy rainfall. This resulted in an increase in the amount of runoff in the river and causing the amount of water in the reservoir to increase rapidly, as shown in Figure 11, which shows the amount of water in Mae Ngad Dam increasing rapidly during heavy rain.

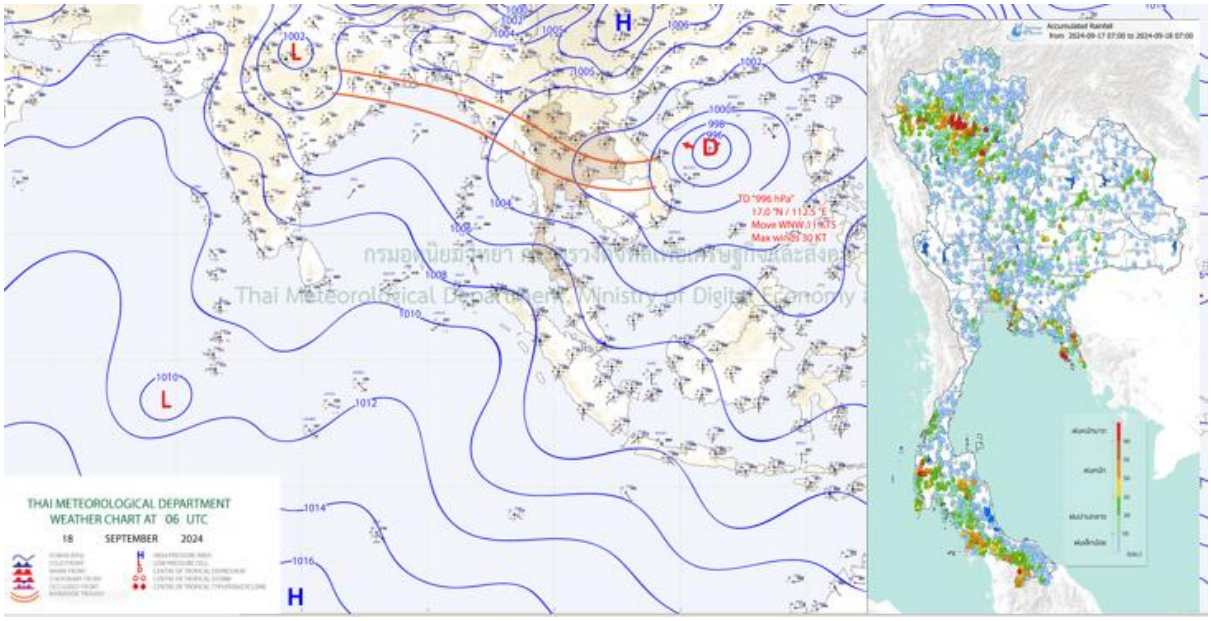


Figure 9: Synoptic Charts and Accumulated Rainfall 24 Hr.

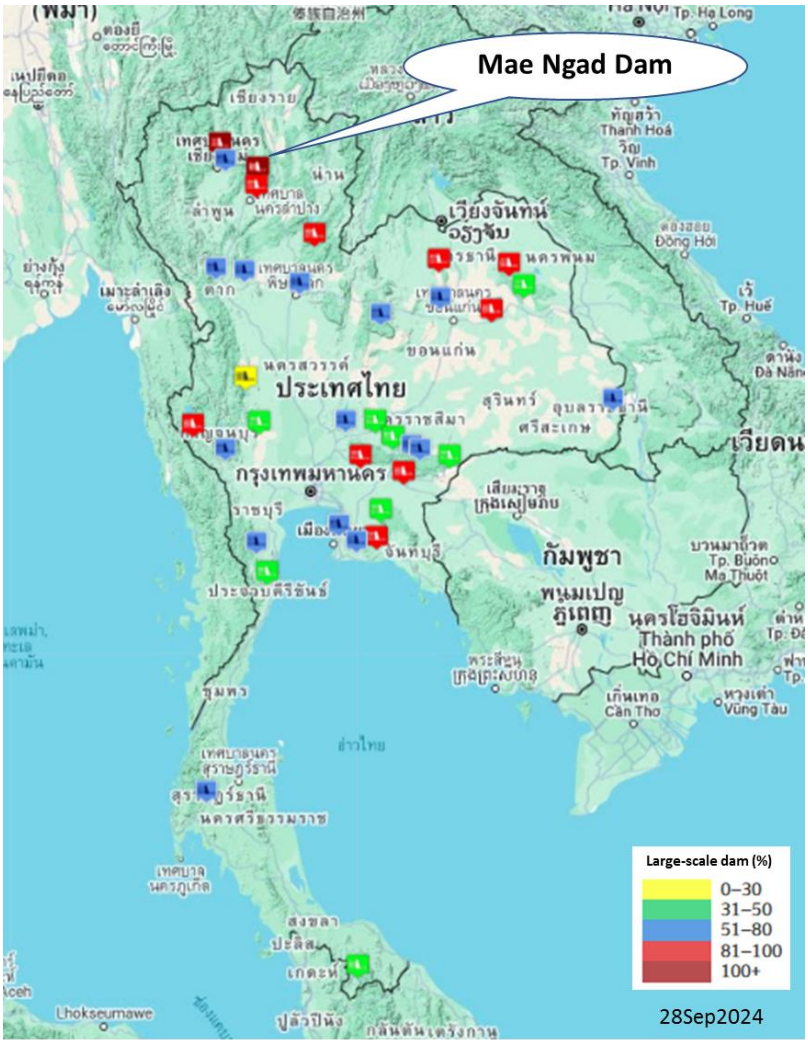


Figure 10: Percent of Water storage on 28 Sep 2024

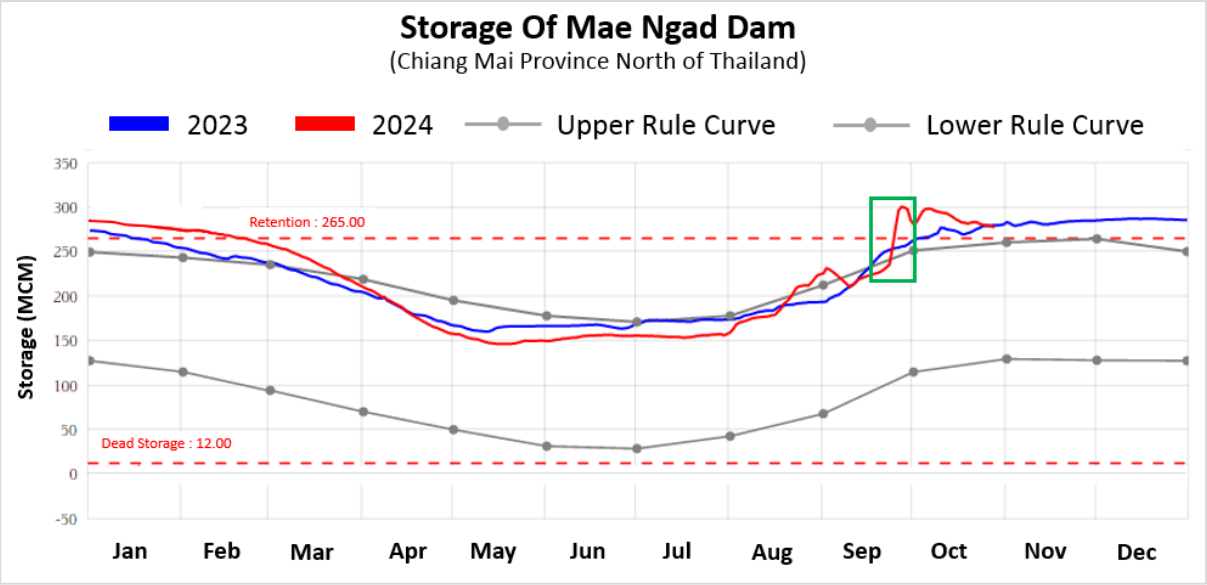


Figure 11: Water Storage at Mae Ngad Dam increases after rainfall

SOULIK weakened into an active low-pressure cell over upper northeastern Thailand. Its remnant low-pressure cell continued moving slightly westward, covering upper northeastern and lower northern Thailand. This tropical cyclone caused plentiful rainfall, resulting in widespread and heavy rainfall in numerous areas of northern and northeastern Thailand from 19 to 20 September.

From the factors mentioned above causing the Ping River basin area which is in the northern part of Thailand, there is a large amount of runoff accumulating in the river basin, resulting in water overflowing the banks in Chiang Mai Province (Ping River at P.1 Station, Mueang District, Chiang Mai Province, 24-28 Sept. 2024, P.81 San Kamphaeng District, Chiang Mai 24-29 Sept. 2024)

2.2.2 Tropical cyclone “MALIKSI” 30 May-1 June 2024

Since this period is the beginning of the rainy season, the rainfall during this period also causes a small amount of runoff, so it does not affect the amount of water flowing into the reservoir.

2.2.3 Tropical cyclone “PRAPIROON” 19-25 July 2024

Due to the influence of a low-pressure cell, heavy rainfall has occurred in some areas of the northern region, northeastern region, and eastern region of Thailand. This has resulted in an increase in water levels in large reservoirs, causing overflow in certain areas.

There are reports of overflow at two stations during this time.

1. 18-21 July 2024 at E.85 Lam Nam Chern Station, Chum Phae District, Khon Kaen Province, water level 5.34 m., water volume 115.60 cms.

2. 19-22 July 2024 at Station S.3, Pasak River, Lom Sak District, Phetchabun Province, water level 9.07 m., water volume 122.7 cms.

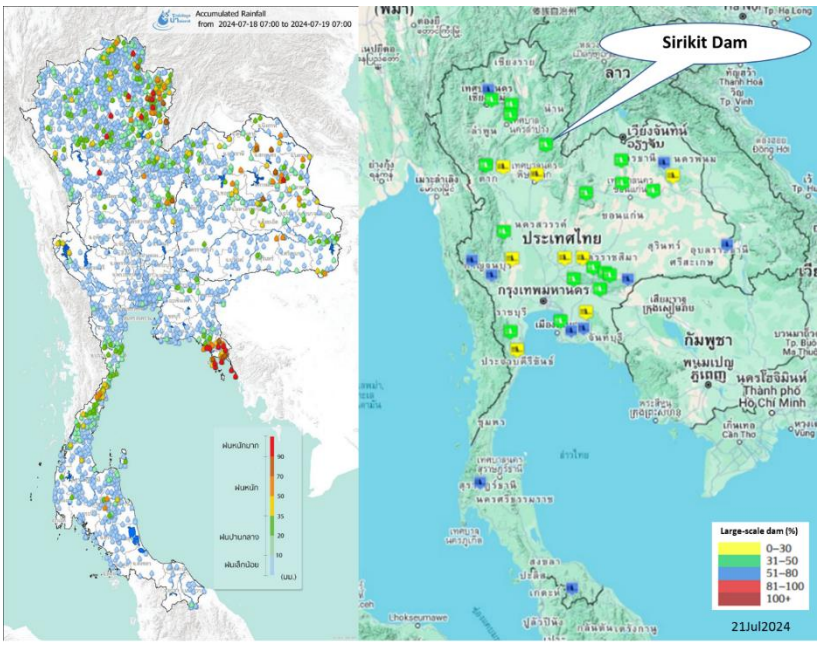


Figure 12: Accumulated Rainfall 24 Hr. and Percent of Water storage on 21 Jul 2024

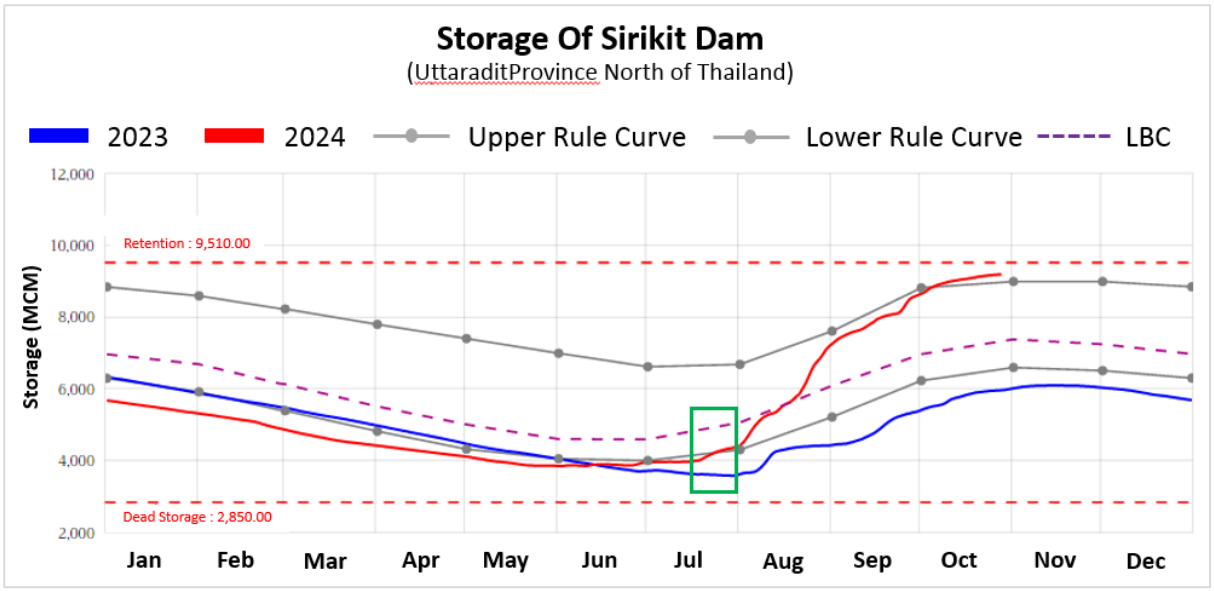


Figure 13: Water Storage at Sirikit Dam increases after rainfall

2.2.4 Tropical cyclone “YAGI” 8-12 September 2024

The impact of Typhoon Yagi on Thailand during this period resulted in heavy rainfall in the upper northern region, which is the upstream area of the Kok River Basin. This led to landslides in mountainous areas, causing damage to the lives and homes of the residents. Additionally, the increased water flow in the Kok River flooded economic areas in downtown Chiang Rai, resulting in significant property damage.

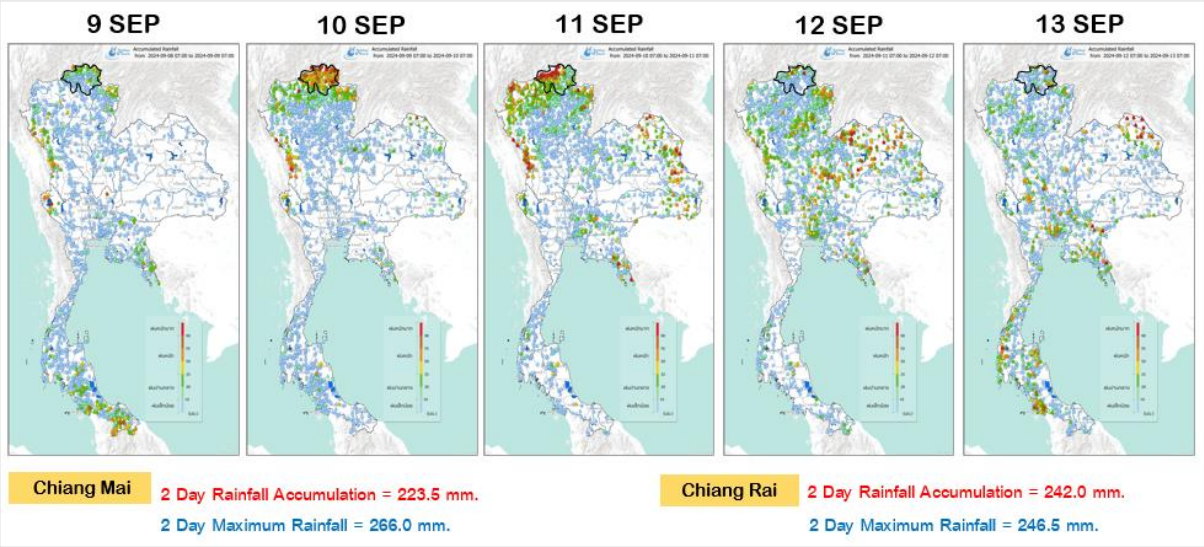


Figure 14: Accumulated Rainfall on 9-13 Sep 2024

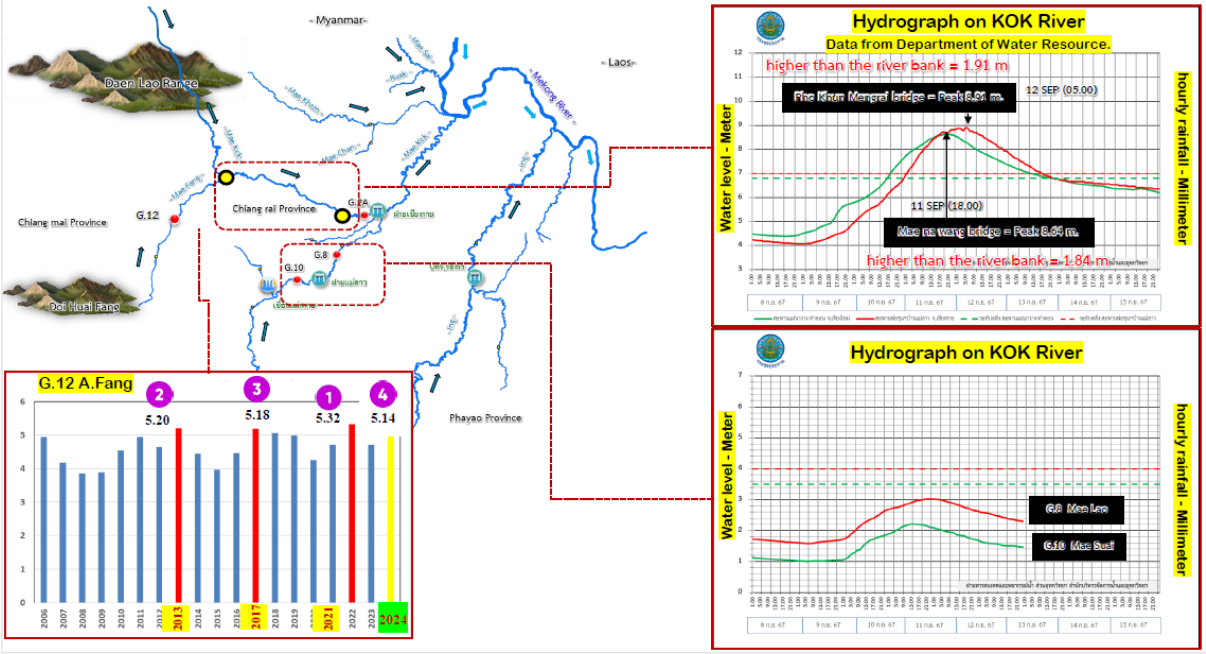


Figure 15: Hydrograph on Kok River

When considering the cumulative average rainfall (Figure 16), it was found that in 2024, the average rainfall is 2% higher than the normal threshold. However, when examining the cumulative rainfall during the rainy season (from May 20 to the present) by region, it is observed that each region of Thailand has cumulative rainfall above the normal threshold, ranging from -2% to 19%. The southern eastern region has the smallest deviation from the normal threshold at -2%, while the northern region has the largest deviation at 19%.

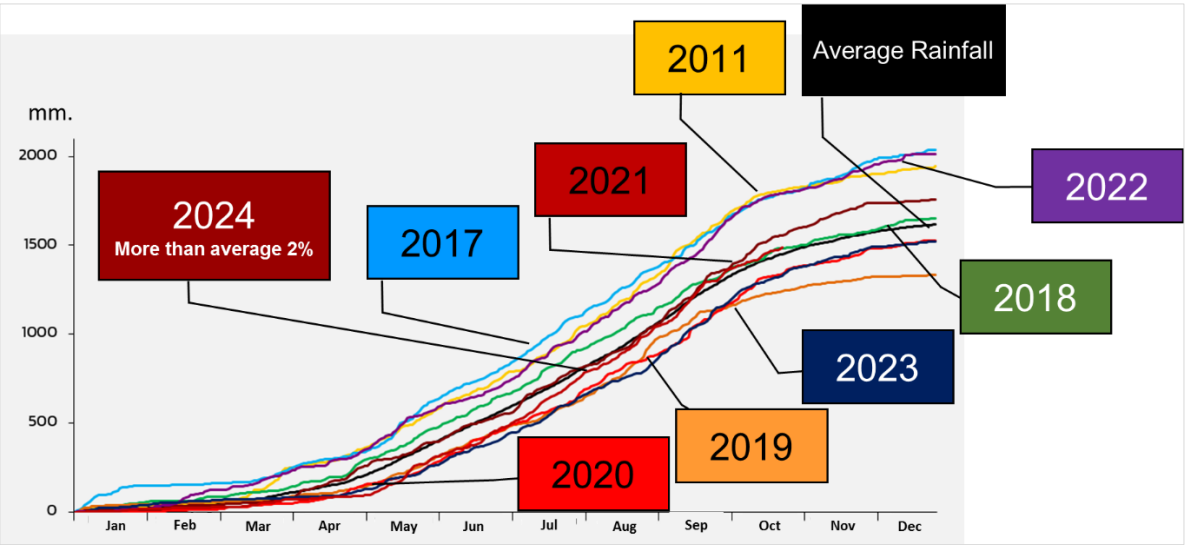
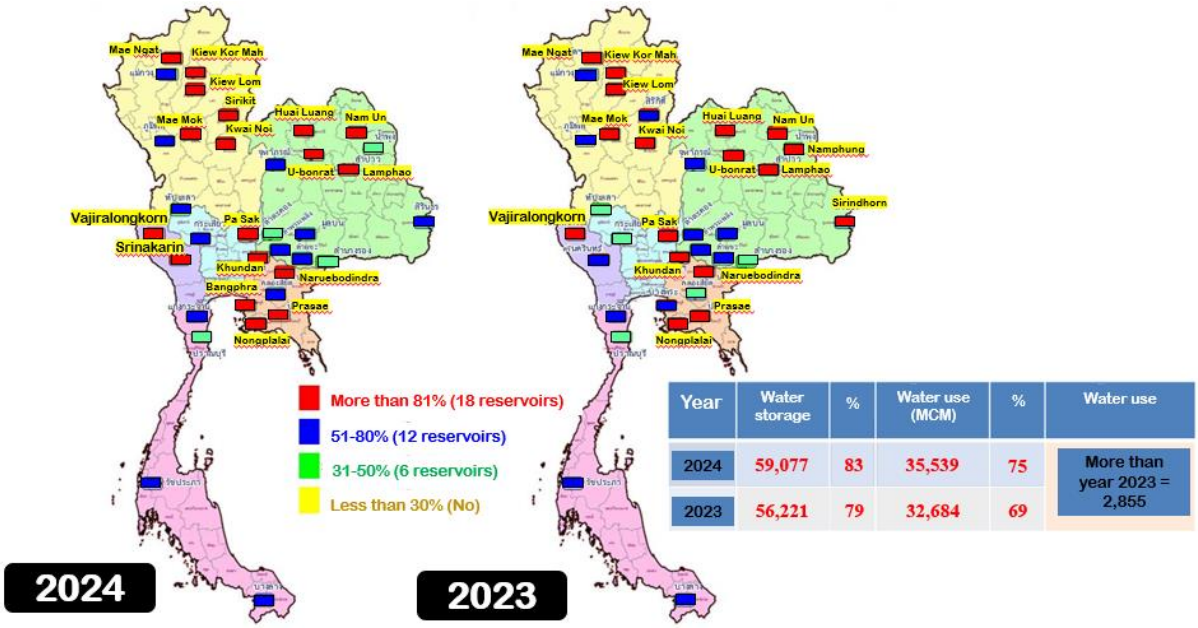


Figure 16: Average annual rainfall 2024 (TMD, 27 Oct 2024)

Region	Rainfall amount in rainy season			
	20 May - Current			
	RF (2024)	RF (normal)	Difference	
			mm.	%
Northern	1161.9	975.4	+ 186.5	+ 19 %
Northeastern	1249.5	1128.2	+ 121.3	+ 11 %
Central	1081.8	995.4	+ 86.4	+ 9 %
Eastern	1691.4	1474.0	+ 217.4	+ 15 %
Southern Eastern	762.8	775.7	- 12.9	- 2 %
Southern Western	2354.9	1990.0	+ 364.9	+ 18 %

Figure 17: Rainfall amount in rainy season (TMD, 27 Oct 2024)

As 31 October 2024, the amount of water storage in 35 large-scale reservoirs is 83% of their capacity or 59,077 MCM. The water-use volume for dry season is 35,539 MCM that about 2,855 MCM. more than year 2023 (Figure 18)



Year	Water storage	%	Water use (MCM)	%	Water use
2024	59,077	83	35,539	75	More than year 2023 = 2,855
2023	56,221	79	32,684	69	

Figure 18: Water storage in large-scale reservoirs as 31st October 2024

3. Socio-Economic Assessment

Overview of tropical cyclones which had affected Thailand area from 1 November 2023 to 31 October 2024 by National Disaster Warning Center (NDWC), Department of Disaster Prevention and Mitigation (DDPM), Thailand are as shown below.

1. Four tropical cyclones in the South China Sea affected rainfall in Thailand:
   - 1.1 'MALIKSI' (2402) from May to June 2024
   - 1.2 'PRAPIROON' (2404) in July 2024
   - 1.3 'YAGI' (2411) in early September 2024
   - 1.4 'TRAMI' (2420) in late October 2024
2. Only 1 tropical cyclone, 'SOULIK' (2415), entered Thailand in Late September 2024.

3.1 Tropical cyclone 'MALIKSI' (2402)

In this case, the storm route did not direct to Thailand, NDWC/DDPM did not officially issue the early warning in Thailand but there was advisory for the people who plan to travel abroad near by the storm route. The active low-pressure cell of MALIKSI in China increased rainfall lightly in upper Thailand leading to slight inundation in some areas of Phayao, Nan, Chiang Rai and Mae Hong Son provinces from 30 May to 1 June 2024. There were no reports of serious damage or deaths from this incident.

3.2 Tropical cyclone 'PRAPIROON' (2404)

The low-pressure cell of PRAPIROON in China caused fairly widespread rain from 20 to 25 July 2024, especially in northern and northeastern Thailand. The short flooding occurred in Chiang Rai, Roi Et, Chanthaburi, Ubon Ratchathani, Phetchabun, Trat and Kanchanaburi provinces. There was no official early warning of this case but

there was the advisory for heavy rain and people who plan to travel abroad. There were no reports of serious damage or deaths from this incident.

3.3 Tropical cyclone 'YAGI' (2411)

NDWC/DDPM had officially issued the flood early warning on 4 September 2024 before its remnant low-pressure cell moved westward and covered Myanmar and upper Laos from 9 to 10 September. Yagi caused heavy to very heavy rainfall to many areas in upper Thailand, causing overflowing and flooding especially in the economically important zone and tourist attractions, such as the Thai-Myanmar border along The Mae Sai River in Mae Sai District, The Kok River, Mueang District, Chiang Rai Province and Chiang Mai Municipality along The Mae Ping River, Mueang District, Chiang Mai Province, etc.

3.4 Tropical cyclone 'SOULIK' (2415)

The tropical cyclone SOULIK from Philippines had entered in central Vietnam and then moved into Laos, where it was downgraded to a tropical depression. In this event, NDWC/DDPM officially issued the first early warning on 17 September and emphasized the second on 20 September. SOULIK active low-pressure cell had entered in Thailand at Nakhon Phanom province and covered the northeastern Thailand between 20 and 22 September, as a result, there was widespread heavy rainfall in numerous areas of northern and northeastern Thailand. Moreover, the combined effects of SOULIK, the southwest monsoon, and the monsoon trough led to prolonged flooding in the north and northeast, such as Chiang Rai, Phitsanulok, Nong Khai, and Nakhon Phanom provinces.

3.5 Tropical cyclone 'TRAMI' (2420)

The official early warning had officially disseminated on 25 October before the TRAMI entered and dissipated in Vietnam territory. TRAMI did not direct to Thailand therefore effect of this tropical cyclone was only slight increase rainfall in some areas in northeastern, eastern and central parts from 26 to 28 October. There were no reports of serious damage or deaths from this incident.

In rainy season 2024, the active southwest monsoon in the south, and, the tropical cyclones YAGI and SOULIK in the upper region damaged to multi dimensions of economic and social sectors. The heavy rainfall causing overbank flow, flash floods from the mountains and landslides, killed total 57 deaths including Chiang Rai 16, Phuket 13, Chiang Mai 12, Payao 4, Lampang 3, Nan 3, Sukhothai 3, Phrae 2 and Song Kla 1, as well as 28 injuries and 268,171 affected households. Presently, overall situations have been resolved and recovered and the temporally shelters have been activated to serve the affected needs. Meanwhile, the Government reserve funds to assist disaster victims in emergencies, financial support and initial humanitarian assistance from Thai government, private sectors as well as volunteers have been provided and deployed to the affected people urgently. Other assistances and long-term

prevention and mitigation will be continuous managed conducting DRR concept of build back better framework.

Figure 19: Flooding at the Thai-Myanmar Border Market,
the Economically Important Zone, Mae Sai District, Chiang Rai Province

Figure 20: Flooding at the Tourist Attraction
The Railway Station and the Elephant Camp, Mae Taeng District, Chiang Mai Province

Figure 21: Disaster Evacuation and Relief from Government and Private Sectors

4. Regional Cooperation

Thailand has implemented bilateral and multilateral partnership strategies on international disaster risk management efforts.

At Asia-Pacific regional level, Thailand was the founding donor and advisory council to the ESCAP Multi-Donor Trust Fund founded in 2005 after the Indian Ocean Tsunami. The Fund has also received support from various countries, namely Sweden, Nepal, Turkey, Bangladesh, the Philippines, Germany, Japan, India and the Netherlands. The Fund aimed to build and enhance the early warning systems regarding Tsunami, climate and weather forecast implementation and capacity in disaster management of Asia and Pacific countries.

At Southeast Asia regional level, Thailand was a member of ASEAN Committee on Disaster Management (ACDM) responsible for jointly putting in place standards and mechanisms to support for regional disaster management cooperation. In this context, Thailand, Lao PDR and The Philippines were appointed for co – chair of the prevention and mitigation working group and responsible for overseeing of priority programme for Risk Assessment and Monitoring, and Prevention and Mitigation along with supporting for the implementation of ASEAN's vision on disaster management.

At sub–regional level, Thailand joined a variety of cooperative frameworks to drive disaster risk management initiative into motion for greater mutual benefits, for instances, Mekong River Commission (MRC), Bay of Bengal Initiative for Multi–Sectoral Technical and Economic Cooperation (BIMSTEC), East Asia Summit (EAS), ASEAN Regional Forum (ARF), etc.

II. Summary of Progress in Priorities supporting Key Result Areas

1. Establishment of tropical cyclone monitoring center

Main Text:

On September 7, 2024, the Thai Meteorological Department (TMD) established the Typhoon "YAGI" monitoring center along with the five TMD regional centers: the Northern Meteorological Center (Chiang Mai), the Upper Northeastern Meteorological Center (Khon Kaen), the Lower Northeastern Meteorological Center (Ubon Ratchathani), the Eastern Southern Meteorological Center (Songkhla), and the Western Southern Meteorological Center (Phuket). Mr. Thanasith Iamananchai, Deputy Director-General, TMD headed the monitoring center. Later, on September 19, 2024, Mr. Prasert Jantararuangtong, the Deputy Prime Minister of Thailand and Minister of Digital Economy and Society, which TMD belongs to, commanded the monitoring center and kept close observation to the tropical storm "SOULIK" together with five TMD's regional centers. The online meetings were held to monitor and report on weather conditions in the affected area. It had been broadcast on TV and

meteorological radio stations, social media systems such as Facebook and Line alerts to warn of the movement's direction and the impact of the storms that will affect various regions of Thailand.

Figure 22: Establishment of tropical cyclone's monitoring center
on 7 and 19 September 2024

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

1. Once the storm makes landfall, storm track and rainfall are monitored by weather radar and AWS weather monitoring in the risk areas to provide warnings, prepare for the potential events, and report/analyze to support disaster prevention and water management.
2. The media will help to distribute news and warning from TMD and people will receive them immediately.

Priority Areas Addressed:

<u>Integrated</u>

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

Meteorology

- Enhance the capacity to monitor and forecast typhoon activities particularly in genesis, intensity and structure change.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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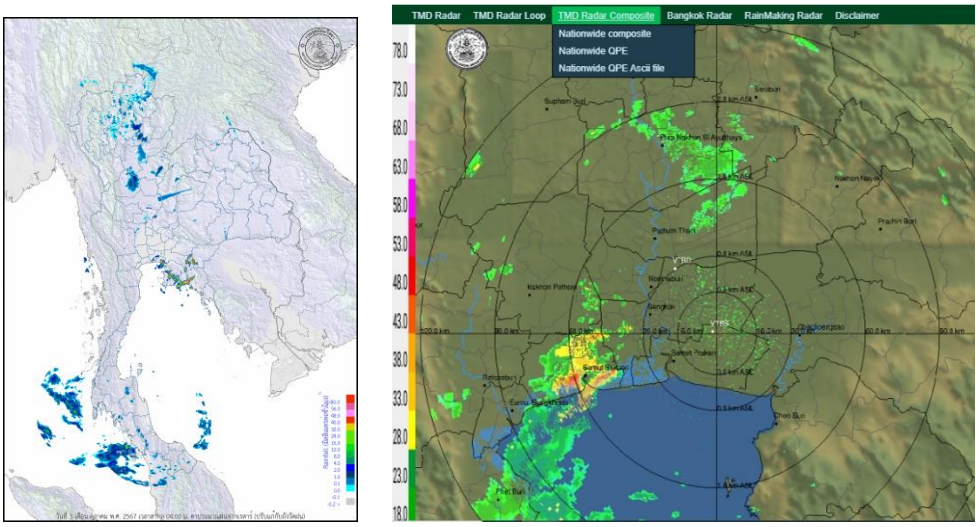
2. Development and exchange radar composite data

Main Text:

Since 2011, under the TC WGM activities of AOP3, TMD and JMA have initiated the exchange of radar data and the transfer of knowledge regarding radar composites. The system developed through this collaboration remains operational today, with data from the product publicly available in both image and ASCII formats. Currently, the radar composite is receiving rain gauge data from relevant agencies to enhance the accuracy of the data.



(a) (b)

Figure 23: (a) Radar composite map and (b) menu tab of composite data provides to the public.

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

1. TMD developed a new feature, TMD RADAR HI QUALITY, offering high-resolution radar data for sub-district areas, with an option for mouse scrolling to facilitate area identification.

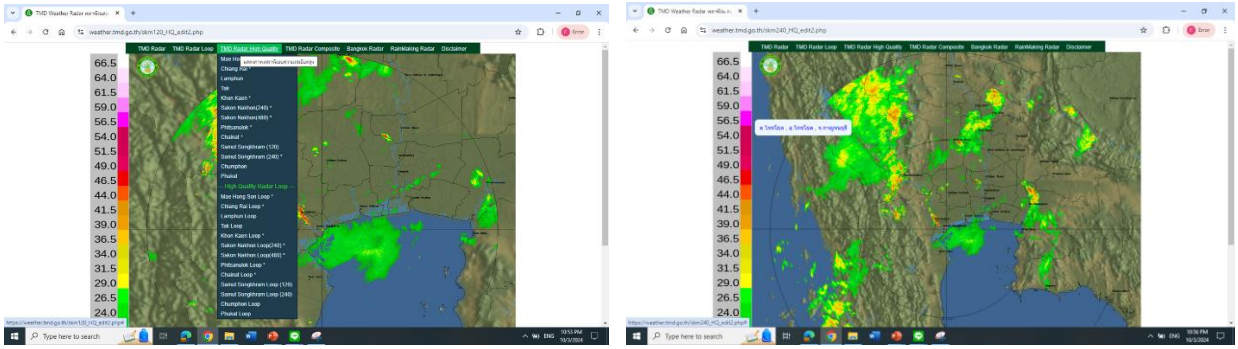


Figure 24: Menu tab of high-resolution data and the mouse scrolling example.

2. TMD provides radar data for certain stations, such as Sakon Nakhon, extending the range from 240 km to 480 km.

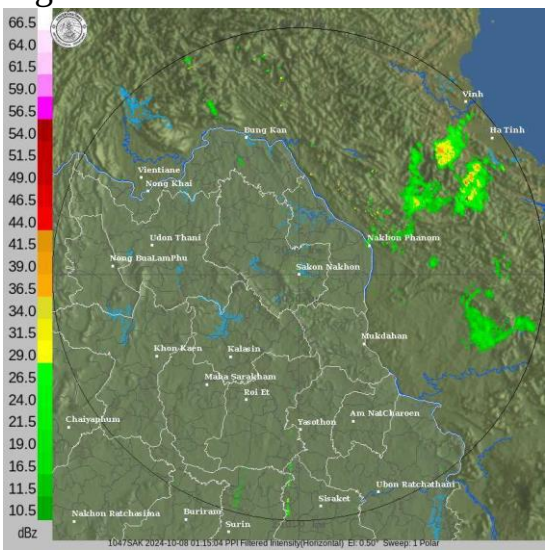


Figure 25: Range of Sakon Nakhon radar station

3. The initiative aims to develop a nowcasting system using pySTEPS, with the pilot area covering Bangkok and its surroundings, providing a 60-minute lead time forecast.

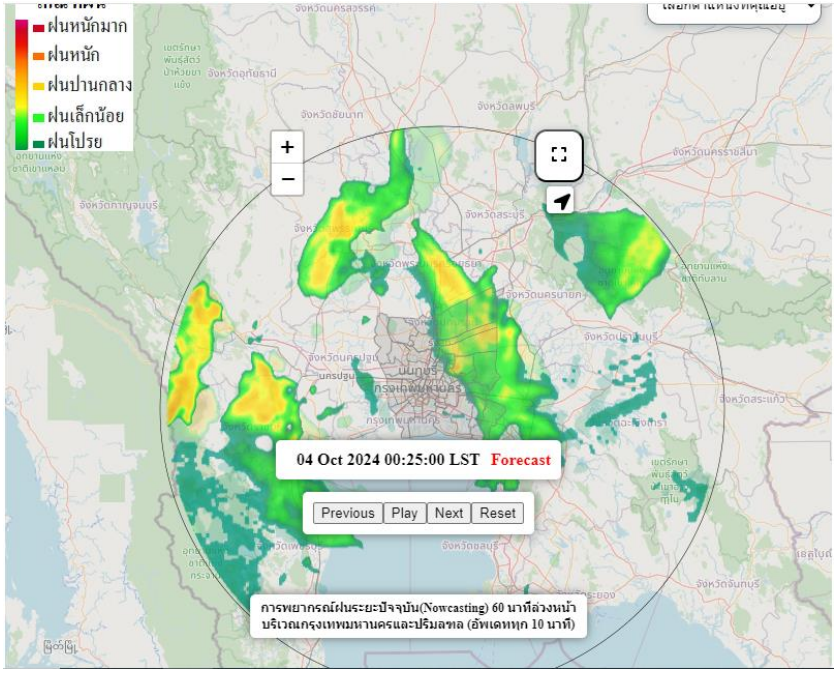


Figure 26: TMD's nowcasting system that provides on the website

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.
- Strengthen cross-cutting activities among working groups in the Committee.

Meteorology

- Develop and enhance typhoon analysis and forecast techniques from nowcast to medium-range, and seasonal to long-range prediction.
- Enhance and provide typhoon forecast guidance based on NWP including ensembles, weather radar and satellite related products, such as QPE/QPF.

Hydrology

- Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
- Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.
- Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓ the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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3. Development of Surface Observation and GTS/WIS network

Main Text:

The domestic telecommunication network has continuously evolved from time to time. Currently, there are a total of 127 synoptic observational stations. In May 2024, TMD successfully met the GBON requirement for surface land observations, implementing a 1-hour observation cycle. This was achieved by using automatic weather stations (AWS) to report observations every hour. All of them have sent observational data to a communication center at headquarters, called METNET, to collect and incorporate to WMO bulletin messages. The dissemination of these bulletins will be made by AMSS (RTH Bangkok) via GTS (Global Telecommunications System) network for international exchange.

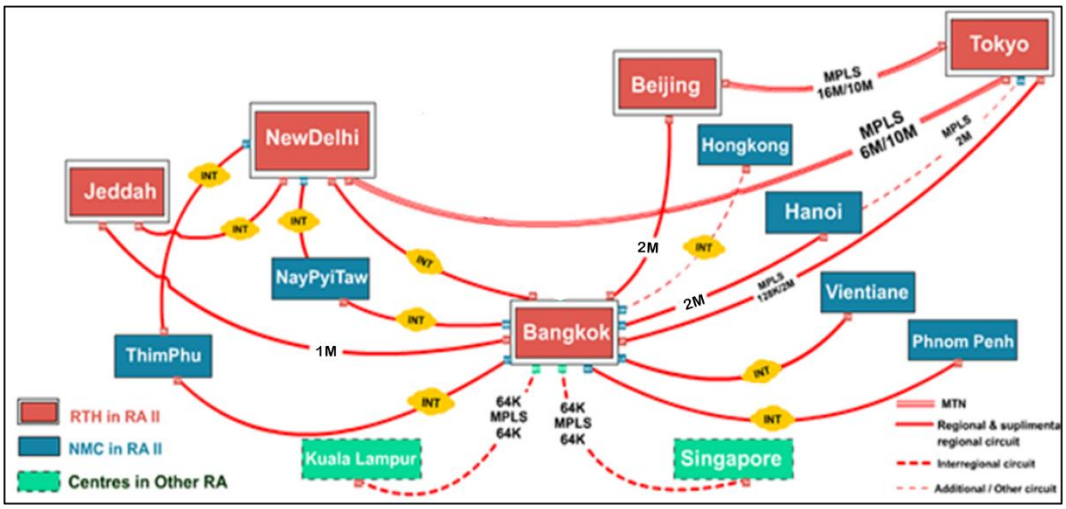

Figure 27: GTS/WIS network with its communication links of RTH Bangkok

Country	Wan Topology	Protocol	Speed
Japan	Leased Line (MPLS)	Socket	2 Mbps
China (Beijing)	Leased Line (MPLS)	FTP	2 Mbps
Malaysia	Leased Line (MPLS)	Socket	64 Kbps
Singapore	Leased Line (MPLS)	Socket	64 Kbps
Hong Kong China	Internet (Public IP)	SFTP	40/10 Mbps
Hanoi	Leased Line (MPLS)/ Internet (Public IP)	FTP	2 Mbps
Laos	Internet (Public IP)	FTP	40/10 Mbps
Cambodia	Internet (VPN/IPsec)	FTP	40/10 Mbps

Recent updates of GTS network connection for the typhoon committee region

- Bangkok - Hanoi
  Successfully transfer data via MPLS with speed at 2 Mbps and use internet (public IP) as backup link.
- Bangkok – Hong Kong China
  Migrated from FTP to SFTP for security issue
- Bangkok – Laos
  Upgraded from IPLC to internet with speed 40/10 Mbps

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

1. Collaboration on WIS 2.0 Implementation: The cooperation between TMD and GISC Tokyo and Beijing on WIS 2.0 provides capacity development for operating as a WIS 2.0 Node.

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	
Preparedness and response capabilities	

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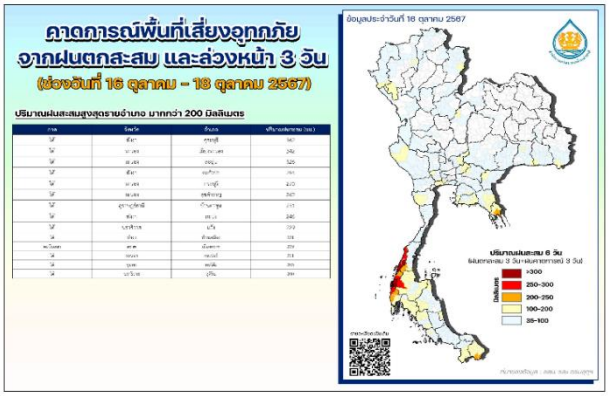
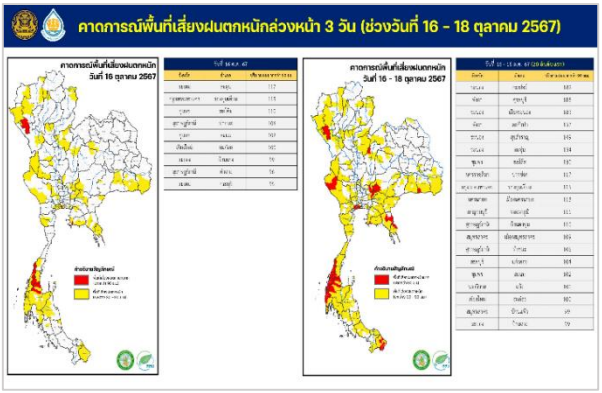
4. Strengthen the cooperation between the relevant agencies to develop impact-based forecasts, decision-support and risk-based warning.

Main Text:

The Office of National Water Resources (ONWR) together with more than 40 relevant agencies such as Thai Meteorological Department (TMD) Hydro Informatics Institute (HII) (Public Organization) Department of Water Resources (DWR) Department of Mineral Resources (DMR) Royal Irrigation Department (RID) Electricity Generating Authority of Thailand (EGAT) Department of Disaster Prevention and Mitigation (DDPM) hold weekly meetings (every Wednesday) to monitor, analyze, and assess the water situation throughout the rainy season. ONWR developed ONE MAP by gathering the rainfall forecast to predict weather conditions and tracking impacts in order to provide decision support for agencies that is involved in water management and issuing alerts to people at risk. The achievement using rainfall forecast data from the ECMWF and WRFDA models from TMD together with WRF- ROM model by HII. The integrated forecast data to identify flood-prone areas 6 months in advance for agencies such as RID EGAT to utilize this information to monitor and assess the flood situation, landslide risk areas and water management in reservoir.





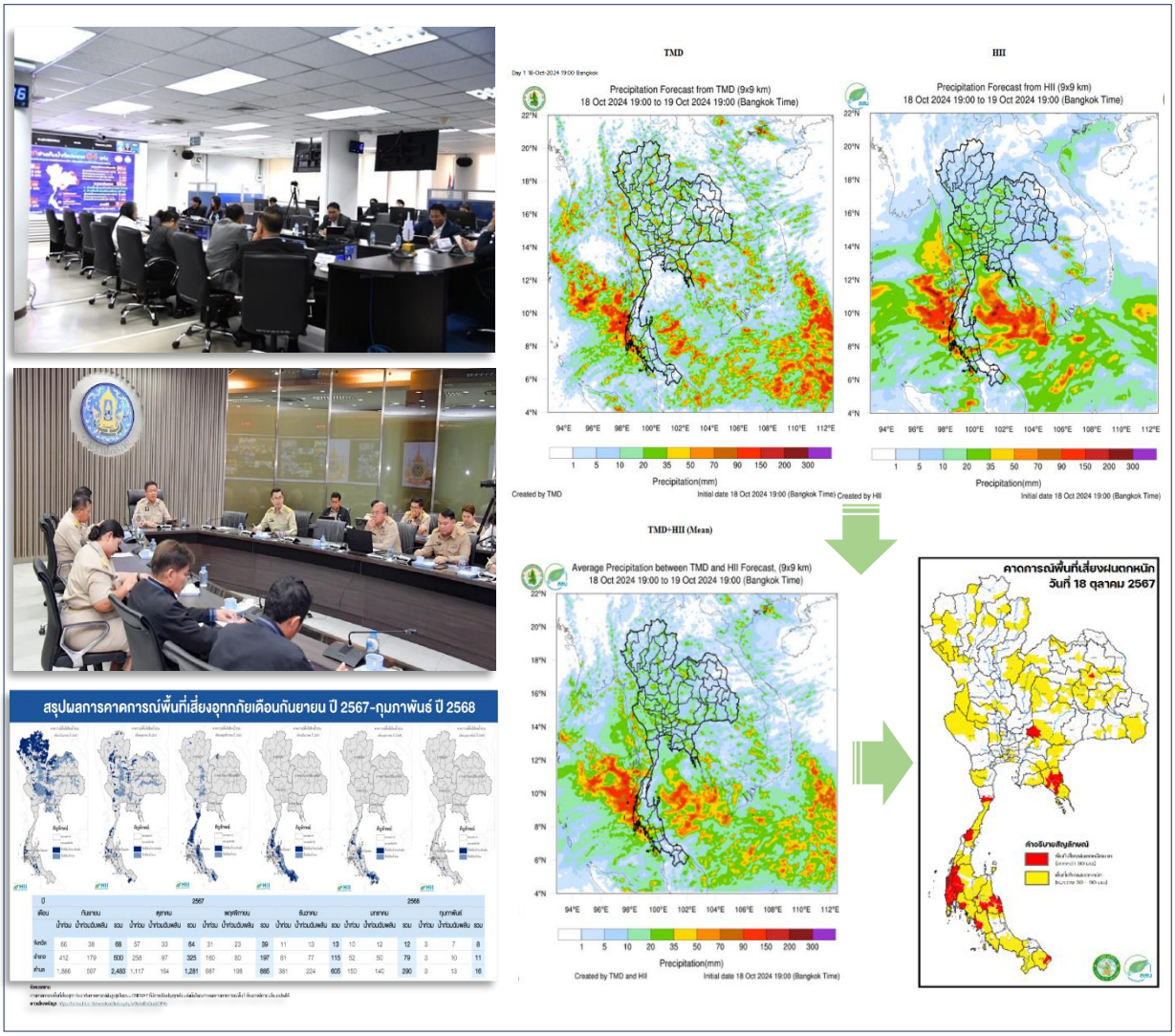


Figure 28: Risk area assessment from “OneMap rainfall forecast”

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

1. **Challenges**: The agency will use the results from "ONE MAP" which is rainfall forecasting system to predict runoff and reservoir inflow in order to manage water during flood risk periods. To minimize inaccurate of the forecast results, the input data should be as precise as possible.
2. **Opportunities**: Agencies responsible for water management, flood management and flood relief can utilize the forecast results to assess the risks by heavy rainfall.

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

Hydrology

- Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
- Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.
- Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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5. Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization

Main Text:

5.1 OWNR work together with relevant agencies to manage water in reservoirs by monitoring and forecasting water volumes in large, medium, and small reservoirs. For developing a management plan for the reservoirs that exceed their maximum storage capacity. The agencies are informed and take action to manage water in accordance with the prevailing conditions. For example, Water situation assessment in the Sirikit Dam, including forecasting inflow along with evaluating the water situation in river basin.

Late September 2024, the Sirikit Dam was releasing 20 million cubic meters of water per day, but continuous rainfall in the area downstream of the dam led to an increase in the tributaries flowing into the Nan River. As a result, a task force meeting was held to assess the situation and decided to adjust the water release plan from September 25 to 28, 2024, reducing the outflow from 20 million cubic meters per day to 15 million cubic meters per day to minimize impacts on the residents in the lower Nan River area.

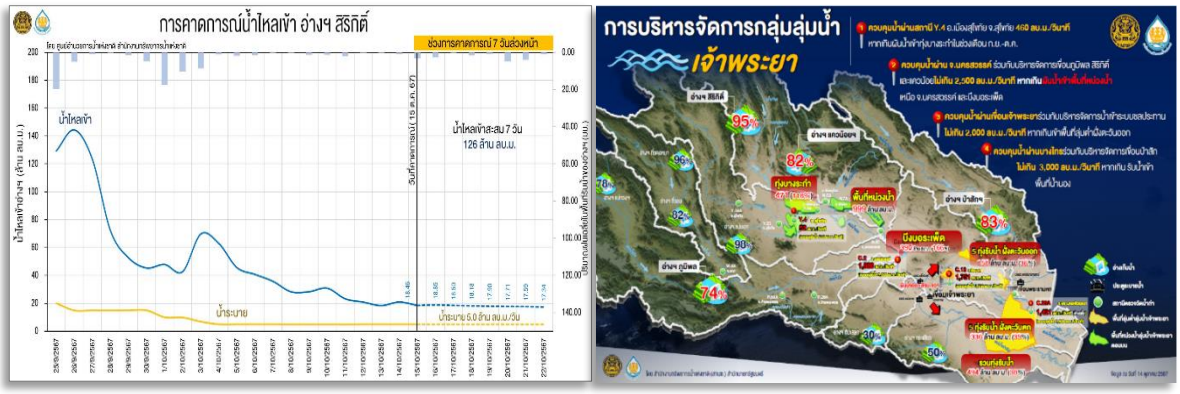

Figure 29: Determination of flood risk area at downstream of reservoir during storm.

5.2 OWNR integrates efforts with relevant agencies to establish "Incident Command Post" as a preparedness measure, a temporary center located near the crisis area. These centers are responsible for monitoring, assessing, and analyzing the water situation in high-risk areas, as well as planning water management strategies. Additionally, they ensure that machinery and equipment are ready and stationed in these vulnerable areas, coordinates with more than 40 government agencies, (including the Royal Irrigation Department), to manage water mechanisms during crisis situations. Risk levels and areas potentially affected are categorized as follows:

-Level: 1 Ad Hoc Crisis Center, which deals with small-scale disasters, typically at the district level.

-Level: 2 National Water Administrative Center, operating at the provincial level

-Level: 3 Ad Hoc Command Center, handling large-scale water crises that extend beyond provincial boundaries. According to Section 24 of the Water Resources Act, B.E. (2018) 2561, when a water crisis affects or damages lives and property, the Prime Minister has the authority to establish an Ad Hoc Command Center and issue orders until the water crisis ends, with ONWR serving as the secretariat.

Figure 30: Establish of incident command post to prepare for flooding.

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

1. Challenges: Analysis and forecasts are used to improve water management and develop decision making. It needs to integrate water related agency between forecasting, warning, water management and practical part to work together within the same direction.
2. Opportunities: Collaboration between relevant agencies has improved water management both in the normal situation and flood period. The result shows increasing response to flood incidents and reducing flood damage.

Priority Areas Addressed:

<u>Integrated</u>

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

Hydrology

- Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
- Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.
- Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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6. Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.

Main Text:

6.1 ONWR and the relevant agencies detects an impending water crisis, such as the tropical cyclones, it will announce the forecast and disseminate the information to relevant agencies, local authorities, and the public in at-risk areas to prepare for the crisis. The information will be shared through all available channels, including mass media, television, radio, newspapers, online media, and social networks.

Figure 31: Monitor and alert in flood risk areas.

6.2 ONWR has developed central data platform "National Thai Water". It linked to ONWR's data center which connected with related agencies databased. In order to develop dashboard for monitoring and publishing water situation on official websites called “https://national thaiwater.onwr.go.th”. The website is as a tool for monitoring the water situation during crises. This website provides an overview of the water situation in Thailand, including real-time data collected from relevant agencies, such as rainfall, reservoirs, water quality, and early warning system status. The website also displays forecast data, including storms, rainfall, tides, flash floods, and salinity. There is also an application called “National Thaiwater”, it is aim to share water information to people and authorities to prepare and deal with water crisis. This can help to rise the efficiency of decision making for water crisis warning.

Figure 32: National Thaiwater Website and Application

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

1. **Challenges**: ONWR has gather and collect necessity data from many agencies. However, it is obvious that telemetry data has various on standards and types. It also found that the measured data has errors.
2. **Opportunities**: Relevant agencies will be able to access essential information, real time data and forecast results on this website for monitoring water situation and warning for coming water crisis in a timely manner.

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

Hydrology

- Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
- Enhance capacity in typhoon-related flood risk management (including land-use management, dam operation, etc.) and integrated water resources management and flood-water utilization.
- Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.

- **Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed**

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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7. Flooding in Chiang Mai 2024

Main Text:

The physical characteristics of the upper Ping River basin consist of a complex mountainous terrain covered with forests, with the Ping River as the main waterway. The source of the Ping River originates in the Phi Pan Nam mountain range in Chiang Dao District, Chiang Mai Province. There is a hydrological station P.20 located in Ban Dong Mueang Fai, Chiang Dao District, Chiang Mai. Significant tributaries that

converge with the river include the Mae Tang River (hydrological station P.4A in Ban Mae Tang, Mae Tang District, Chiang Mai) and the Mae Rim River (hydrological station P.21 in Ban Rim Tai, Mae Rim District, Chiang Mai). The river flows toward the city of Chiang Mai, where there is a flood warning hydrological station, P.1, located in Mueang District, Chiang Mai.

Figure 33: Schematic of upper Ping River basin

Due to the influence of Typhoon SOULIK, from September 21 to 25, 2024, heavy rainfall occurred in the upper Ping River basin, with a total accumulation of 326.4mm. over three days (September 25-23, 2024).

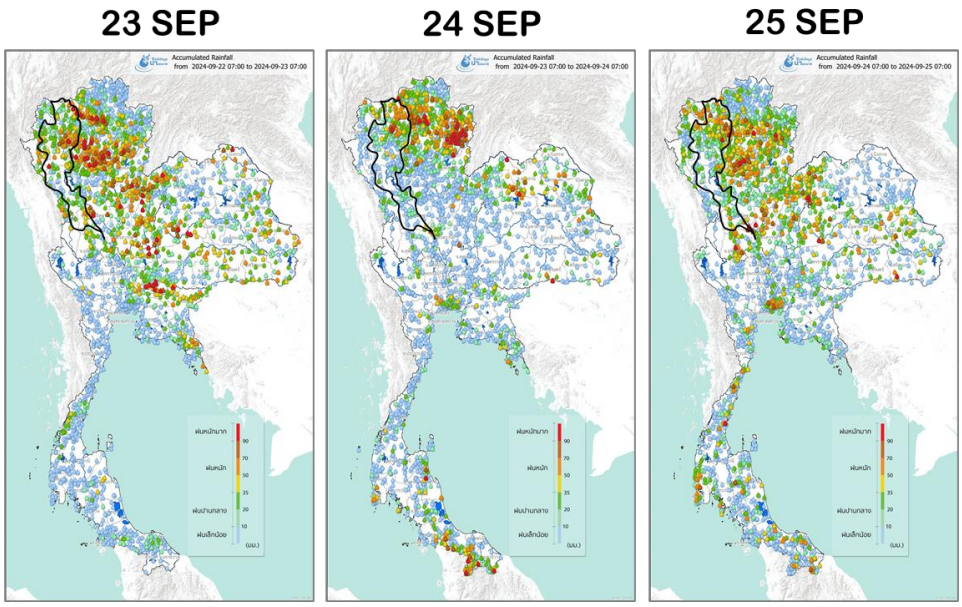

Figure 34: Accumulated Rainfall 24 Hr. 23-24 Sep 2024

When compared to the highest recorded three-day rainfall in Chiang Mai Province, which is 354.0mm., this rainfall is significant and close to the record levels previously observed. The resulting precipitation affected the water flow in the Ping River coming from Chiang Dao (P. (20and the Mae Rim River (P.(21, which merged with the Ping River and flowed into the city of Chiang Mai. At hydrological station P. 1 in Mueang District, Chiang Mai, the river overflowed its banks by 1.2meters, flooding residential areas and economic zones within the city.

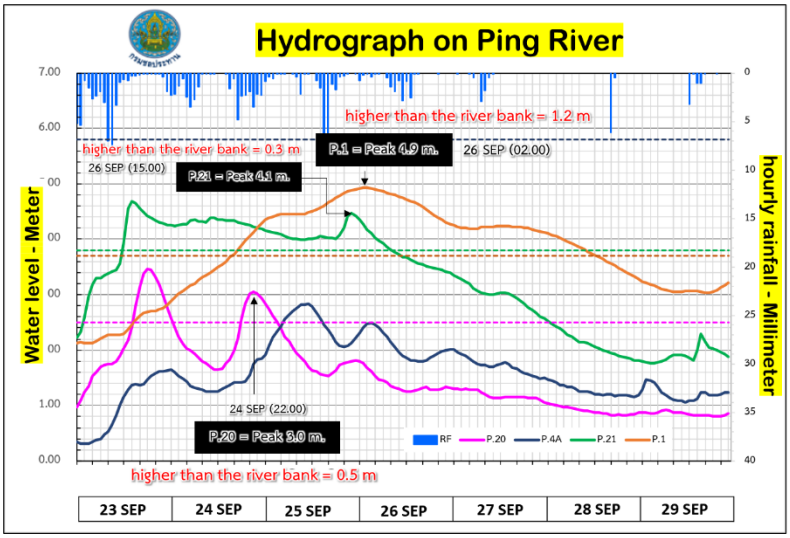

Figure 35: Hydrograph of upper Ping River basin on 23-29 Sep 2024

From October 1 to 3, 2024, a monsoon trough passed through the Ping River basin, resulting in significant rainfall with a total accumulation of 306.1mm. over three days.

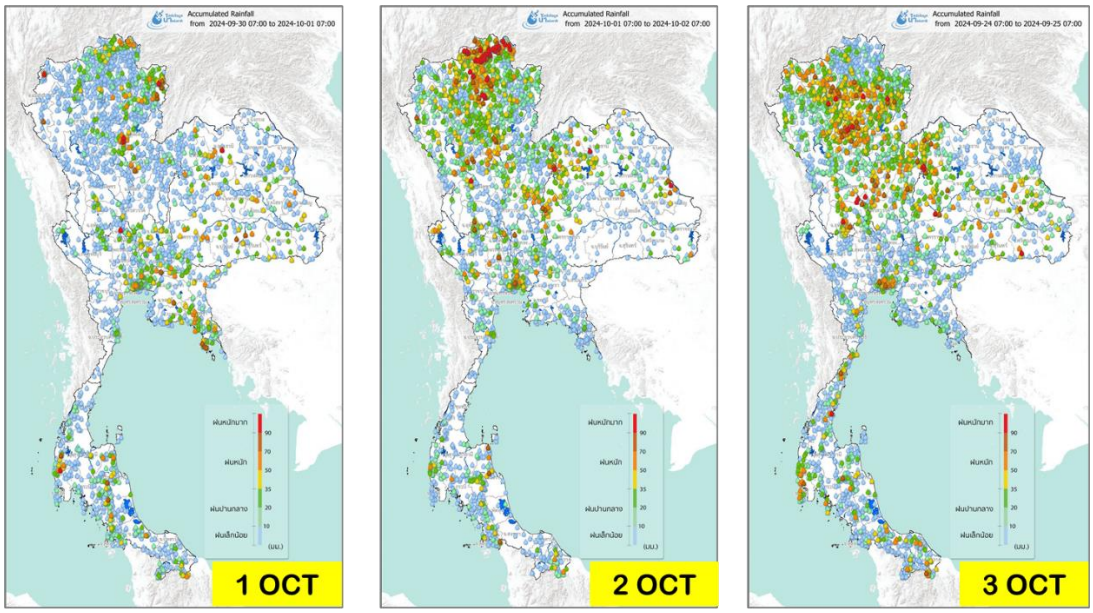

Figure 36: Accumulated Rainfall 24 Hr. 1-3 Oct 2024

This led to an increase in water flow in the upper Ping River, the Mae Tang River, and the Mae Rim River. As water from these three rivers converged and flowed toward Chiang Mai, it caused the river to overflow its banks. At hydrological station P.1, the river overflowed by 1.6meters, reaching a maximum water level of 5.30meters, which is the highest recorded level since data collection began.

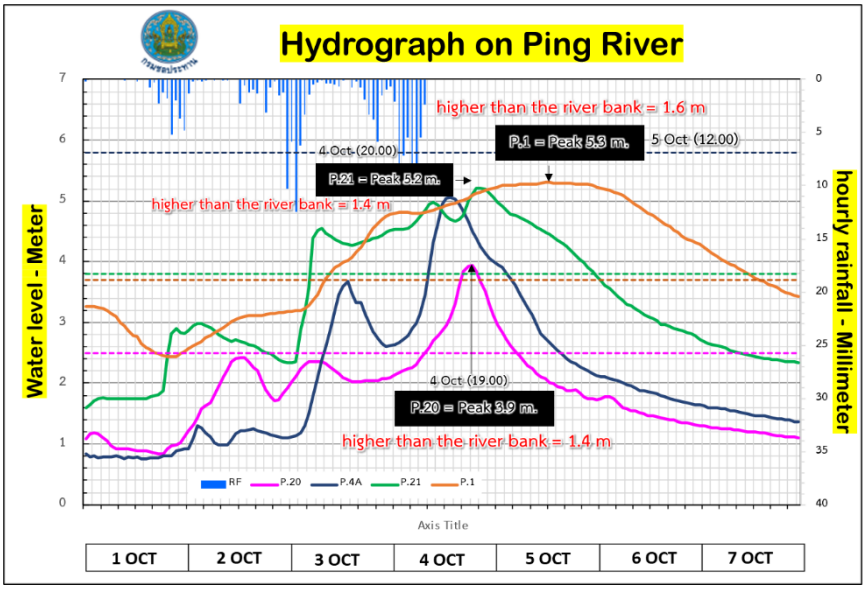

Figure 37: Hydrograph of upper Ping River basin on 1-7 Oct 2024

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

Reduced loss from flood in Chiang Mai

1. Flood management

- Monitor storm using forecast data from TMD, HAII, Windy.com and JAXA

-Water forecasting is conducted using daily and hourly flow data from the Royal Irrigation Department's stations: P. 20on the Ping River in Chiang Dao District, Chiang Mai; P. 75 on the Ping River (downstream of Mae Ngad Dam) in Mae Tang District, Chiang Mai; P.4A on the Mae Tang River in Mae Tang District, Chiang Mai; and P. 21 on the Mae Rim River in Mae Rim District, Chiang Mai.

- Analysis will utilize Hydrograph, Stage-Correlation, ANNs, and Mike 11 (from ONWR). In the future, other models such as IFAS, RRI, or HEC-HMS will also be developed and incorporated.

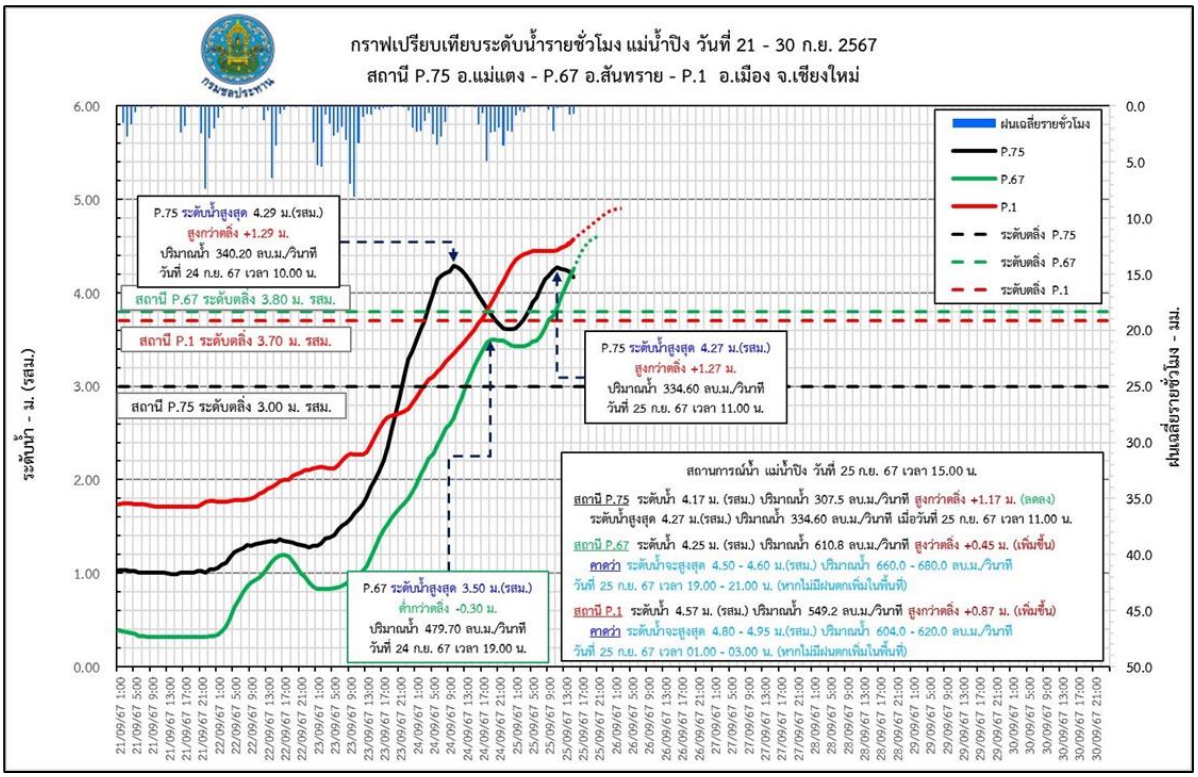

Figure 38: Hydrograph Analysis

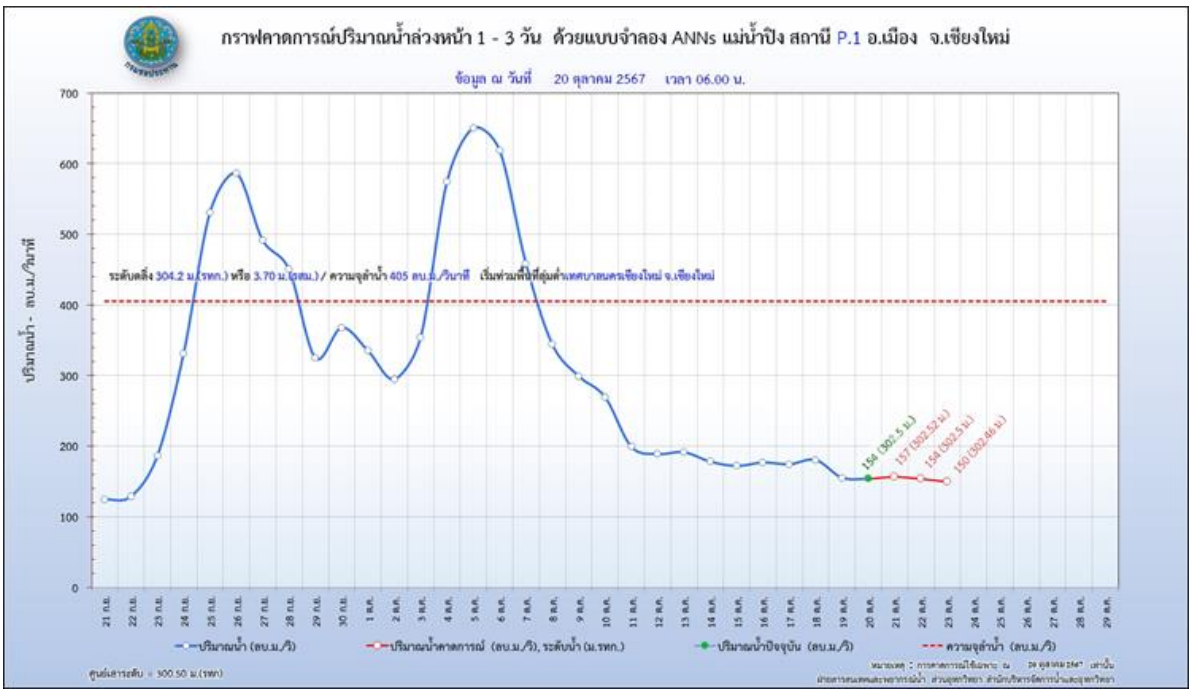

Figure 39: ANNs Analysis

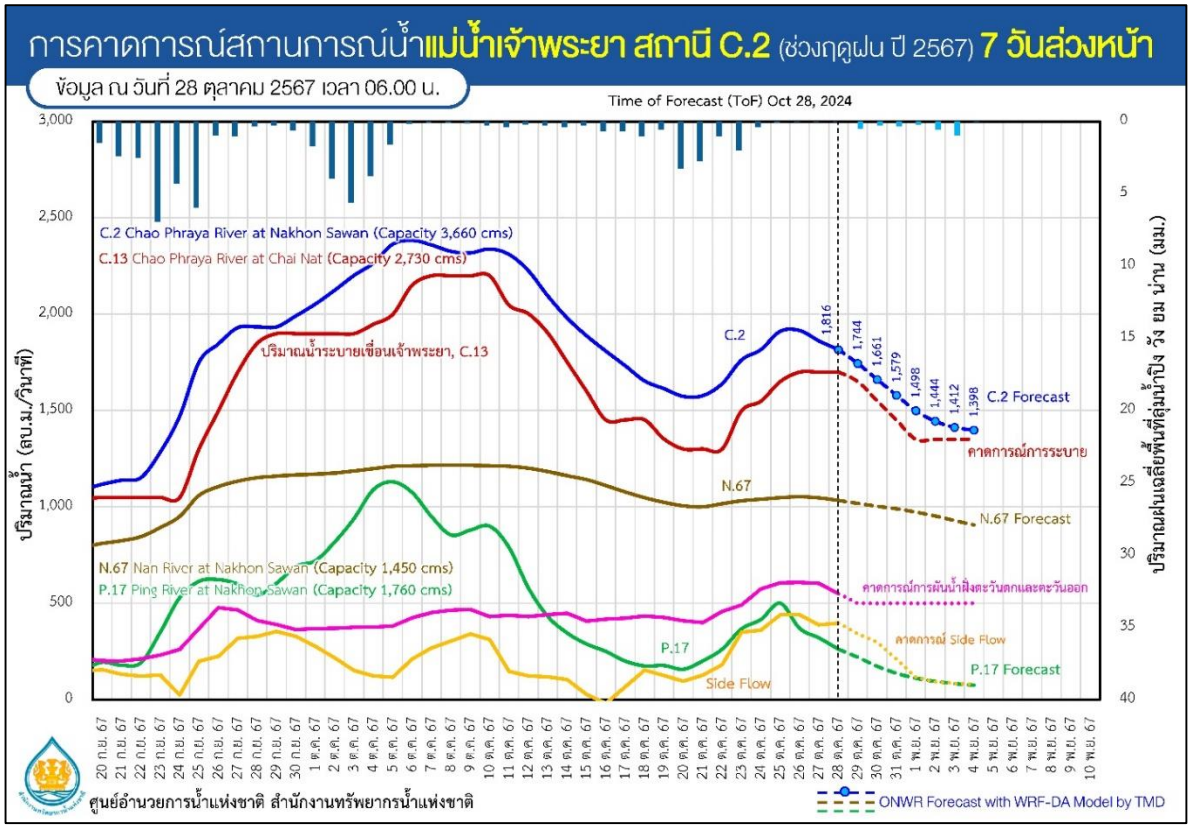

Figure 40: Stage-Correlation Analysis

2. Enhance capacity of Telemetry

In some upstream areas, there are limitations in accessing the locations of water measurement stations, requiring data to be collected through manual readings by staff. As a result, only daily data can be obtained. This creates challenges during flood events, as it is not possible to continuously gather water level data. Installing automatic telemetering stations would enable continuous data collection, providing timely information for forecasting and issuing flood warnings.

Figure 41: Mae Tang River (Hydrological station P.92 in Ban Muang-Keud, Mae Tang District, Chiang Mai) Upstream P.4A

Priority Areas Addressed:

Hydrology

- Improve typhoon-related flood (including riverine flood, flash flood, urban flood, and coastal flood) monitoring, data collection and archiving, quality control, transmission, processing, and sharing framework.
- Strengthen capacity in effective flood forecasting and impact-based early warning, including hazard mapping and anticipated risk based on methodological and hydrological modelling, and operation system development.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	

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8. Development of Decision Support System (DSS) for Local Flood Impact Forecasting and Early Warning

Main Text:

In response to The Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction 2015-2030, the global blueprint to prevent new and reduce existing disaster risk and the National Disaster Prevention and Mitigation Plan B.E. 2564 – 2570 (2021 – 2027), the master plan and guideline of disaster risk reduction management of Thailand, The Disaster Prevention and Mitigation (DDPM), Thailand has been developing and implementing the Decision Support System (DSS) at the local level for Flood Impact-Based Forecasting (IBF) using hybrid approach to develop the Application Programing Interface (API) integration platform form relevant partner agencies, such as DDPM, The Thai Meteorological Department (TMD), The Royal Irrigation Department (RID), The Department of Water Resource (DWR), The Hydro - Informatics Institute (HII) (Public Organization), Local and Provincial Administrative Organizations, The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), etc. Concurrently, the DSS also integrate the forecasting models, Geo-Information System (GIS) data, historical information and local wisdoms to develop the application tools, such as mobile application or web portal will be developed to enhance the dissemination efficiency of early warning information to relevant stakeholders in the specific risk area including government officials, volunteers, communities, private sectors and general people. In Addition, the local knowledge management also will be conducted in parallel with digital technology development to enhance the open data accessible capacity of community. Finally, this system will support the end-to-end multi-hazard early warning system to amplify the Early Warning for All (EW4ALL) at the national level operated by the National Disaster Warning Center (NDWC).

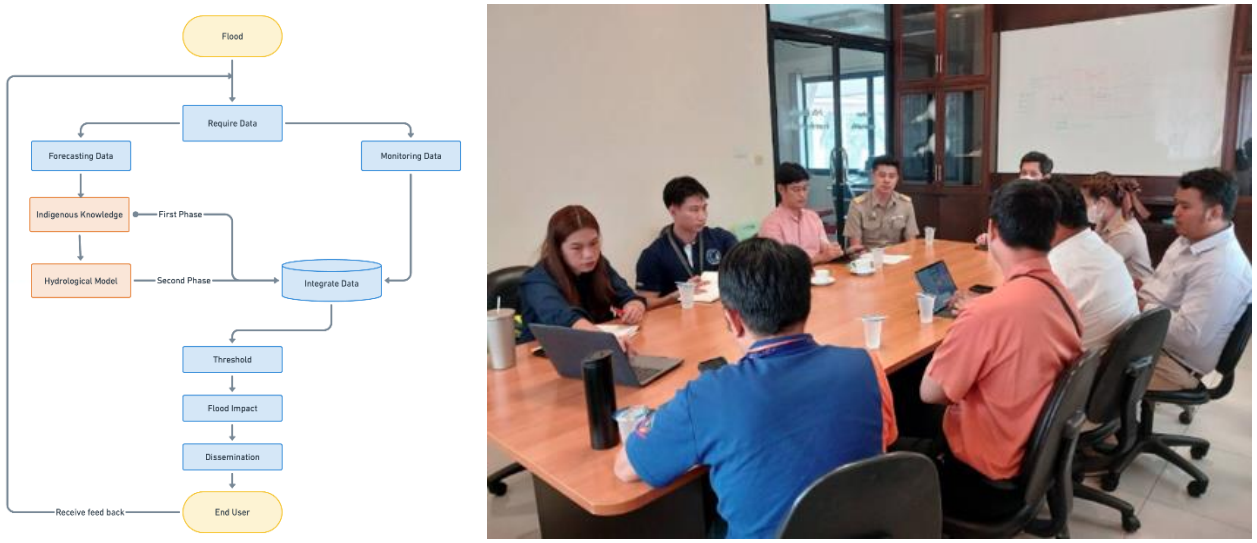

Figure 42: Flood DSS Framework and Meeting with Local Administrative Organization

Figure 43: Local Data Collection and Information Analysis

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

1. The sensors for example, closed circuit television (CCTV) or multi-sensor telemeters should be installed more in the lack areas to improve the accuracy of the monitoring, modeling and forecasting at the local level.
2. Local administrative organizations should be promoted to have the ability to use and access data for risk assessment and management in their areas of responsibility to effectively reduce the disaster risks.

Priority Areas Addressed:

<u>Integrated</u>

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.

- Enhance collaborative activities with other regional/international frameworks/organizations, including technical cooperation between TC/AP-TCRC and TC/PTC cooperation mechanism.

Meteorology
- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
- Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.

DRR
- Promote international cooperation of DRR implementation project.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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9. Establishment of Cell Broadcast Service (CBS) for Disaster Early Warning

Main Text:

Due to the current conditions and limitations of equipment, communication signals and disaster warning technology, people who are not in the radius of the warning tower's signal or who do not use the early warning application "Thai Disaster Alert", and other social media will not receive disaster warning information. DDPM has studied the guidelines for developing digital technology to warn of disasters so that they can reach a large number of people in a short time and in specific areas. Presently, Thailand has been establishing the Cell Broadcast System (CBS) to increase the efficiency of the disaster warning system. The CBS is expected to be completed by mid-2025 to enhance the safety of everyone within the country. The CBS can integrate

the system with government agencies to send various warning messages to all cell of mobile phones of both Thais and foreign tourist users in specific risk areas. Every cell phone user will receive messages immediately at once separated from normal channels with no data congestion to increase the efficiency of response with risk or emergencies promptly, and making the security and safety of life of Thai people and foreign tourists. The CBS covers all mobile phone users located in the risk areas without the need to register in advance. The warning messages will be sent in the form of text, images, and sounds displayed on the screen. In addition, CBS also supports Text to Speech, an assistive technology that reads text aloud making it useful for warning people with visual disabled people

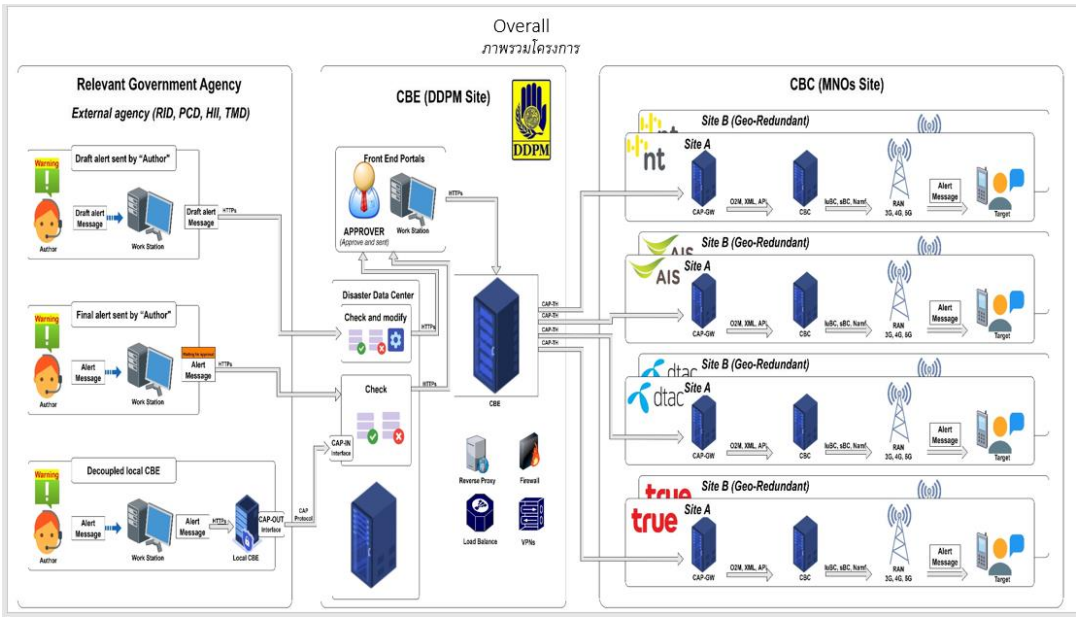

Figure 44: Diagram of Work Flow of CBS

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

1. The CAP protocol and relevant Standard Operating Procedures (SOPs) should be developed and integrated for effective multi-hazard and disaster early warnings dissemination.
2. The international collaboration of best practices sharing should be promoted regarding Thailand's CBS.

Priority Areas Addressed:

Integrated

- Strengthen the cooperation between TRCG, WGM, WGH, and WGDRR to develop impact-based forecasts, decision-support and risk-based warning.
- Enhance collaborative activities with other regional/international frameworks/organizations, including technical cooperation between TC/AP-TCRC and TC/PTC cooperation mechanism.

Meteorology

- Promote communication among typhoon operational forecast and research communities in Typhoon Committee region.
- Enhance RSMC capacity to provide regional guidance including storm surge, responding to Member's needs.

DRR

- Promote international cooperation of DRR implementation project.

Key Pillars of UN's Early Warnings for All (EW4All) Initiative Addressed:

Key Pillars of EW4All	Please ✓the related pillar(s)
Disaster risk knowledge and management	✓
Detection, observation, monitoring, analysis, and forecasting	✓
Warning dissemination and communication	✓
Preparedness and response capabilities	✓

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