MEMBER REPORT
MALAYSIA

ESCAP/WMO Typhoon Committee
18th Integrated Workshop
ESCAP - UN Conference Center, Bangkok, Thailand
28 November - 1 December 2023

CONTENTS

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

1. Meteorological Assessment

The Malaysian Meteorological Department (MET Malaysia) recorded three Typhoons (Tys) and one Severe Tropical Storm (STS) within its designated area of responsibility (latitudes 0° - 20°N and longitudes 95°E - 130°E) between November 2022 and October 2023. They were Ty Mawar, Ty Koinu, Ty Doksuri and STS Talim. The track of the TCs are plotted using the latest data from the RSMC Tokyo Best Track dataset as shown in **Figure 1**. The red boundary on the map indicates the maritime areas monitored by the MET Malaysia for the issuance of marine warnings on strong wind and rough sea conditions are depicted in **Figure 2**.

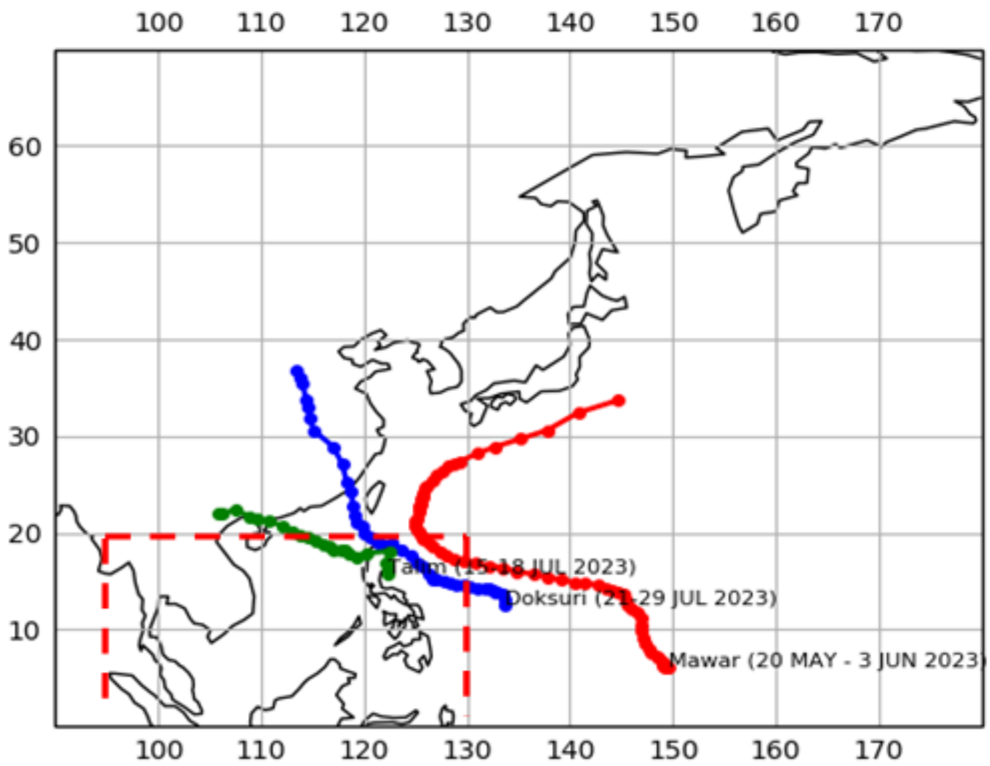


Figure 1: TC track occurred within the area of responsibility for MET Malaysia
(Note: Track of TCs is plotted using latest data from RSMC Tokyo Best Track dataset)

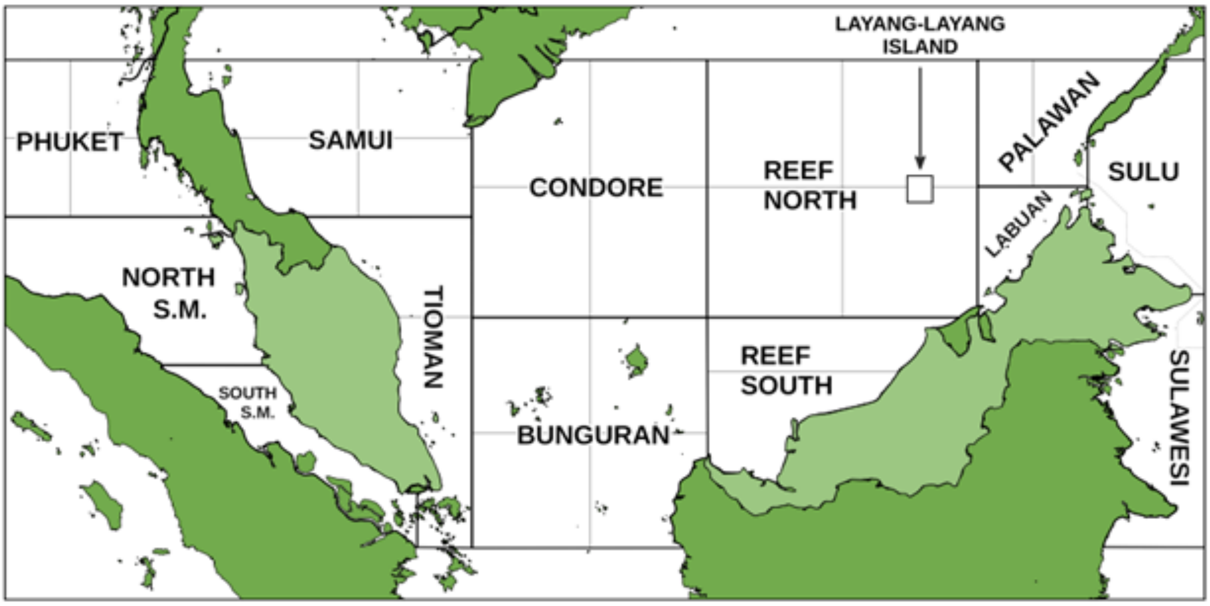


Figure 2: Maritime Area Monitored by MET Malaysia

The areas of Malaysian waters affected by TCs are listed in **Table 1.** TCs that are located in the vicinity of South China Sea (SCS) can lead to strong winds and rough seas over the east coast of Peninsular Malaysia and the coastal areas of Sabah and Sarawak. During Ty Mawar, MET Malaysia issued 13 strong wind and rough sea warnings, the highest number of warnings issued during this TCs season.

Table 1: Total Number of Areas Affected in Malaysia due to TCs between November 2022 and October 2023

No.	Tropical Cyclone (TC)	Classification	Date		Strong Wind / Rough Seas Warnings due to Tropical Cyclones (area affected)
			Birth	Dissipation	
1	Yamaneko	Tropical Storm	12/11/2022	14/11/2022	-
2	Pakhar	Tropical Storm	11/12/2022	12/12/2022	8 (Condore, Reef North, Layang-Layang, Palawan, Labuan, Tioman, southern part of Samui, Reef South)
3	Sanyu	Tropical Storm	20/04/2023	22/4/2023	-
4	**Mawar**	Typhoon	20/05/2023	03/06/2023	13 (Phuket, northern part of Condore, Reef North, Layang-Layang, Palawan, Straits of Melaka, western part of Samui, northern part of Tioman, Bunguran, Reef South, Labuan, Sulu, Sulawesi.
5	Guchol	Typhoon	06/06/2023	12/06/2023	1 (waters of Phuket)

6	**Talim**	Severe Tropical Storm	15/07/2023	18/07/2023	10 (waters of Western Sabah, waters of Reef North, Layang-Layang, Labuan, Palawan, eastern part of Samui, Condore, northern part of Reef South, Sulu, Phuket)
7	**Doksuri**	Typhoon	21/7/2023	29/7/2023	9 (waters of Northern Straits of Melaka, northeastern part of Samui, northern part of Condore, northern part of Reef North, Layang-Layang, Palawan, Phuket, northern part of Reef South, Labuan)
8	Khanun	Typhoon	27/07/2023	10/08/2023	7 (waters of Phuket, northeastern part of Condore, Reef North, Layang-Layang, Labuan, Palawan, Sulu)
9	Lan	Typhoon	08/08/2023	17/08/2023	4 (Phuket, Samui, northern part of Condore, northern part of Reef North)
10	Dora	Typhoon	12/08/2023	15/08/2023	4 (Phuket, Samui, northern part of Condore, northern part of Reef North)
11	Saola	Typhoon	24/08/2023	02/09/2023	4 (northern part of Phuket, northern part of Condore, northern part of Reef North, Palawan)
12	Damrey	Severe Tropical Storm	24/08/2023	29/8/2023	4 (northern part of Phuket, northern part of Condore, northern part of Reef North, Palawan)
13	Haikui	Typhoon	28/08/2023	05/09/2023	4 (waters of northern part of Phuket, northern part of Condore, northern part of Reef North, Palawan)
14	Kirogi	Severe Tropical Storm	30/08/2023	03/09/2023	4 (Phuket, northern part of Condore, northern part of Reef North, Palawan)
15	Yun-yeung	Tropical Storm	05/09/2023	08/09/2023	4 (northern part of Phuket, northern part of Condore, northern part of Reef North, Palawan)
16	**Koinu**	Typhoon	29/09/2023	05/10/2023	11 (Phuket, northern part of Condore, northern part of Reef North, Palawan, waters of Perlis, Kedah, Penang, Western Sabah, Labuan, Northern Straits of Melaka.
17	Bolaven	Typhoon	7/10/2023	14/10/2023	-
18	Sanba	Tropical Storm	18/10/2023	20/10/2023	-

The tracks of TCs Mawar, Koinu, Doksuri and Talim are shown in **Figure 3**. Most of this year's TCs have had no significant impact on the weather over Malaysia.

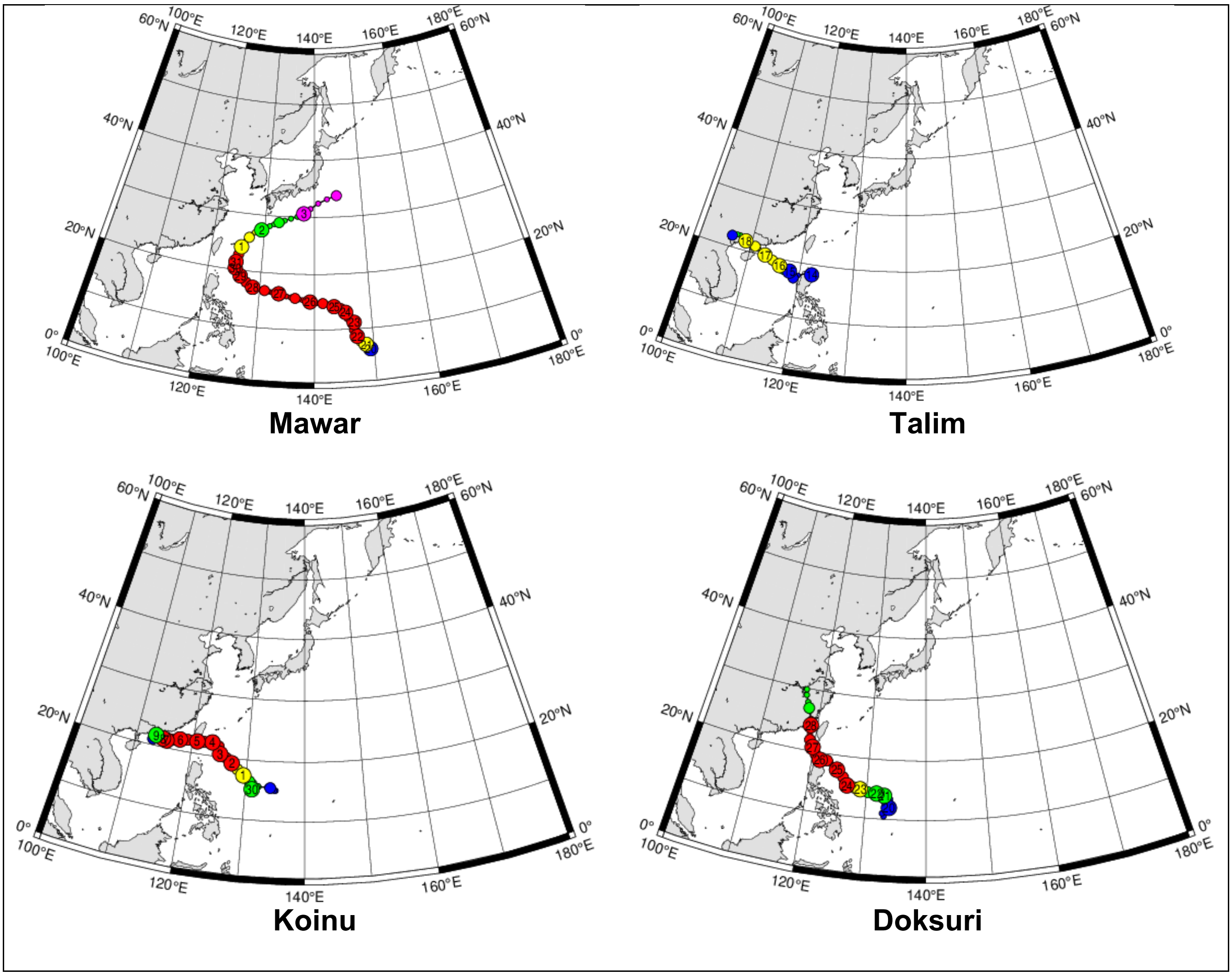


Figure 3: Tracks of four Tys and STS within Malaysia's area of responsibility from November 2022 until October 2023. The circled numbers represent the date of occurrence of the TYs and TSs (Source: National Institute of Informatics (NII), Research Organization of Information and Systems (ROIS), Japan http://agora.ex.nii.ac.jp/digital-typhoon/latest/track).

The 850hPa wind circulation derived from the ERA-5 dataset, during the passage of TCs are illustrated in **Figure 4**. Southwesterly winds were observed over the Malaysian region during the passage of the four TCs. This period is known as the Southwest monsoon. Southwest monsoon usually begins in mid-May and ends in mid-October. During this time, the monsoon trough is located over the north of the Malaysian region.

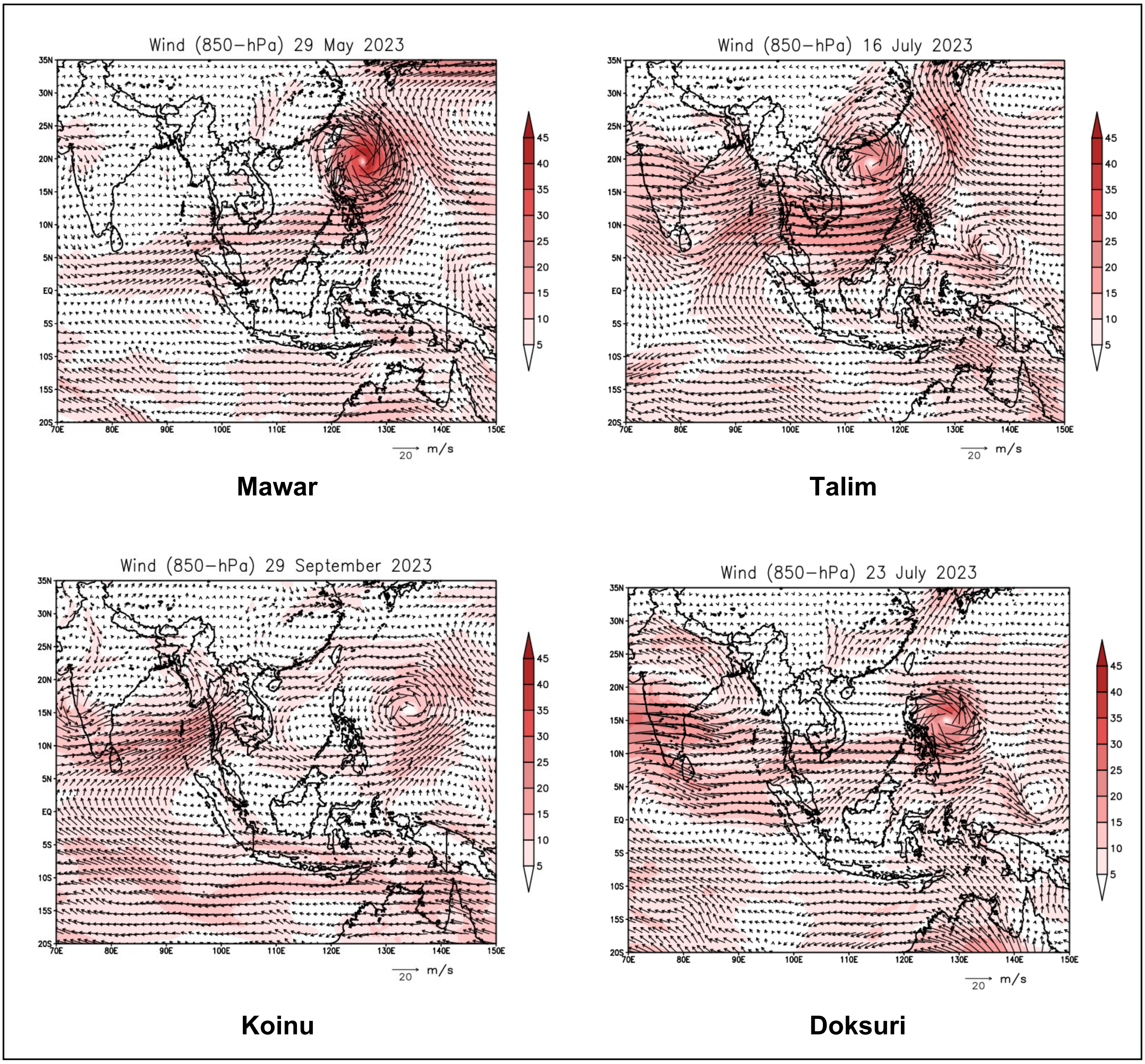


Figure 4: 850hPa wind circulation derived from the ERA-5 dataset during the passage of the four TCs within Malaysia's area of responsibility.

Figure 5 showed FY-2G satellite imageries during the presence of TCs Mawar, Koinu, Doksuri, and Talim. Most of the TCs did not contribute to heavy rainfall in Malaysia and the TCs only have a distant impact on Malaysia's weather. Depending on the path, intensity and location of the TCs, it might cause the weather to be drier or wetter as they could influence the wind flow over the Malaysia's region.

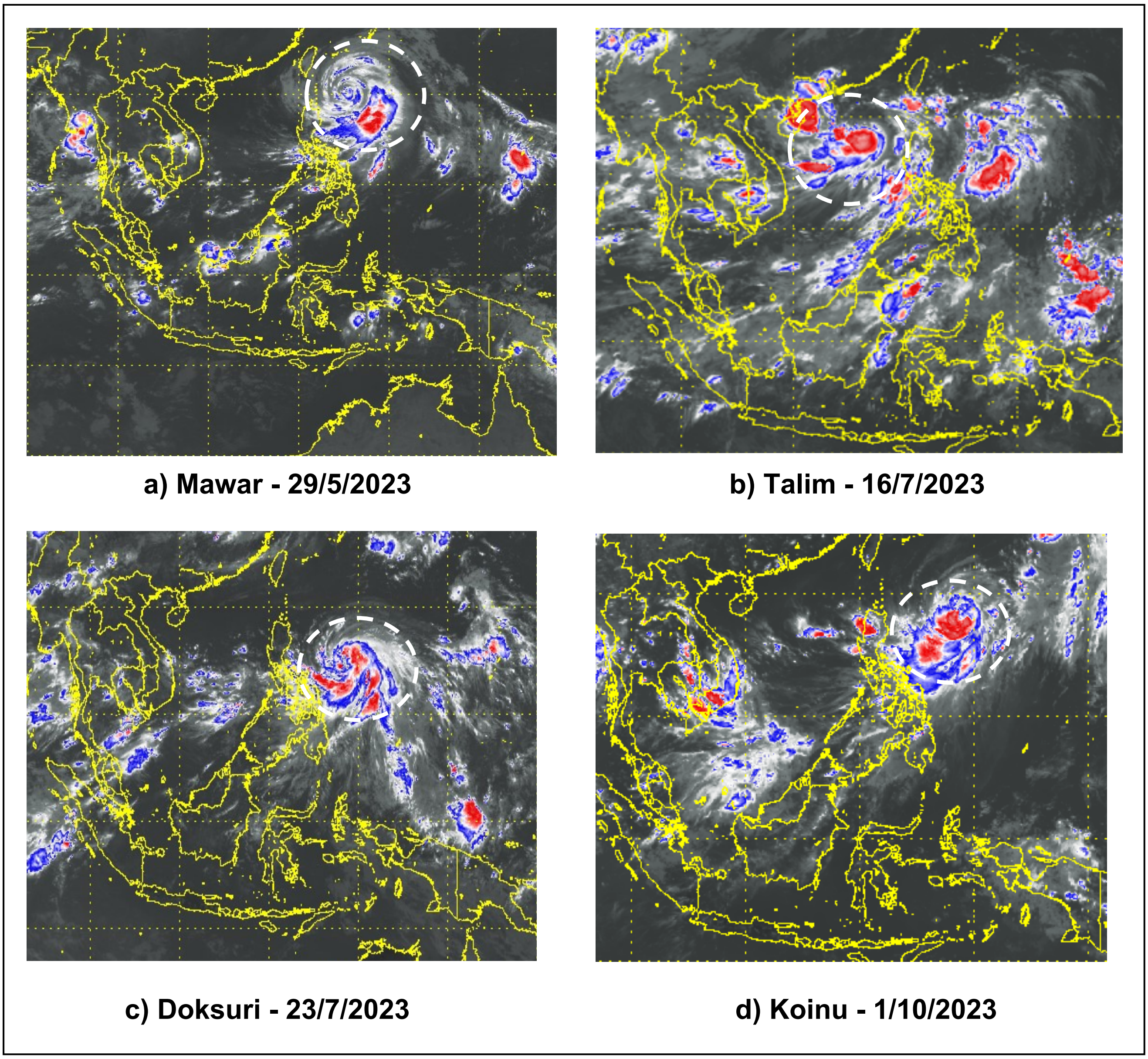


Figure 5: FY-2G satellite imageries of TCs that affected the Malaysian region.

Figures 6 to **Figure 9** respectively shows daily accumulated rainfall of the chosen meteorological stations over Malaysia during each of the TCs occurrence. The daily accumulated rainfall for the months of May, June, July, and September mostly showed that the rainfall amount was less than 100 mm. Only, two rainfall stations showed rainfall amounts of more than 100mm, namely at Kota Bharu and Miri, during the passing of Ty Mawar and Ty Doksuri, respectively.

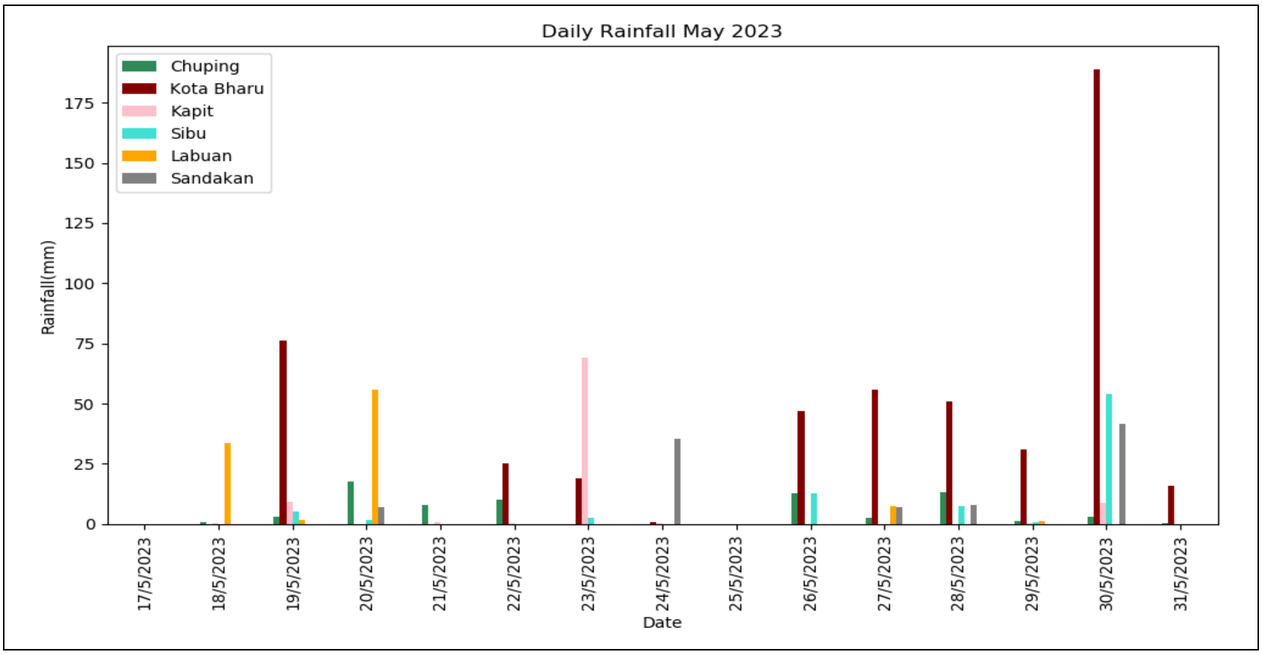


Figure 6: Daily rainfall during May 2023 for Typhoon Mawar (20/5/2023 - 3/6/2023)

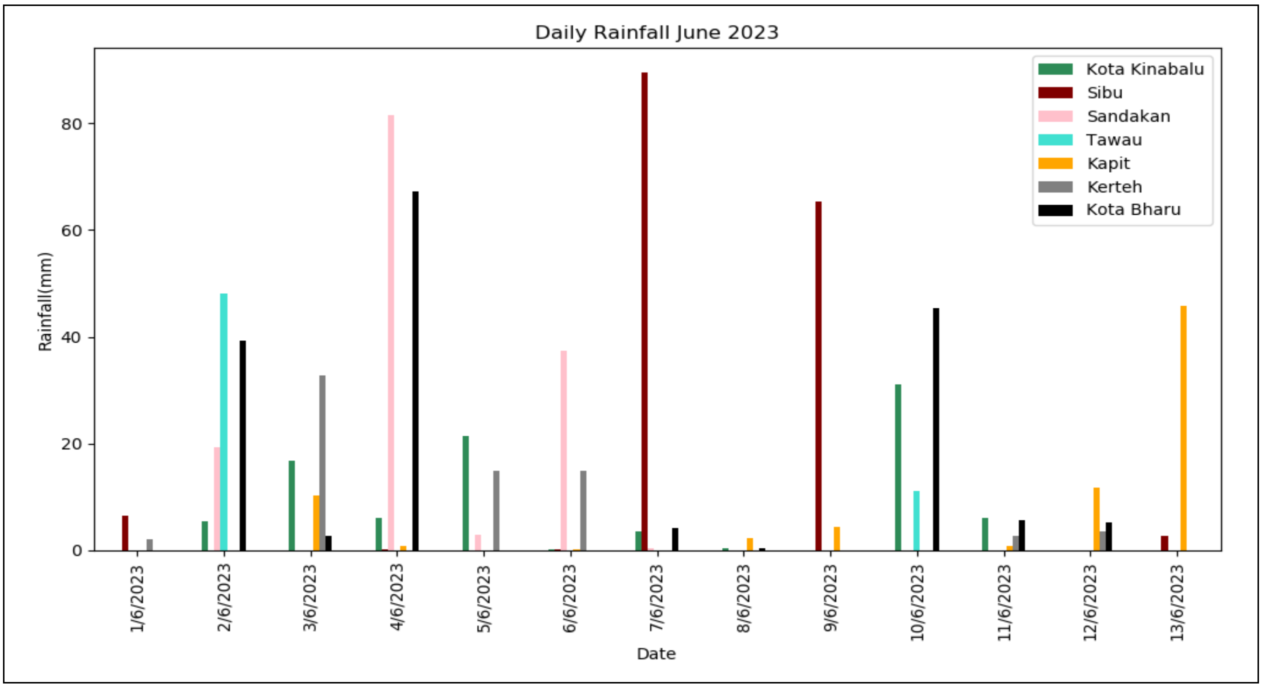


Figure 7: Daily rainfall during May 2023 for Typhoon Mawar (20/5/2023 - 3/6/2023)

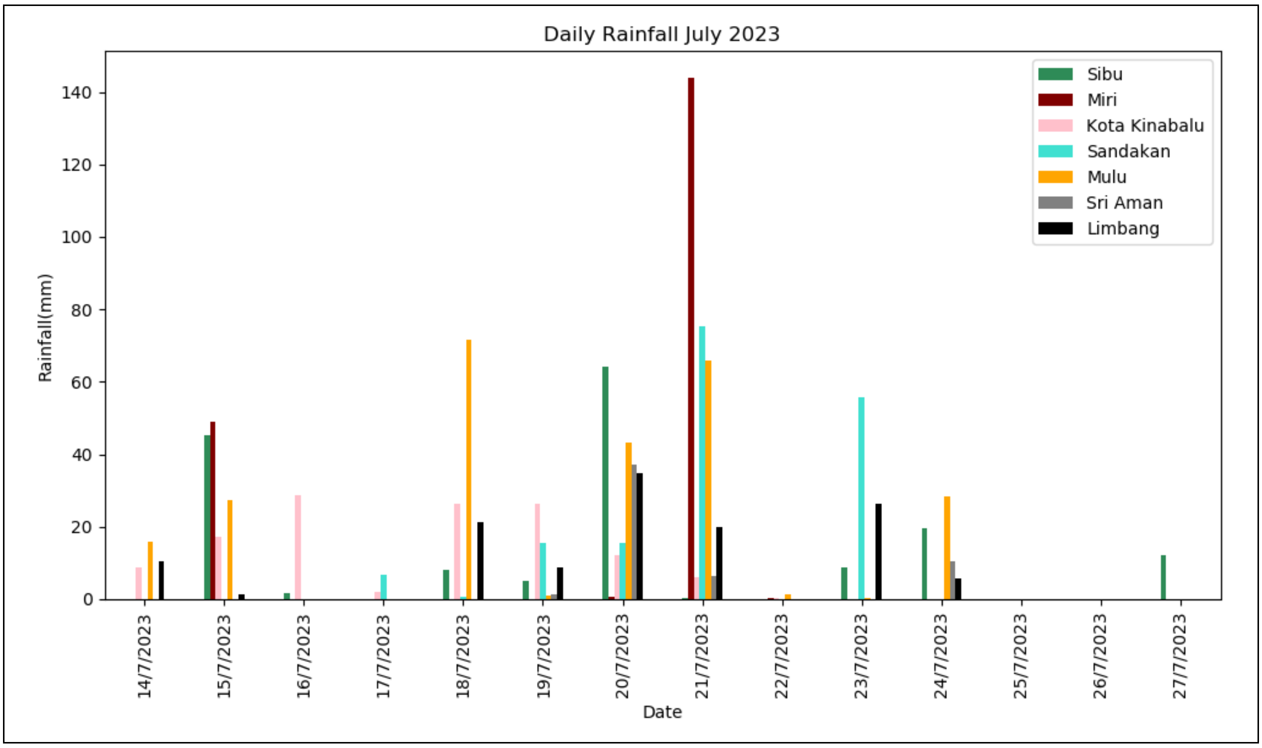


Figure 8: Daily rainfall during July 2023 for STS Talim (15/7/2023 - 18/7/2023) and Typhoon Doksuri (21/7/2023 - 29/7/2023)

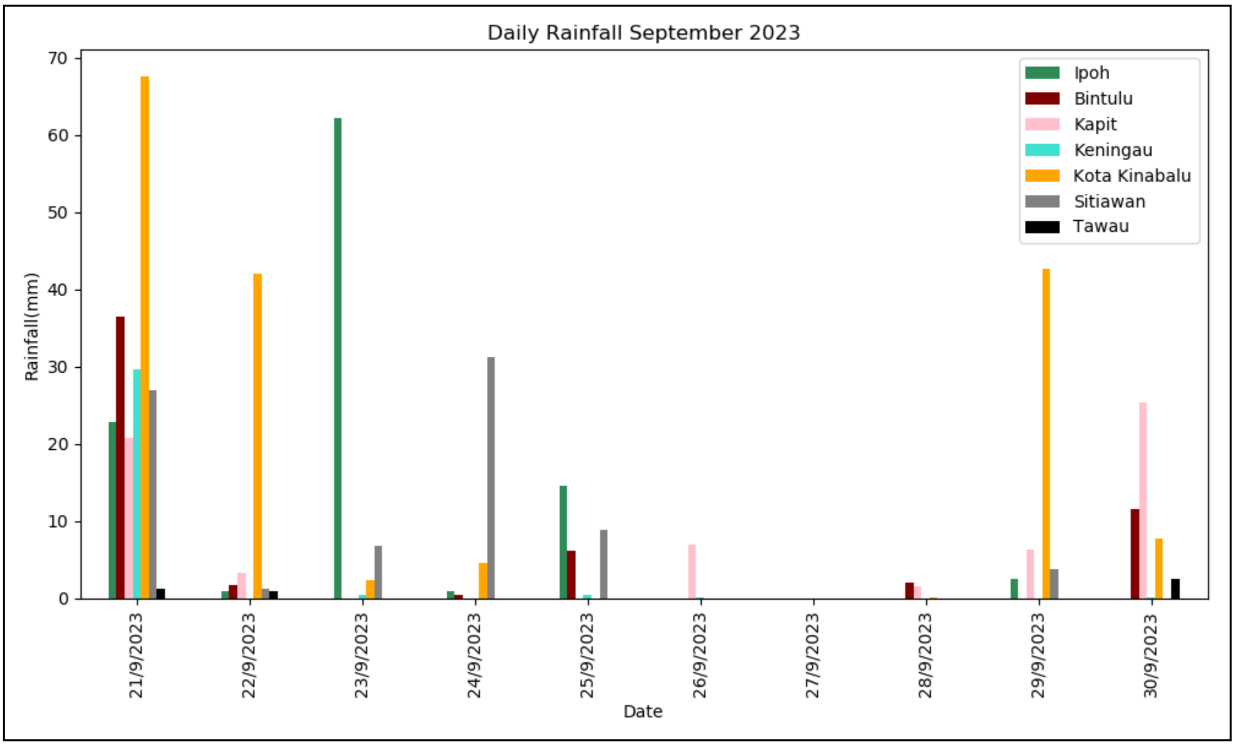


Figure 9: Daily rainfall during September 2023 for Typhoon Koinu (29/9/2023 – 5/10/2023)

In conclusion, under the maritime areas monitored by MET Malaysia, only 4 TCs observed between November 2022 and October 2023 compared to 16 TCs observed from November 2021 until October 2022. This shows the number of TCs developed in 2022/2023 is far lesser than the number of TCs in 2021/2022. The difference is probably due to the presence of the El Niño phase beginning from mid of 2023. Generally, El Niño presence could decrease the number of the TC formation over the Northwestern Pacific region. Due to low number of TC formation in this season, there is no significant impact to Malaysia's weather pattern.

2. Hydrological Assessment

a) Flood Scenario in Malaysia

Malaysia recorded 983 flood incidents in 2022. The 10 years trend shows the flood events increase significantly from 90 flood in 2012 to 983 in 2022. Details of the annual flood records since 2001 shown in **Figure 10**. The monsoon floods that occurred in 2022 hit 14 states and 88 districts. Study carried out by Department of Statistics Malaysia found that in year 2022, floods have killed 12 people and displaced almost 200,000 people. Losses due to floods reached RM 622.4 million and the detail loss for each category shown in **Table 2**. Meanwhile, for the year 2023, 286 flood incidents have been recorded till august 2023 which hit 11 states and badly impacted the state of Johor.

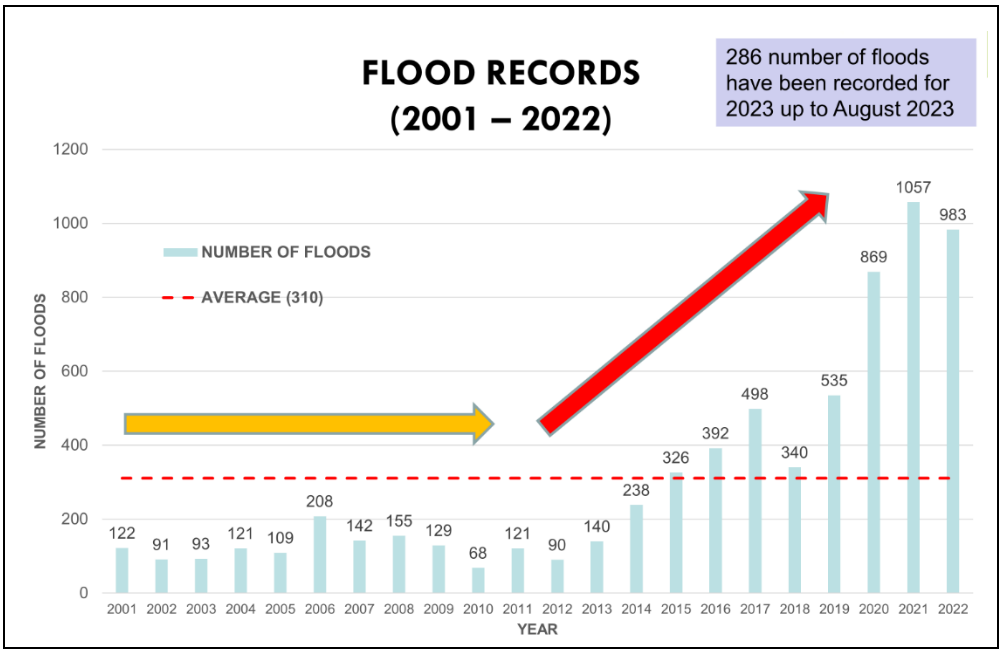


Figure 10 : Annual flood records since 2001 until 2022

Table 2 : Category of flood loss in 2022

Category	Loss (RM Million)
Public Assets and Infrastructure	232.7
Vehicles	18.8
Manufacturing	8.6
Living Quarters	157.4
Agriculture	154.5
Business Premises	50.3
Total	**622.4**

During monsoon flood that occurred from 28 February until 3 March 2023, rainfall data showed very high intensity at most stations of Johor and the highest rainfall depth in a 24-hour period was 322mm - 430mm at Segamat, Kluang and Muar District which equates to over 100 years return period. There was unusual rainfall intensity occurred at Johor due to heavy downpour during the monsoon season. More than 30 locations affected and more than 40,000 people evacuated. **Figure 12** shows the location of Johor and related districts. **Figure 13** shows the flood images in 2023 at the state of Johor.

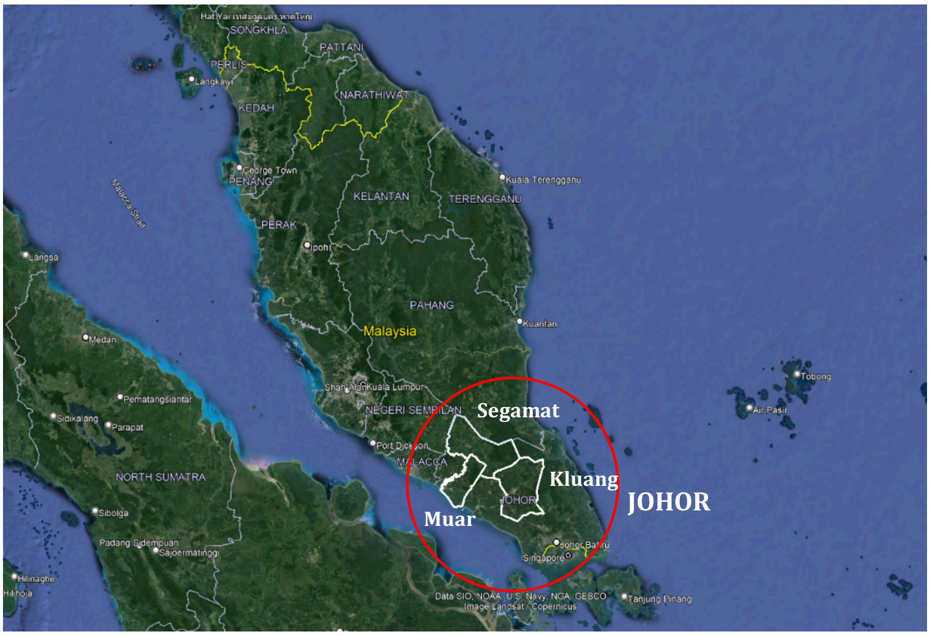


Figure 12: Location of Johor

Figure 13: Flood images at the State of Johor

During the flood event from 28 February until 4 March 2023 in the state of Johor, rainfall data showed high intensity at Segamat, Kluang and Muar stations. **Figure 14** shows the 24 hours Isohyet Map for the state of Johor from 28 February to 3 March 2023. The rainfall depth in a 24-hour period at Air Panas Station was 430mm, Pekan Paloh Station was 322mm and Liang Batu Station was 404mm which equates to over 100 years return period as shown in **Table 3**.

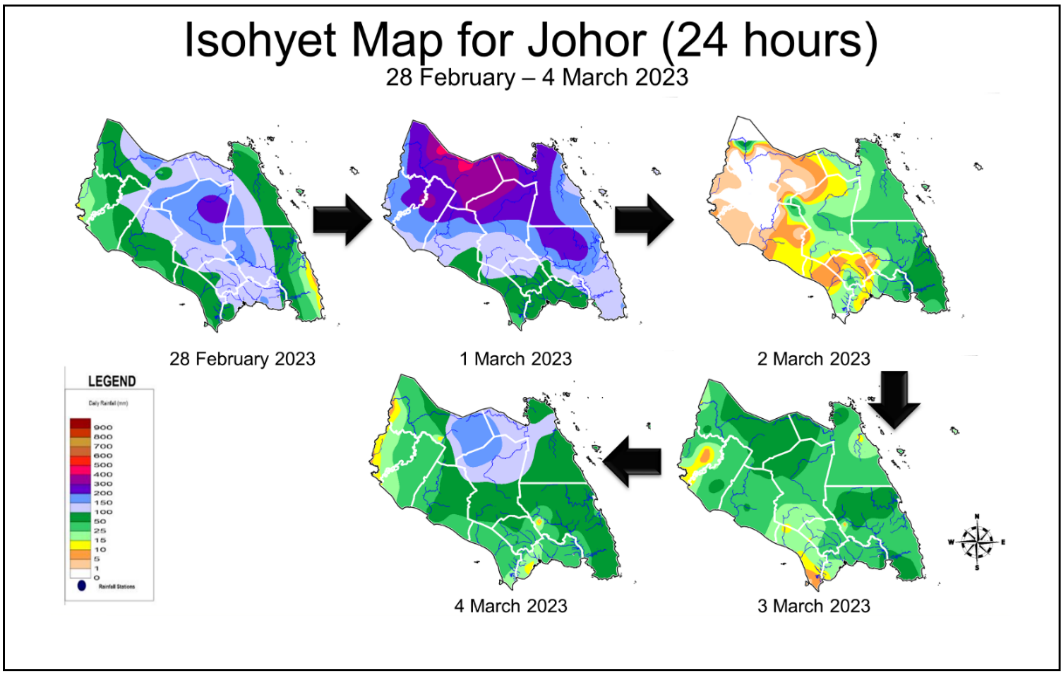


Figure 14: Flood images at the State of Johor

Table 3: Rainfall intensity for the State of Johor in 2023

RAINFALL RETURN PERIOD (ARI) FOR THE STATE OF JOHOR
DURATION (28 FEB 2023 TO 4 MARCH 2023)

Highest Rainfall Distribution at Each District of Johor

Bil.	Daerah	Nama Stesen	28/2/2023		1/3/2023		2/3/2023		3/3/2023		4/3/2023	
			Rainfall (mm)	ARI	Rainfall (mm)	ARI	Rainfall (mm)	ARI	Rainfall (mm)	ARI	Rainfall (mm)	ARI
1	Segamat	Air Panas	219	9	430	**172**	2	0	80	0	141	1
2	Kluang	Pekan Paloh	178	7	322	**121**	6	0	51	0	169	6
3	Kulai	Ladang Sedenak	111	1	138	2	10	0	15	0	60	0
4	Muar	Liang Batu	116	1	404	**414**	1	0	27	0	53	0
5	Tangkak	Sawah Ring	33	0	213	38	0	0	6	0	31	0
6	Batu Pahat	Ladang Union	138	2	251	47	3	0	52	0	67	0
7	Pontian	Pintu Air Parit Salleh	93	1	114	1	12	0	12	0	42	0
8	Kota Tinggi	Kg. Mawai	81	0	222	4	40	0	62	0	62	0
9	Johor Bahru	Ulu Tiram	132	1	85	0	48	0	31	0	51	0
10	Mersing	Empangan Labong	54	0	298	4	30.5	0	69	0	55	0

>100 Hari

b) National Flood Forecasting and Warning Programme (PRAB)

Since 2015, Malaysia is developing a Flood Forecasting and Warning System namely Program Ramalan dan Amaran Banjir, PRAB throughout the country. The 15 years project (2015-2030) aims to provide monsoon flood forecast 7 days in advance and early warning flood forecast up to 2 days in advance to the flood related agencies and public. PRAB consists of four main components (detection, forecast, integrated forecast operation system & warning and dissemination) plans to develop flood forecast modelling system at 74 river basins throughout the country and currently 25 river basins have been completed and ready for operational as shown in **Table 4**. The development of additional 11 river basins has been initiated for Selangor, Negeri Sembilan, Melaka and Johor in 2022 as shown on **Table 5**. Besides, PRAB also involved in the construction of hydrological telemetry stations which includes parameter of rainfall, water level, streamflow, soil moisture and evaporation. A numbers of siren and camera systems will be installed at selected locations of the flood prone area. Non-structure elements that related to public awareness also have been carried out to provide basic knowledge on flood forecast and warning. The awareness programme involve many parties such as flood related agencies, student (school and higher education), villagers, local leaders, non-governmental organizations and others.

Table 4 : List of operational river basins under National Flood Forecasting and Warning System (NAFFWS)

No.	State	River basin
1.	Perlis	Sg. Perlis
2.	Kedah	Sg. Kedah
3.	Kedah	Sg. Muda
4.	Kedah	Sg. Melaka at Langkawi
5.	Pulau Pinang	Sg. Juru
6.	Pulau Pinang	Sg. Perai
7.	Pulau Pinang	Sg. Jawi
8.	Pulau Pinang	Sg. Pinang
9.	Perak	Sg. Kerian
10.	Perak	Sg. Kurau
11.	Perak	Sg. Perak
12.	Johor	Sg. Johor
13.	Johor	Sg. Mersing
14.	Johor	Sg. Endau
15.	Pahang	Sg. Rompin
16.	Pahang	Sg. Pahang
17.	Pahang	Sg. Kuantan
18.	Terengganu	Sg. Kemaman
19.	Terengganu	Sg. Dungun
20.	Terengganu	Sg. Paka
21.	Terengganu	Sg. Terengganu
22.	Terengganu	Sg. Setiu
23.	Terengganu	Sg. Besut
24.	Kelantan	Sg. Kelantan
25.	Kelantan	Sg. Golok

Table 5 : List of initiated river basins under National Flood Forecasting and Warning System (NAFFWS)

No.	State	River basin
1.	Selangor	Sg. Klang
2.	Selangor	Sg. Bernam
3.	Selangor	Sg. Selangor
4.	Selangor	Sg. Langat
5.	Selangor	Sg. Buloh
6.	Johor	Sg. Muar
7.	Johor	Sg. Batu Pahat
8.	Johor	Sg. Skudai
9.	Negeri Sembilan	Sg. Linggi
10.	Melaka	Sg. Kesang
11.	Melaka	Sg. Melaka

II. Summary of Progress in Priorities supporting Key Result Areas

1. Verification of the Radar Integrated Nowcasting System (RaINS) during One (1) Squall-Line Event in Malaysia

The *Radar Integrated Nowcasting System* (RaINS) was developed by MET Malaysia based on the *Short-Range Warning of Intense Rainstorms in Localized Systems* (SWIRLS) and the *Rainstorm Analysis and Prediction Integrated Data-processing System* (RAPIDS) introduced by the Hong Kong Observatory (HKO). For purposes of continuous improvement, the nowcast accuracy of RaINS was evaluated with respect to radar observation, during a squall-line event. This was a severe event on the 1st of July 2022 that is reported by local media. Based on skill score analysis, RaINS had a useful lead time of 50-60 minutes in advance, during this squall-line event.

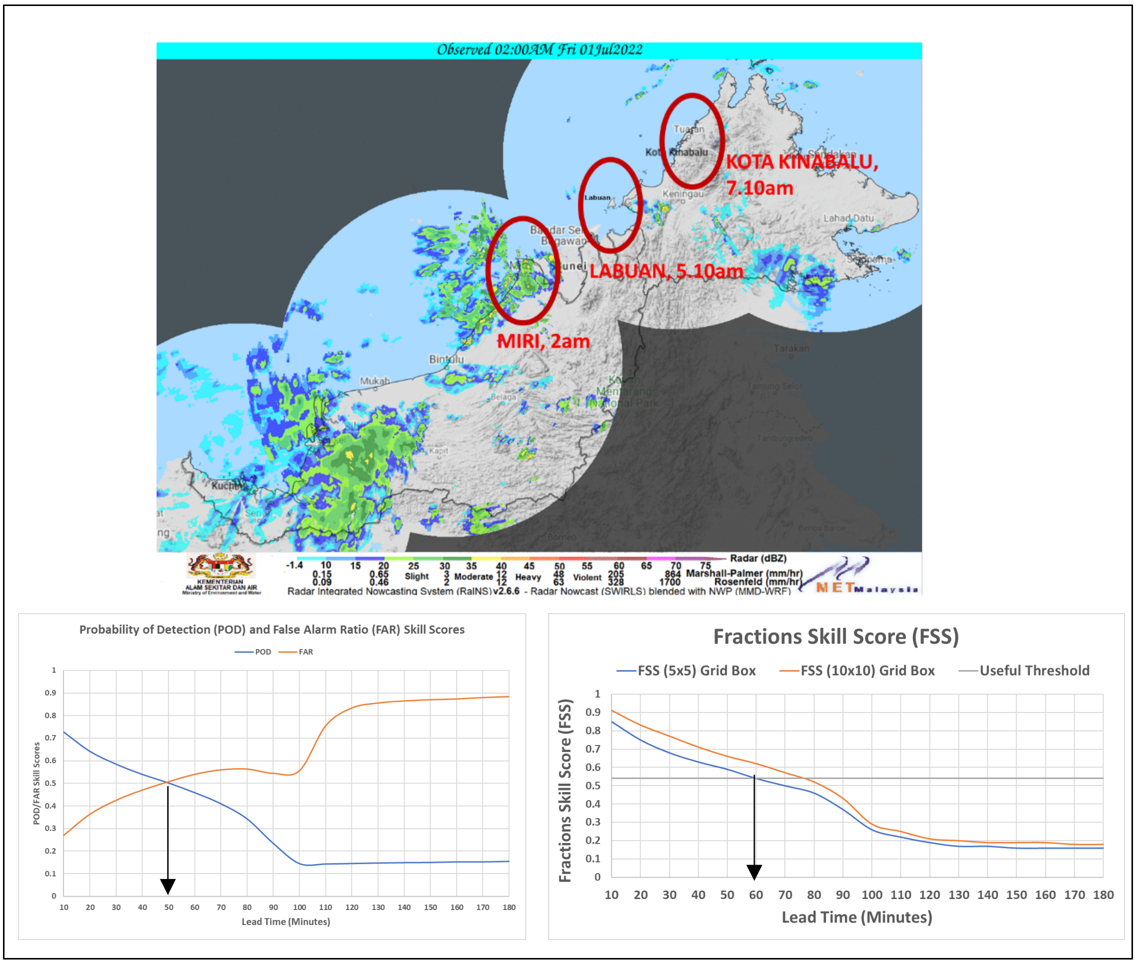


Figure 15. The squall-line event is depicted on top. The landfall time of the squall-line in each city is written within the figure on top. Meanwhile, the *probability of detection* (POD), and the *false alarm ratio* (FAR) skill scores are shown on the bottom left. Subsequently, the *fractions skill score* (FSS), is shown on the bottom right. The useful lead time is 50 minutes (bottom left) where the POD (blue) exceeds the FAR (orange). Meanwhile, the useful lead time is 60 minutes within a box length of 3km by 3km (bottom right) where the FSS (blue) exceeds the threshold (black line).

2. Annual Operating Plan for Working Group of Hydrology (AOP6: Flood Risk Watch Project for Live – Saving)

Introduction

The implementation of Annual Operation Plan 6 for Typhoon Committee Programme (AOP6) which is Flood Risk Watch for Life Saving in Malaysia has started at the end of 2018 after Ministry of Land, Infrastructure, Transport and Tourism (MLIT), submitted a proposal at the Working Group of Hydrology (WGH) meeting. In early January of 2019, Department of Irrigation and Drainage (DID) were managed a technical visit for MLIT with delegates from International Centre for Water Hazard and Risk Management (ICHARM) and Infrastructure Development Institute (IDI), Japan to Malaysia. The objective of technical visit is to obtain information related to the construction of hydrological telemetry stations in Malaysia. Second visit to Malaysia was conducted in October 2019 in conjunction with the higher-level meeting about dam safety. Recently, in December 2019, 2 delegates from IDI, Japan attend the technical field inspection in Malaysia for further clarification and understanding of hydrological data collection in Malaysia.

During the field survey, IDI experts have been taken to several hydrological station in the Klang River, Langat River and Pinang River. This is to make sure they understand and will identify the most suitable location for the establishment of a 3L Water Level Gauge (WLG) station. At the end of the visit, IDI experts has agreed to consider to install 3L WLG at 2 locations, namely Sulaiman Bridge Station in Klang River and Batu Lanchang station in Pinang River (Refer **Figure 16** & **Figure 17**).

Following on from IDI's visit to Malaysia, MLIT was pleased to invite the DID delegation to Japan to find out the real condition of the operation of 3L WLG station in Japan. A technical visit was held at the end of January 2020.

Figure 16: Sulaiman Bridge Station

Figure 17 : Batu Lanchang Station

Both departments have planned to hold further technical discussions to finalize all the station’s construction requirements in Malaysia such as technical requirements, construction methods, notes of understanding, responsibility and security, data transmission methods and so on. However, due to the Covid-19 endemic, all such activities have been postponed since March 2020 and it is hoped that it will recover in 2021. Thus, during this period, DID and MLIT in process to finalizing all documentation requirements that do not require physical activity. It is planned that the installation of 3L WLG stations will be implemented in early of 2021 and is expected to start recording and transmitting data in March 2021.

The Covid-19 endemic has prolonged until early of year 2022. However, Japan and Malaysia still continue discussing regarding the detailed conditions for test installation plans in preparation for resuming overseas travel after the endemic had subsided. At the same time, MLIT Japan has recruited four (4) WLG manufacturers to participate in the test installation programme. On the 25th of January 2022, the MLIT has submitted a letter to DID informing an intention to carry out testing of 3L WLG equipment in Malaysia, through the involvement of four (4) manufacturing companies, namely as eTRUST Co.,Ltd., Midori Engineering Laboratory, YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc., and MEISEI ELECTRIC Co.,Ltd.. DID has expressed their consent for the implementation of this test through a letter to MLIT dated on 17th of February 2022.

Then, on the 2nd of March 2022, DID and MLIT has held an online meeting to discuss about the installation plan of 3L WLG, the process of delivery items to Malaysia, and custom clearance procedure including import tax exemption application method. At that meeting, the participating companies was invited to present their proposal on installation plan. The installation location of the WLG also was decided to be changed to the Sentul Hydrology Station, Kuala Lumpur. Only one location was selected in order to make fairly comparison on data analysis and equipment performance between all the WLG installed. Besides that, it can facilitate the monitoring work by the DID personnel. The proposed installation location is as shown in the **Figure 18** below.

Figure 18: Propose Location for 3L WLG Installation

There are 2 objectives to achieve in this study, which are:

i. To share installation procedure and data utilization of 3L WLGs; and

ii. To study on application to Typhoon Committee members.

3L Water Level Gauge

MLIT Japan has been promoting an innovative initiative using 3L Water Level Gauge (WLG) to decrease flood damages. The meaning of 3L (Low Cost, Long Life and Localized) can be described as:

a. Low Cost : The initial cost of development is less than 10,000 USD;

b. Long Life : The WLG station can operate more than 5 years without power supply; and

c. Localised : The WLG station installation method can be modified to fit local situation.

MLIT Japan has commissioned the development of 3L WLGs to support flood management of small and medium-sized rivers from 2016 to 2017. As of the end of 2020, a number of 11,000 3L WLGs have been installed and operated in Japan. MLIT Japan has published the observation status of 3L WLGs on following English website (https://www.river.go.jp/e/).

Under the AOP6 programme, MLIT has recruited four (4) WLG manufacturers to participate in the testing programme. In order to facilitate the delivery and installation process in Malaysia, the participating companies has appointed their representative in Malaysia. The list of the participating company and their representatives are as listed in the **Table 6** below.

Table 6: List of the Participating Company

No.	Participating Company Name	Web Page (English Site)	Representative Company Name in Malaysia
1	eTRUST Co., Ltd.	https://etrust.ne.jp/corporate/	Vanguard Electronic Sdn. Bhd.
2	Midori Engineering Laboratory	https://midori-eng.com/en/	Maintek Technologies Sdn. Bhd.
3	YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc.	https://www.yachiyo-eng.co.jp/e/ https://www.osasi.co.jp/en/	Spatialworks Sdn. Bhd.
4	MEISEI ELECTRIC Co.,Ltd.	https://www.meisei.co.jp/english/	IHI Corporation, KL Branch (as Representative), and NEXTGMATRIX ENGINEERING (as installer)

Installation Progress

Before the delivery of WLG to Malaysia was carried out by the participating companies, several matters has been informed and decided as follows:

a. All the WLG shall be installed on the existing 30-meter-long steel bridge at the Sentul Hydrology Station, Kuala Lumpur. The Picture and sketches of the steel bridge as shown in **Figure 19** have been sent to all the participating companies through MLIT, for their reference;

b. The WLG installation point on the bridge has been set as shown in **Figure 20**;

c. The participating companies were informed about the existence of one (1) WLG unit owned by DID at the steel bridge which it will be used for data comparison with WLG from Japan. In addition, the installation of WLG must be done at a distance of at least 6m from the river bank due to the existence of exposed sedimentation during low water level at a distance of 4m from the river bank. Please refer to **Figure 21**; and

d. The participating companies is allowed to install the WLG on the existing safety railing on that steel bridge, but they must responsible for the damage and failure that will occur. In addition, the participating companies also need to make repairs to the original condition of the safety railing after the testing programme is completed. The picture of the safety railing is as shown in **Figure 22**.

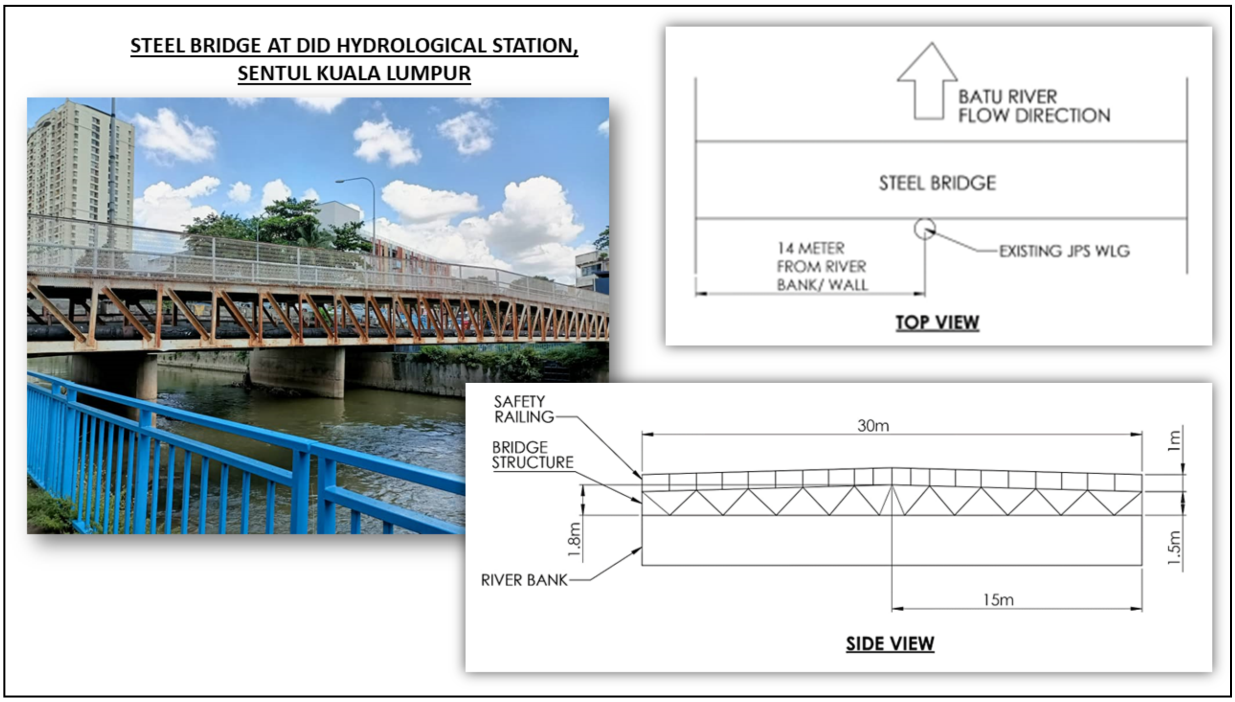
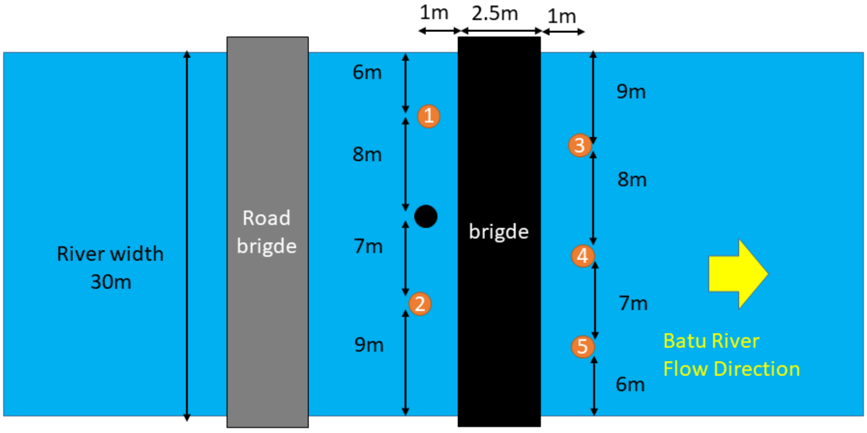


Figure 19: Steel Bridge At Sentul Hydrological Station, Kuala Lumpur



Symbol	Participant Company Name
1	eTRUST Co.,Ltd.
2	eTRUST Co.,Ltd.
3	Midori Engineering Laboratory
4	YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc.
5	MEISEI ELECTRIC Co.,Ltd.

Figure 20: Arrangement of Sensor Placement on the Bridge

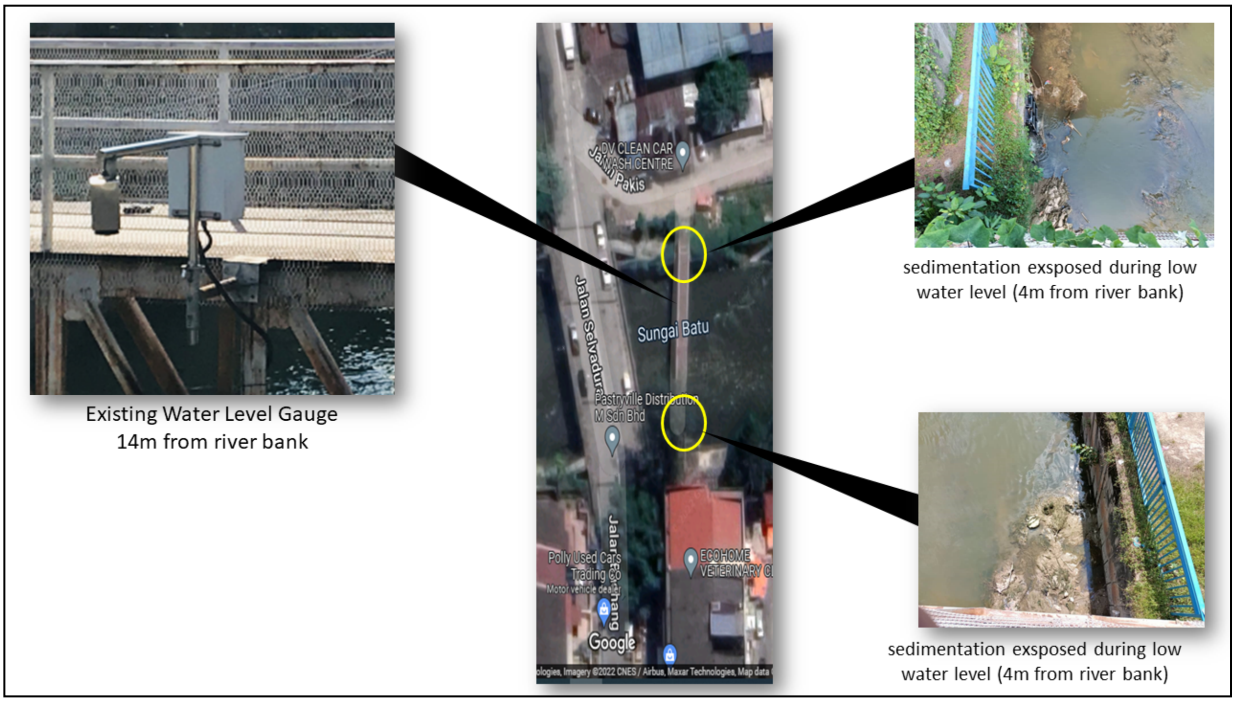


Figure 21: Installation Location

Figure 22: Steel Bridge Safety Railing

The installation work has been carried out in stages by each of the participating companies. The first installation works was carried out by the Midori Engineering Laboratory on the 11th of May 2022, followed by MEISEI ELECTRIC Co.,Ltd. on the 23rd of May 2022. Then, the YACHIYO Engineering Co., Ltd. / OSASI Technos Inc. completed their WLG installation works on the 27th of June 2022. And finally, on the 26th of June 2022, eTRUST Co.,Ltd. have installed their WLG on site. The picture of all WLG installed on the steel bridge at the Sentul Hydrology Station is as shown in the **Figure 23**. The summary of installation date of WLG is shown in the **Table 7** below.

Table 7*: Installation Date*

No.	Participating Company	Installation Date
1	Midori Engineering Laboratory	11/5/2022
2	MEISEI ELECTRIC Co.,Ltd.	23/5/2022
3	YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc.	27/6/2022
4	eTRUST Co.,Ltd.	26/7/2022

Figure 23: Picture of all WLG installed at site

WLG Installation by Midori Engineering Laboratory

The installation works of WLG from Midori Engineering Laboratory was carried out from 11th to 13th of May 2022 with the assistant of Maintek Technologies Sdn. Bhd. from Malaysia. The picture of the installed WLG are shown in **Figure 24** below.

Figure 24: Picture of WLG Installation Progress of Midori Engineering Laboratory

WLG Installation by MEISEI ELECTRIC Co.,Ltd.

Installation works of WLG by MEISEI ELECTRIC Co.,Ltd. was completed on 23rd of May 2022 by IHI Corporation and NEXTGMATRIX ENGINEERING who are respectively appointed representatives and installers in Malaysia. The picture of installation works are shown in the **Figure 25** below.

Figure 25: Picture of WLG Installation Progress of MEISEI ELECTRIC CO., Ltd.

WLG Installation by YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc

Installation works of WLG from YACHIYO Engineering Co.,Ltd. / OSASI Technos Inc. was implemented from 27 June 2022 by their appointed representative in Malaysia, namely Spatialworks Sdn. Bhd. The picture of installation work are shown **Figure 26** below

.

Figure 26: Picture of WLG Installation Progress of YACHIO Engineering Co., Ltd. / OSASI Technos Inc.

WLG Installation by eTRUST Co.,Ltd.

The installation works of two (2) numbers of WLG by eTRUST Co.,Ltd. was completed by their own staff, namely Mr. Masaru Suzuki and the engineer Mr. Watanabe from 26th to 29th of July 2022. This works was assisted by personnel from Vanguard Electronic Sdn. Bhd., which is the appointed representative in Malaysia. The picture of installation works is shown in **Figure 27** below.

Figure 27: Picture of WLG Installation Progress of eTRUST Co., Ltd.

Data Monitoring and Analysis

The main purpose of the 3L WLG testing programme is to check the accuracy of observation data and operability of the Japan WLG equipment. The **Figure 28** below shows the observation and analysis processes which are consist of data acquisition, data analysis, result and as well as findings. During the installation process, all the 3L WLG elevation values except AOP6-5 were deployed based on the stick gauge level installed at site. Besides that, the elevation value (Reduced Level) for AOP6-5 was set using GPS Surveying method. At the data acquisition stage, all WLG data was downloaded from the DID server for a period of time for analysis purposes. The 3L WLG data also displayed at DID Web Portal as shown in the **Figure 29**, and it can be monitored in real-time. In order to verified the WLG data captured by the sensor, DID had obtain the water level stick gauge reading at site, from 15th August to 8th September 2022. Then, data analysis was done for all the data obtain from WLG and stick gauge. The performance analysis is based on data received performance, compliance to data format, and data quality or accuracy.

DID, IDI and MLIT has held a meeting on 28th September 2022 to discuss the early findings and results of the testing programme. The analysis result shows that there are big difference between water level data for DID WLG, 3L WLG and stick gauge. The conclusion and decision of the meeting are as follows:

i. Possible causes of differences in observed values is due to the initial value setting of 3L WLG elevation. 3L WLG elevation values were set by each company based on stick gauge at Sentul Station and GPS surveying, however the surveying accuracy may vary and effected by parallax error;

ii. Propose solution is to do correction (tuning) for the elevation value of each 3L WLG based on DID WLG observation data. The DID WLG elevation data will be used as basis (reference) for tuning the 3L WLG; and

iii. The test observation period for 6 month starts from October 2022 until March 2023.

The 3L WLG consist of 2 different types of sensor which is Radar and Ultrasonic. The water level of all the 3L WLG were configured and set based on DID water level gauge. While the DID water level gauge is using stick gauge as a reference level. By using this method, fair and square comparison is made because all the 3L WLG were refer to only one reference level. Then, all data received in DID server was compared between DID WLG and 3L WLG. During the early stage of data observation period, which is after all the 3L WLG successfully installed, the participant companies were unable to come again to Malaysia to set the zero (0) difference level between 3L WLG and DID WLG. Solution for this issue is by adding the correction value (offset value) to the observed data during that period of time.

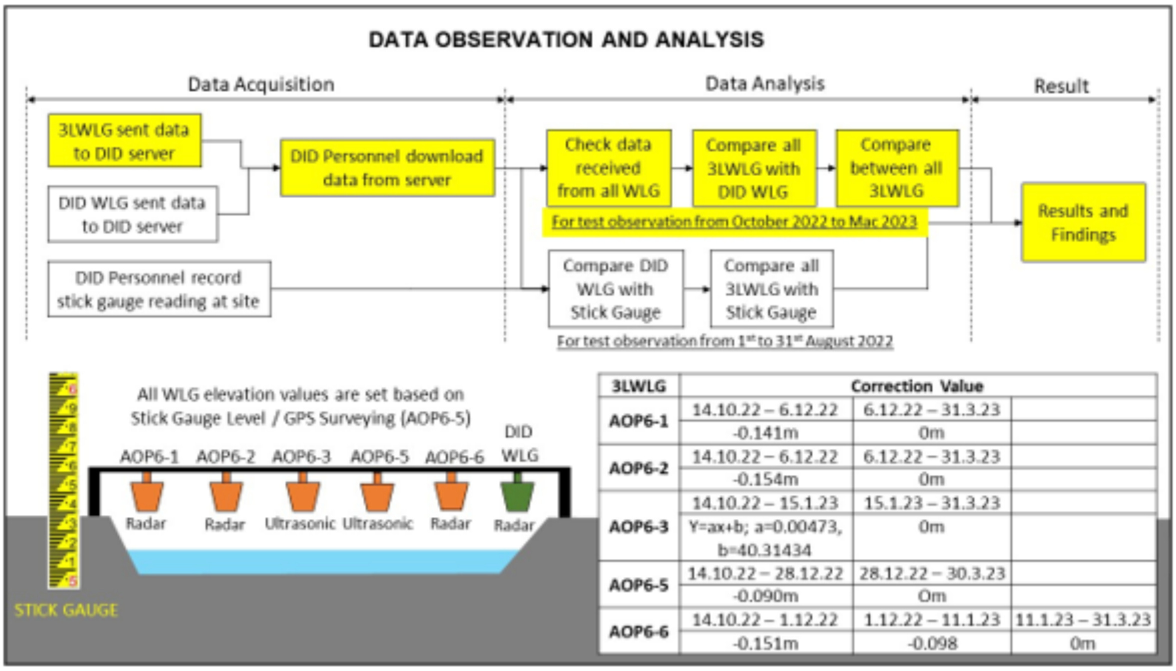


Figure 28: Data Observation and Analysis Flow Chart

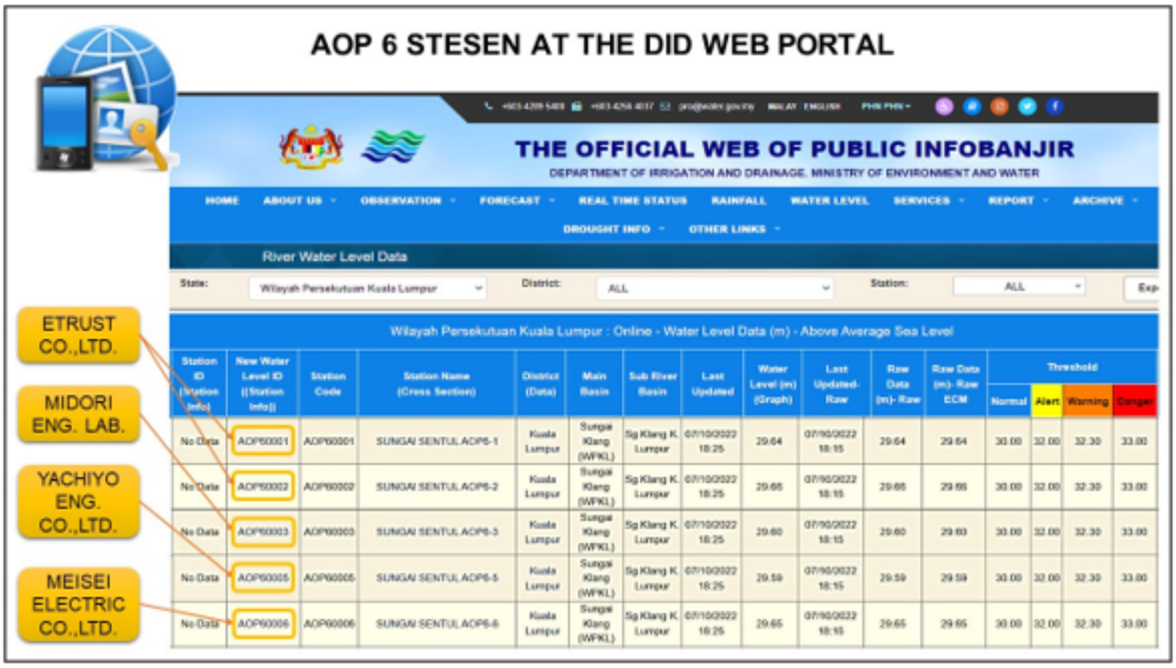


Figure 29: DID Web Portal for Flood Information and Hydrology Data

The analysis of data received at server has been done by checking number of files and data received at DID server. The analysis result is as shown in **Figure 30**. The acceptance criteria for percentage of data received is set to 95% and more. This acceptance criteria is also used in development project supervised by DID in accepting the hydrological station. Based on this criteria, the AOP6-1 and AOP6-2 were not meet the acceptance criteria which is the average data received is below than 95%. The root cause of low data transmission performances for these 2 AOPs is unidentified, and should be investigated. Meanwhile the transmission performance for AOP6-3 is satisfactory because the average data received is 96%. However, it contribute to 2 month low data transmission performance which is in January 2023 and Mac 2023. The AOP6-5 and AOP6-6 shows very good data transmission performance, where their percentage of data received is almost 100%.

DATA RECEIVED & MISSING ANALYSIS AT DID SERVER FROM OCTOBER 2022 TO MAC 2023

Month	AOP60001		AOP60002		AOP60003		AOP60005		AOP60006		DID WL	
	No. of Missing Data	% Received	No. of Missing Data	% Received	No. of Missing Data	% Received	No. of Missing Data	% Received	No. of Missing Data	% Received	No. of Missing Data	% Received
Oct 2022	251	97%	924	89%	17	100%	3	100%	0	100%	448	95%
Nov 2022	777	91%	654	92%	250	97%	177	98%	32	100%	0	100%
Dec 2022	351	96%	519	94%	291	96%	90	99%	20	100%	6	100%
Jan 2023	312	96%	354	96%	497	94%	48	99%	35	100%	6	100%
Feb 2023	635	92%	258	97%	351	96%	6	100%	3	100%	0	100%
Mac 2023	5908	29%	339	96%	579	93%	222	97%	6	100%	12	100%
TOTAL	8234	84%	3048	94%	1985	96%	546	99%	96	100%	472	99%

Highlighted with yellow, shows the percentage of data that have less than 95%.

Figure 30: Data Received Analysis Result

According to the analysis for compliance to DID data format, it can be concluded that data sent by all the 3L WLG is follow the DID data format, except for a few parameters. List of non-compliance data format is as shown on **Figure 31**. However, the data sent is acceptable for this test and observation programme due to the non-compliance items are not crucial for this testing programme. In order to fulfil the DID data format, it is possible for manufacturing companies to make some improvement in term of setting in their Data Logger/ RTU to ensure the data sent meet the DID data format.

COMPLIANCE OF DATA FORMAT

	$ - Start of message	Station Code	RTU I.D	Date and Time stamp	Nr – Normal, A1 – Rainfall Alarm, A2 – Water Level Alarm, A3 – RF and WL Alarm	Battery Voltage (V)	GSM/Comm – GSM/Comm signal strength (dbm or ASU : 0 to 33 integer)	Int_Bat – Internal battery voltage (V)	Solar Output (V)	WL_Alert threshold value (m)	WL_Warning threshold value (m)	WL_Danger threshold value (m)	WL1_Sensor ID	Water Level 1 in meter, +/- (m)	Hand-phone Officer 1 (PHN)	Station Name	Lat – Latitude	Long – Longitude	* - End of message
AOP60001	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No data	No data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AOP60002	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No data	No data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AOP60003	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No data	Wrong data send. Data send is battery voltage.	Yes	Yes	Yes	Yes	Yes	No data	No data	Yes	Yes	Yes
AOP60005	Yes	Yes	Yes	Yes	Send alert code 'A2', even the WL below alert threshold.	Yes	Yes	No data	Wrong data send. Data send is battery voltage.	Yes	Yes	Yes	Yes	Yes	No data	No data	Yes	Yes	Yes
AOP60006	Yes	Yes	Yes	Yes	Yes	Yes	Data send for 15th minute only. No data for 5th and 10th minute.	No data	No data	Yes	Yes	Yes	Yes	Yes	No data	No data	Yes	Yes	Yes

List of Non Compliance of Data Format:

1. No data for internal battery voltage, and solar output voltage.
2. The data sent for alert code 'A2', even the water level is below alert threshold (normal). The correct data is nr.
3. The data sent for internal battery voltage, and solar output voltage is battery voltage, which is wrong.
4. No data for Officer Handphone Number and Station Name.
5. Data of communication signal strength sent for 15th minute only, which is no data for 5th and 10th minute.

Figure 31: Data Format Analysis Result

Figure 32 below shows the result of comparison between the water level for 3LWLG and DID WLG. The average difference of water level between all 3LWLG and DID WLG are small which is from 0.16cm to 1.19cm. Even there are big water level difference up to 87.90cm, however the event for this big difference are rarely happens. This can be prove by small number of standard deviation, which means the water level difference are closely clustered around the average. In general, the water level difference are acceptable for this testing programme.

WATER LEVEL DATA COMPARISON BETWEEN 3LWLG AND DID WLG FROM OCTOBER 2022 TO MAC 2023

WATER LEVEL DIFFERENCE IN CM

Mth.	AOP60001				AOP60002				AOP60003				AOP60005				AOP60006			
	Min.	Max.	Ave.	σ	Min.	Max.	Ave.	σ	Min.	Max.	Ave.	σ	Min.	Max.	Ave.	σ	Min.	Max.	Ave.	σ
Oct 2022	-8.90	30.10	-0.01	0.02	-7.40	25.60	0.13	0.02	-7.89	13.03	1.47	0.03	-7.40	9.00	0.04	0.02	-9.50	7.60	-0.01	0.02
Nov 2022	-19.00	34.10	0.12	0.03	-21.50	28.40	-0.12	0.03	-15.40	12.68	0.98	0.04	-12.60	11.40	-0.15	0.02	-20.90	7.30	-0.23	0.03
Dec 2022	-13.90	23.10	0.83	0.02	-6.70	27.80	0.95	0.02	-6.50	13.20	2.00	0.03	-8.60	11.70	0.70	0.02	-11.30	8.20	0.55	0.02
Jan 2023	1.10	39.10	-0.93	0.02	1.00	49.30	-0.43	0.02	2.70	12.91	0.99	0.04	1.90	9.00	0.13	0.02	0.00	8.60	-0.82	0.02
Feb 2023	3.10	40.10	0.11	0.03	2.60	87.90	0.34	0.03	3.70	13.40	1.06	0.03	2.10	24.10	0.32	0.02	0.80	9.60	-0.24	0.02
Mac 2023	2.10	34.10	-1.20	0.03	1.00	42.90	0.10	0.02	4.70	12.90	0.64	0.04	1.60	14.10	0.08	0.02	-0.20	10.30	-0.58	0.02
Min.	-19.00				-21.50				-15.40				-12.60				-20.90			
Max.	40.10				87.90				13.40				24.10				10.30			
Ave.	0.18				-0.16				-1.19				-0.19				0.22			
σ	0.03				0.02				0.04				0.02				0.02			

Unit in CM
σ = Std. Dev.

- Average difference are small which is from 0.16cm to 1.19cm.
- Small number of standard deviation means the water level difference are closely clustered around the average.

Figure 32: Water Level Data Comparison

The analysis has also been carried out on battery voltage data for all 3L WLG during the test period. As shown in **Figure 33**, all 3L WLG show good battery performance and comparable with DID WLG. This result means that power supply system of 3L WLG are working well and can support the consumption for the entire test period.

BATTERY VOLTAGE OF 3LWLG AND DID WLG FROM OCTOBER 2022 TO MAC 2023

BATTERY VOLTAGE IN VOLT

Month	AOP60001			AOP60002			AOP60003			AOP60005			AOP60006			DID WLG		
	Min.	Ave.	Max	Min.	Ave.	Max	Min.	Ave.	Max	Min.	Ave.	Max	Min.	Ave.	Max	Min.	Ave.	Max
Oct 2022	12.70	13.02	14.20	12.90	13.29	14.40	12.90	13.25	14.50	12.60	12.96	13.90	12.90	13.48	14.70	12.64	13.31	14.33
Nov 2022	12.60	12.99	14.10	12.90	13.28	14.30	13.00	13.26	14.40	12.60	12.98	13.90	12.90	13.44	14.70	12.62	13.28	14.29
Dec 2022	12.60	12.96	14.10	12.90	13.27	14.30	13.00	13.26	14.40	12.60	12.98	13.90	12.90	13.42	14.70	12.59	13.26	14.29
Jan 2023	12.50	12.96	14.20	12.90	13.27	14.40	12.90	13.25	14.50	12.60	12.99	14.00	12.90	13.44	14.70	12.59	13.27	14.29
Feb 2023	11.80	12.74	14.10	12.90	13.25	14.40	12.90	13.23	14.40	12.60	12.96	14.00	12.90	13.41	14.70	12.55	13.25	14.34
Mac 2023	11.80	12.31	14.00	12.90	13.25	14.40	12.90	13.23	14.40	12.60	12.93	13.90	12.90	13.46	14.70	12.53	13.30	14.33
Ave.	**12.33**	**12.83**	**14.12**	**12.90**	**13.27**	**14.37**	**12.93**	**13.25**	**14.43**	**12.60**	**12.97**	**13.93**	**12.90**	**13.44**	**14.70**	**12.59**	**13.28**	**14.31**

All 3LWLG show good battery performance and comparable with DID WLG.

Figure 33: Battery Voltage Data Comparison

Conclusion

After going through of long planning and the implementation delayed due to the Covid-19 endemic, the 3L WLG testing programme has started after all five set of (5) WLG have been successfully installed by four (4) participating companies at the Sentul Hydrology Station, Kuala Lumpur. Data analysis has been completed, therefore findings and results can be summarize as follow;

a. The data sent comply with DID data format, however it is incomplete because there are few parameters that are not sent such as Alert Code, Internal Battery Voltage, Solar Output, and Officer Phone Number. The data format comparison result is accepted for this test programme purposes only since the incomplete parameters are not affecting data analysis processes;

b. Data transmission performance for AOP6-1 and AOP6-2 can be concluded as unsatisfactory judging by DID acceptance criteria for telemetry station development, which is 95% threshold value for data availability. Data transmission performances for other three 3L WLG are satisfactory, with particularly good results for AOP6-5 and AOP6-6. The root cause of low data transmission performances for AOP6-1 and AOP6-2 compared with other 3L WLG is unidentified, and should be investigated;

c. The average difference of water level between 3L WLG and DID WLG is small which is around 0.16cm to 1.19cm. Small value of standard deviation means that the water level difference are closely clustered around the average, indicating less variability or dispersion. In summary, dataset of water level difference are very consistent with the average (mean) value;

d. The battery voltage for all 3L WLG are consistent throughout the testing period. The result shows that they have good battery performance and comparable with DID WLG; and

e. All 3L WLG are comparable with DID WLG. However, in evaluating the water level gauge station in project development supervised by DID, usually there are four (4) process of evaluation should be done before it can be accepted, which are:

    i. Product/ material spesification check;

    ii. Testing of mockup station at DID testing facility at Ampang Kuala Lumpur, before the deployment work at site;

    iii. Pre-test by the contractor, after deployment work at site; and

    iv. Testing and commissioning, for final acceptance.

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

1. Deep learning techniques such as *conv-lstm*, or *traj-gru* which can predict the future evolution of radar images, could be studied as a nowcasting tool, and compared with the proven method of optical flow for radar extrapolation.
2. Radar nowcasting can include radar observation which is gauge-calibrated (adjusted closer to gauge rainfall as ground truth), and/or integrated with satellite data (enhanced coverage).
3. The challenges in implementing this hydrology project can be categorized into 3 forms namely:
   i. Determination of technical specifications of hydrological and communication equipment to meet the operational requirements in Malaysia;
   ii. Method of installation and data sharing; and
   iii. The current scenario related to Covit'19 which makes it difficult to implement physical projects.

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

- 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.
- Enhance training activities with TRCG, WGH, and WGDRR in accordance with Typhoon Committee forecast competency, knowledge sharing, and exchange of latest development and new techniques.

DRR

- Enhance Members' disaster risk reduction techniques and management strategies.

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	

Priority Areas Addressed:

Hydrology

Ensure complete and consistent hydrological data in a various weather condition. Hydrological data is a key input in flood modeling that has a significant impact on the accuracy of the flood forecast result. Hydrological data especially rainfall and water level can measure the flood condition and also flood warning. The robust and reliable instrumentation for collecting hydrological data is crucial for flood forecasting and monitoring.

Contact Information:

Member: **Malaysia**

Name of contact for this item: Mr. Hamray bin Muhammd Yazit

Telephone: (603) 7954 2146 (ext 100)

Email: hamray@met.gov.my

Name of contact for this item: Ir. Dr. Norlida binti Mohd Dom

Telephone: 03-42895585

Email: norlidamd@water.gov.my

Name of contact for this item: Ir. Surdiman Zahuri bin Sulaiman

Telephone: 03-42895544

Email: surdiman@water.gov.my