MEMBER REPORT
(MALAYSIA)

ESCAP/WMO Typhoon Committee
15th Integrated Workshop
Video Conference

1-2 December 2020
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I. Overview of tropical cyclones which have affected/impacted Malaysia in 2020

1. Meteorological Assessment (highlighting forecasting issues/impacts)

During the period of 1 November 2019 to 31 October 2020, 27 tropical cyclones (TCs) formed over the Western Pacific Ocean, the Philippines waters as well as the South China Sea. Eight of the TCs entered the area of responsibility of the Malaysian Meteorological Department (MET Malaysia) as shown in **Figure 1**. The TCs, which consisted of seven typhoons and a tropical storm that required the issuance of strong winds and rough seas warnings over the marine regions under the responsibility of MET Malaysia, are listed in **Table 1**. The presence of these TCs over the southern South China Sea could either bring heavy thunder showers or fair and dry weather conditions depending on the location of the TCs' track over the large water bodies and also the extension of the TCs' rain bands. In addition, the lines of thunderstorms or squalls accompanied by strong gusty winds had resulted in widespread intense rainfall over Malaysia.

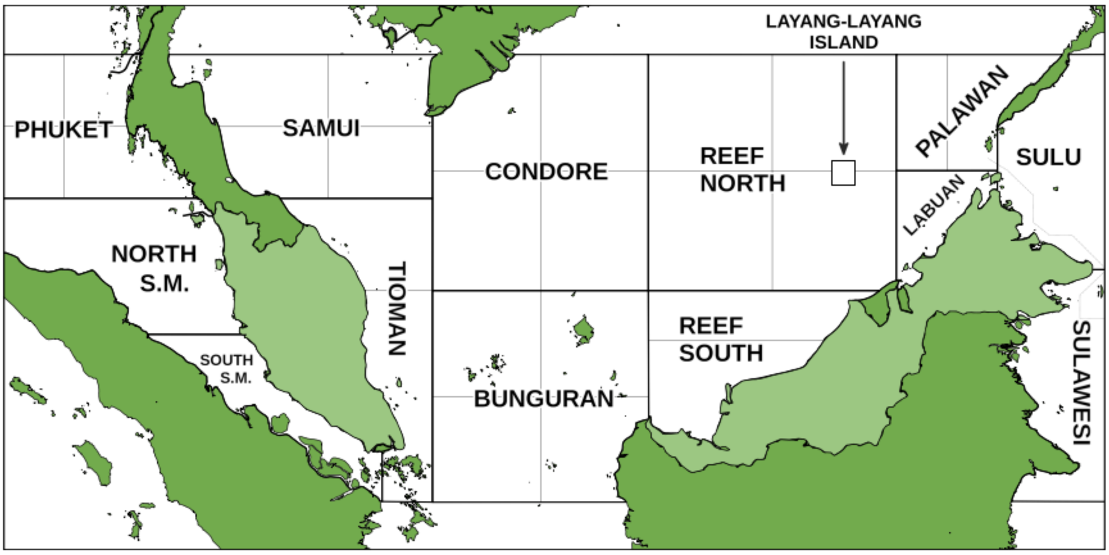


Figure 1: Map of Malaysia area of responsibility waters

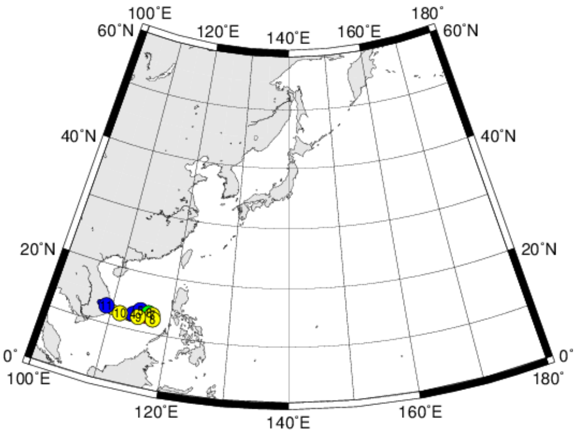
High waves accompanied with storm surges had also affected the Malaysian coastal areas facing the South China Sea and Sulu Sea during the formation and passage of the TCs. Strong winds and rough seas warnings for the

Malaysian waters, South China Sea and Sulu Sea were issued during the passage of these TCs.

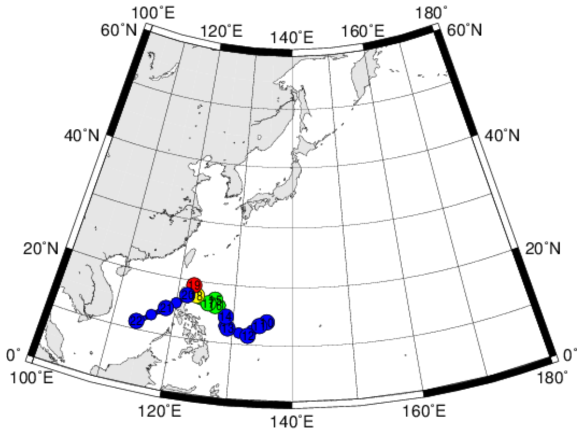
Table 1: **List of typhoons and tropical storms with JTWC classification, date of birth and death and maximum wind from November 2019 to October 2020**

No.	Tropical Cyclone	JTWC Classification	Date		Maximum wind (knots)
			Birth	Death	
a.	Nakri	Typhoon	5/11/2019	11/11/2019	65
b.	Kalmaegi	Typhoon	14/11/2019	20/11/2019	70
c.	Kammuri	Typhoon	26/11/2019	5/12/2019	90
d.	Phanfone	Typhoon	22/12/2019	28/12/2019	80
e.	Vongfong	Typhoon	12/5/2020	16/5/2020	85
f.	Noul	Tropical Storm	15/9/2020	18/9/2020	50
g.	Molave	Typhoon	24/10/2020	29/10/2020	85
h.	Goni	Typhoon	28/10/2020	5/112020	120

The trajectories of the eight TCs closest to Malaysia are illustrated in **Figure 2**.



NAKRI



KALMAEGI

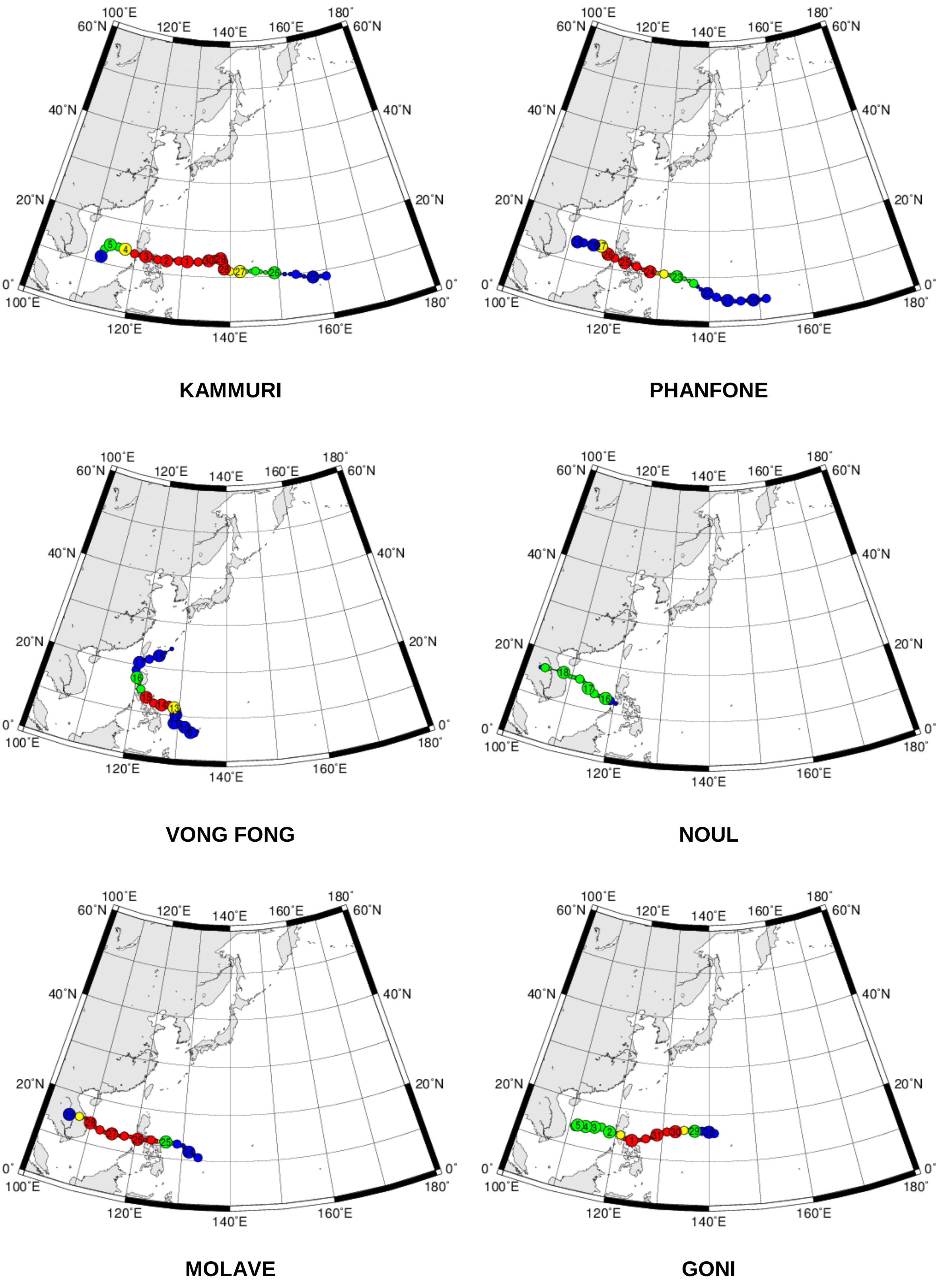
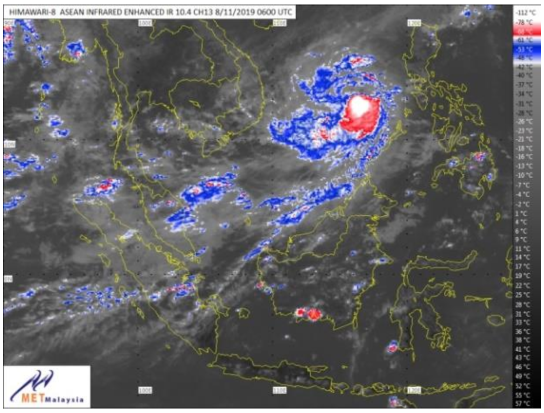
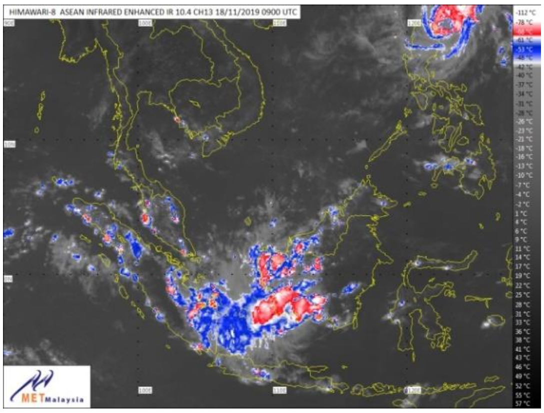


Figure 2: Tracks of eight TCs relatively close to Malaysia waters for the period November 2019 to October 2020. The circled numbers represent the date of occurrence of the TCs (Source: National Institute of Informatics (NII), Research Organization of Information and Systems (ROIS), Japan [(http://agora.ex.nii.ac.jp/digital-typhoon/latest/track)](http://agora.ex.nii.ac.jp/digital-typhoon/latest/track).

The impacts of TCs over the Malaysian region were restricted to rainfall events and gusting due to the tail effect of the TCs. The tail effect was generally responsible for enhancing the afternoon convective weather over Malaysia, especially over northern Peninsular Malaysia, Sabah and coastal Sarawak. The satellite imageries of rain cloud clusters centred upon the Malaysian region during the transits of TCs close to Malaysia are shown in **Figure 3** and were derived from the HIMAWARI-8 Enhanced Infrared and Feng Yun FY-2G satellites.



NAKRI
Image produced by MET Malaysia at 06:00UTC 8/11/2019



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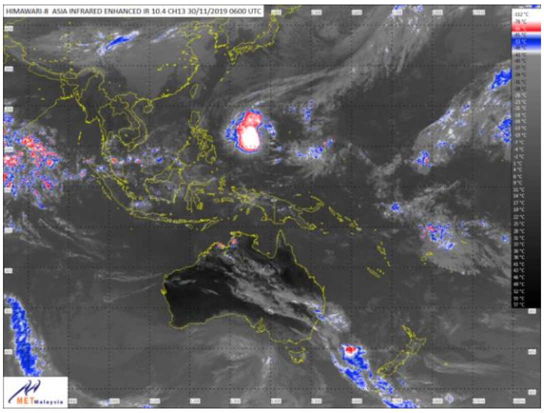

KAMMURI
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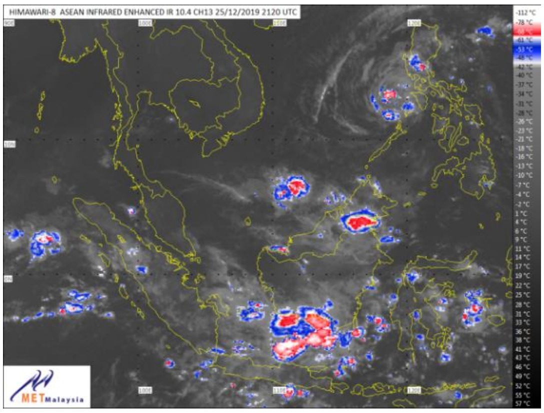
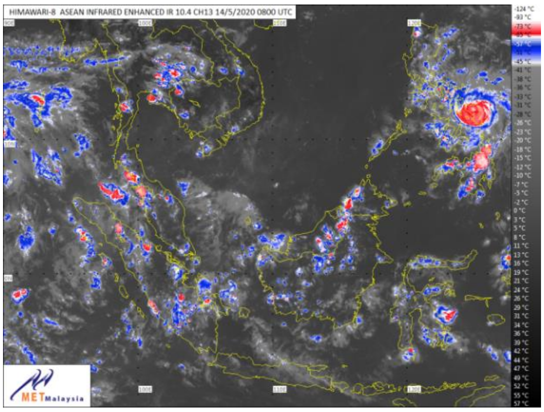
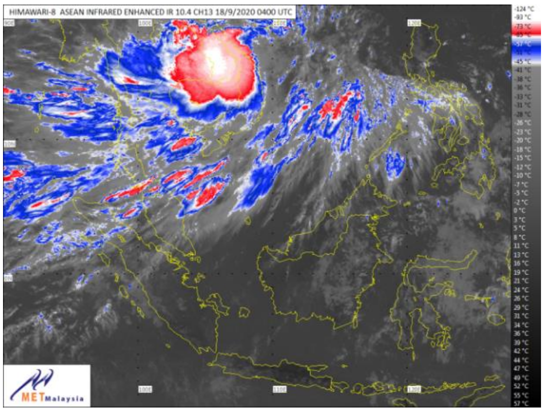


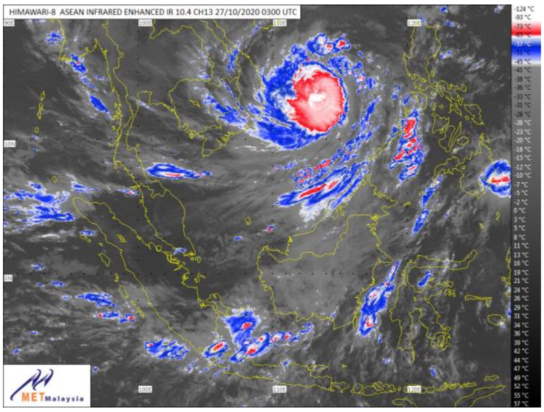
PHANFONE
Image produced by MET Malaysia at 21:20 25/12/2019



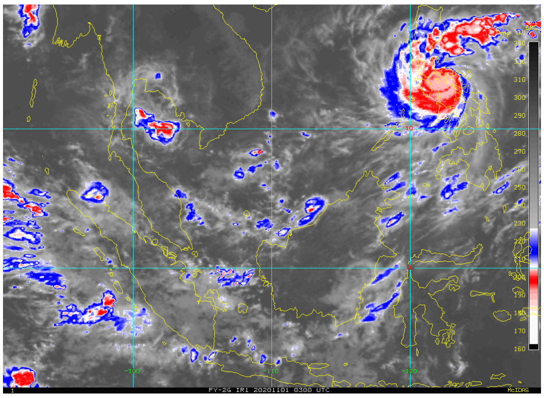
VONG FONG
Image produced by MET Malaysia at 08:00UTC 14/05/2020



NOUL
Image produced by MET Malaysia at 04:00UTC 18/09/2020



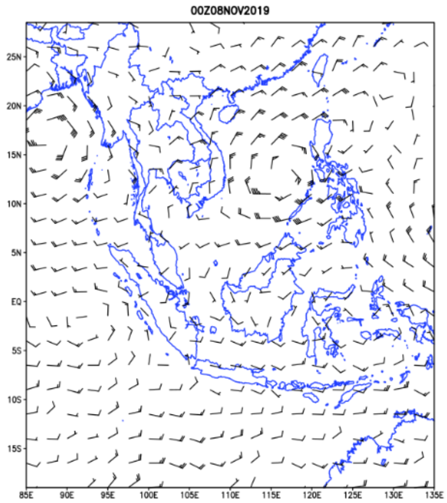
MOLAVE
Image produced by MET Malaysia at 03:00UTC 27/10/2020



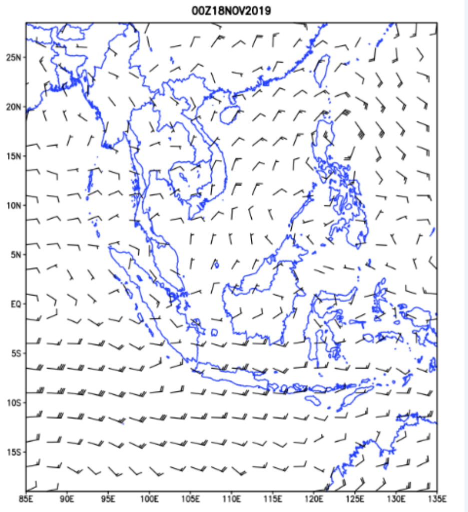
GONI
Image produced by MET Malaysia at 03:00UTC 31/10/2020

Figure 3: **HIMAWARI-8 Enhanced Infrared Scale and Feng Yun FY-2G satellite imageries showing the rain cloud clusters associated with some of the selected TCs over the Malaysian region**

These TCs were not the only factors that contributed to heavy rainfall in Malaysia. The monsoon surge also had brought heavy rainfall to parts of Malaysia. In addition to strong winds and heavy rainfall, high waves accompanied with storm surges had also affected the Malaysian coastal areas facing the South China Sea and Sulu Sea. **Figure 4** illustrates the wind flow at 850hPa atmospheric pressure level during the transits of TCs closest to Malaysia. The charts were derived from the Global Forecast System (GFS) analysis.



NAKRI
Image produced by MET Malaysia at 00UTC
8/11/2019



KALMAEGI
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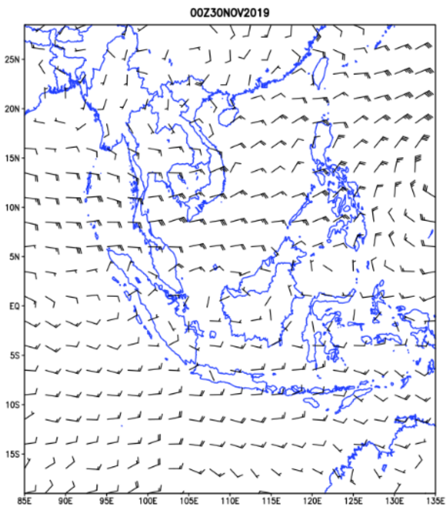
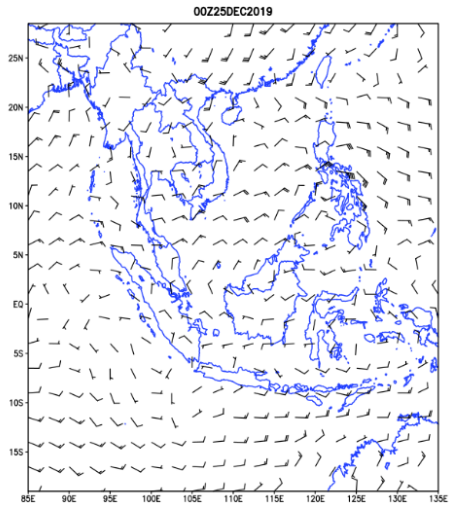
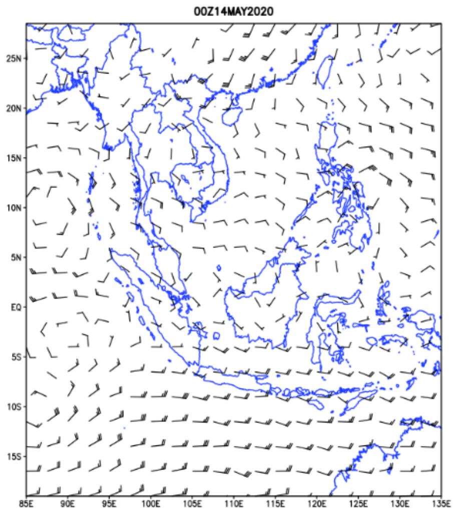
18/11/2019



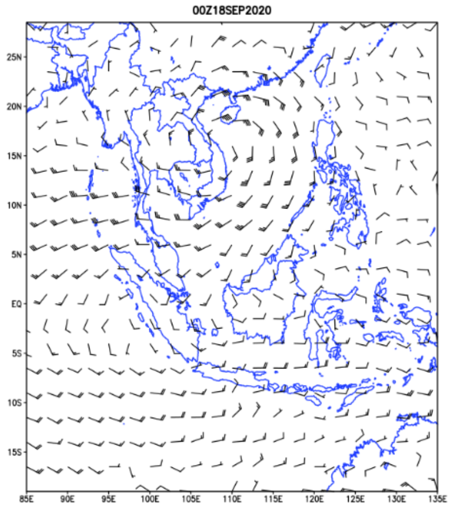
KAMMURI
Image produced by MET Malaysia at 00UTC
30/11/2019



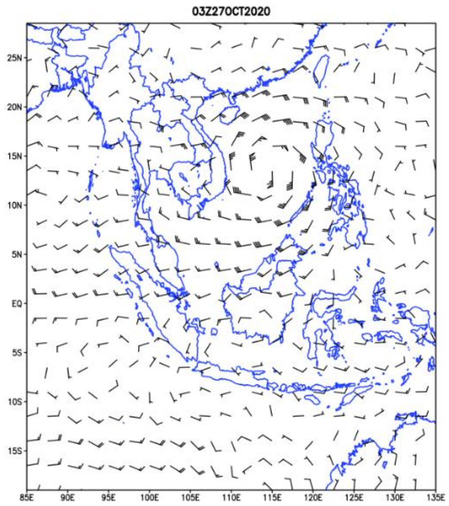
PHANFONE
Image produced by MET Malaysia at 00UTC
25/12/2019



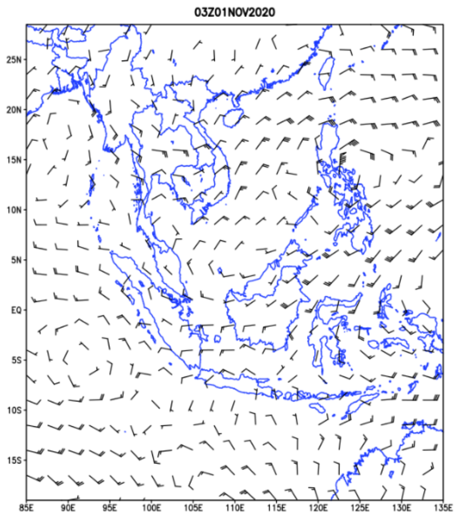
VONG FONG
Image produced by MET Malaysia at 00UTC 14/05/2020



NOUL
Image produced by MET Malaysia at 00UTC 18/09/2020



MOLAVE
Image produced by MET Malaysia at 03UTC 27/10/2020



GONI
Image produced by MET Malaysia at 03UTC 31/10/2020

Figure 4: **850 hPa wind charts from the GFS showing wind patterns during the passage of TCs**

Daily rainfall charts of selected meteorological stations in northern and east coast of Peninsular and East Malaysia were used to depict rainfall events induced by the tail effect of TCs. The daily rainfall charts for the months of November and December 2019 as well as May, September and October 2020 are shown in **Figures 5a to 5j**.

The qualitative analysis of satellite imageries as well as daily rainfall charts had revealed that the rain cloud bands are associated with the TCs over Malaysia. However, the rainfall charts for November and December 2019 clearly show a significant amount of rainfall was observed over north and east coast of Peninsular Malaysia. The enhanced rainfall intensity over East Malaysia coincided with the passage of Typhoon Kalmaegi and Typhoon Kammuri.

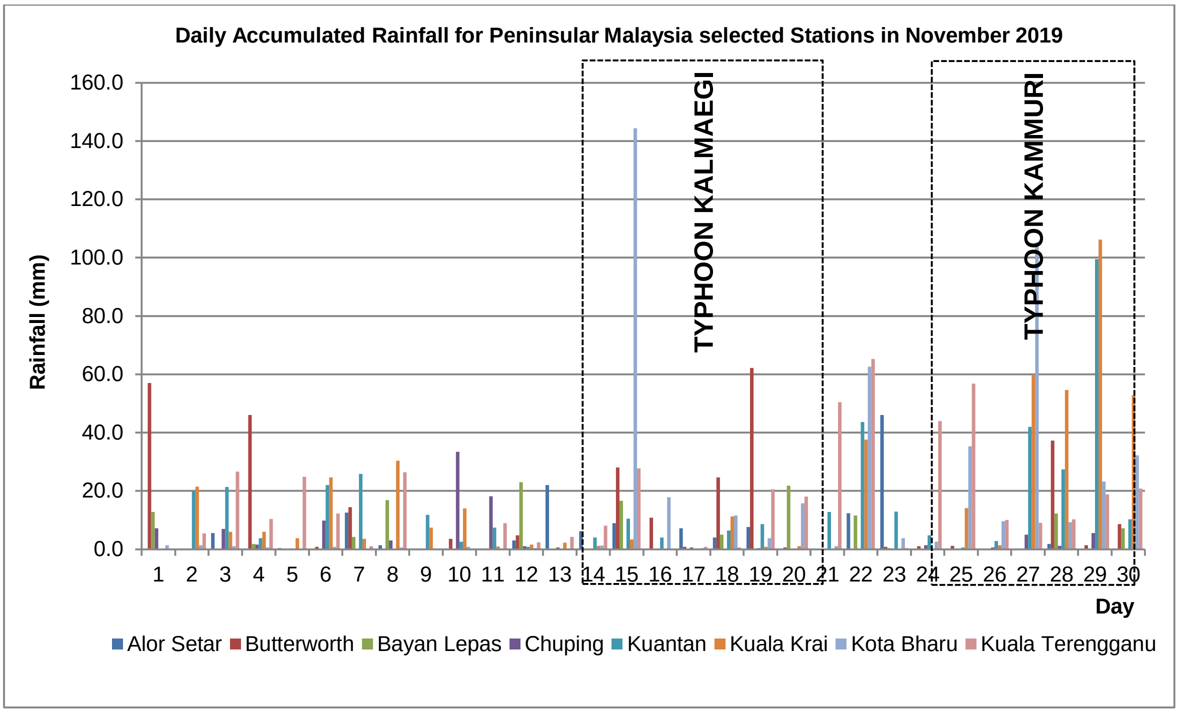


Figure 5a: **Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for November 2019**

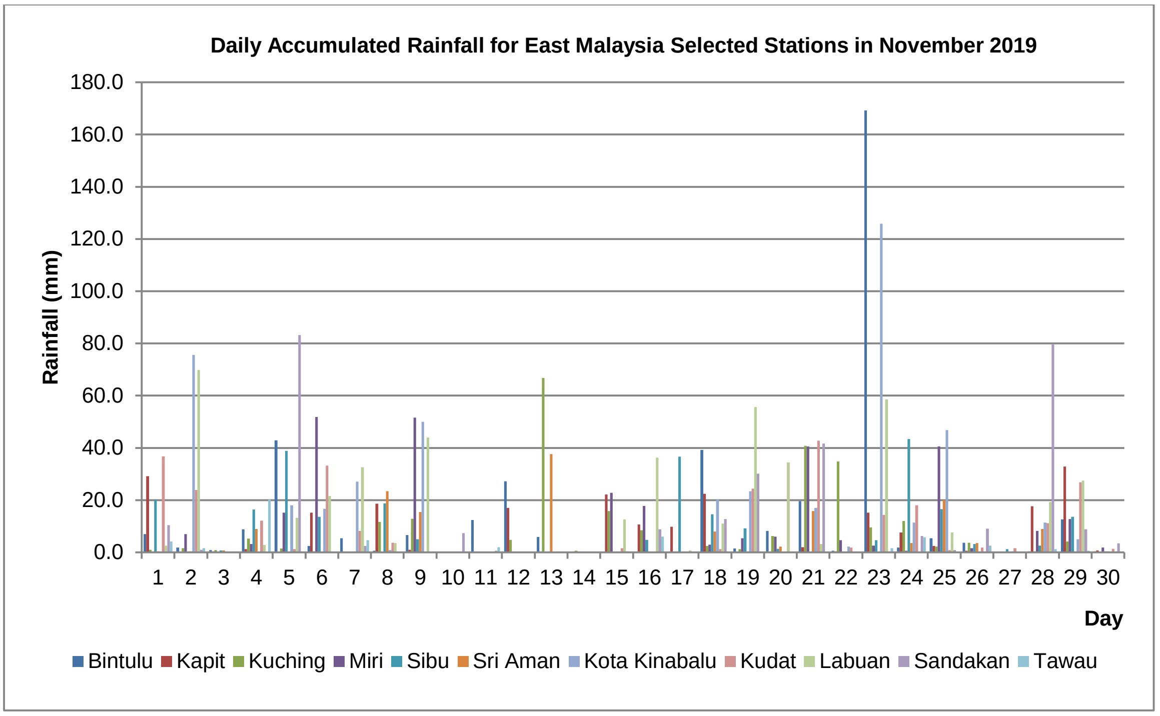


Figure 5b: **Daily rainfall chart of selected meteorological stations in East Malaysia for November 2019**

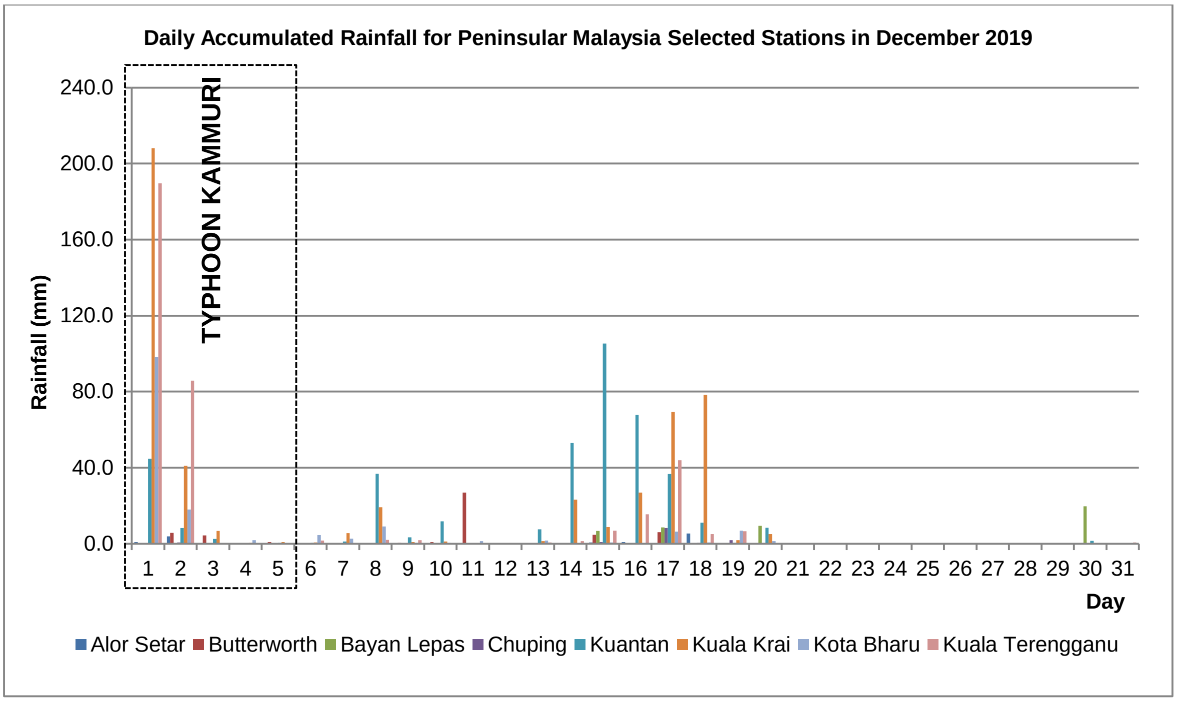


Figure 5c: **Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for December 2019**

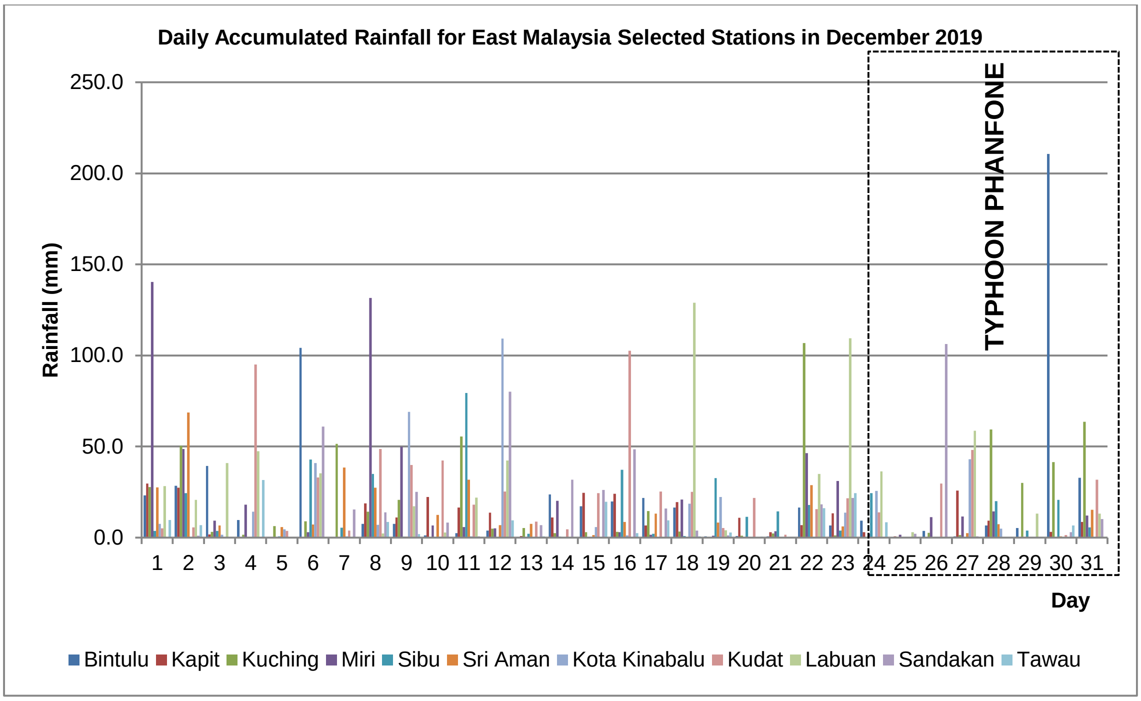


Figure 5d: **Daily rainfall chart of selected meteorological stations in East Malaysia for December 2019**

On May 14, Typhon Vong Fong made its first landfall and gradually weakened and affected the rainfall over northern parts of Peninsular Malaysia.

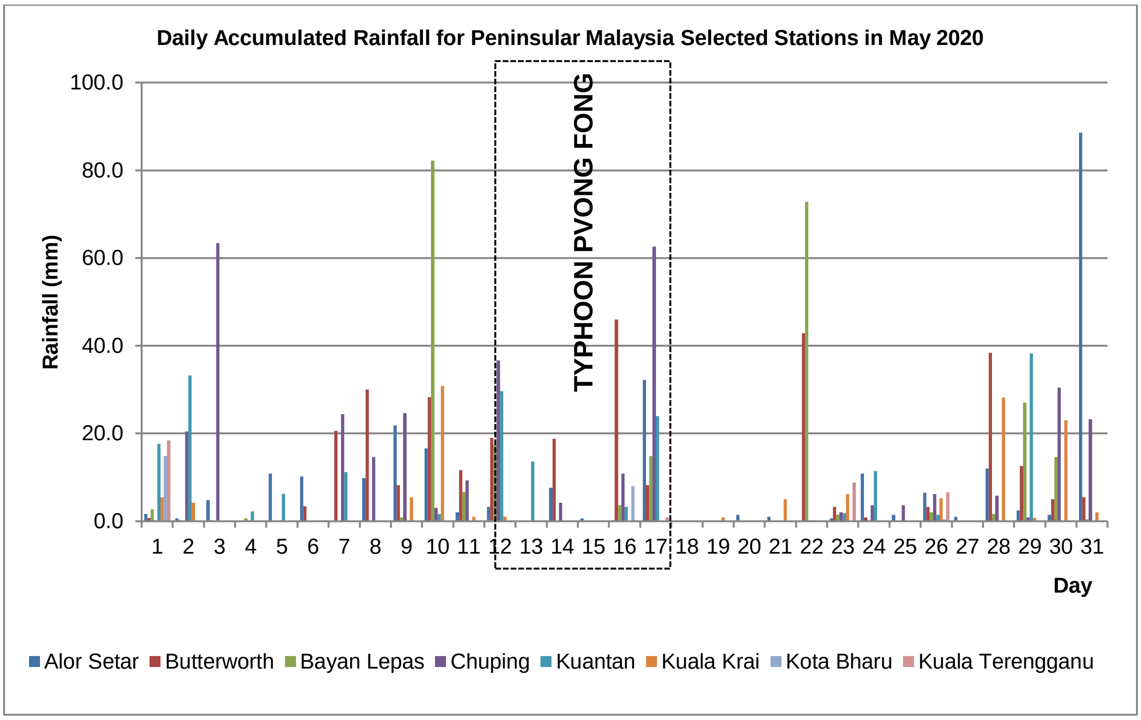


Figure 5e: **Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for May 2020**

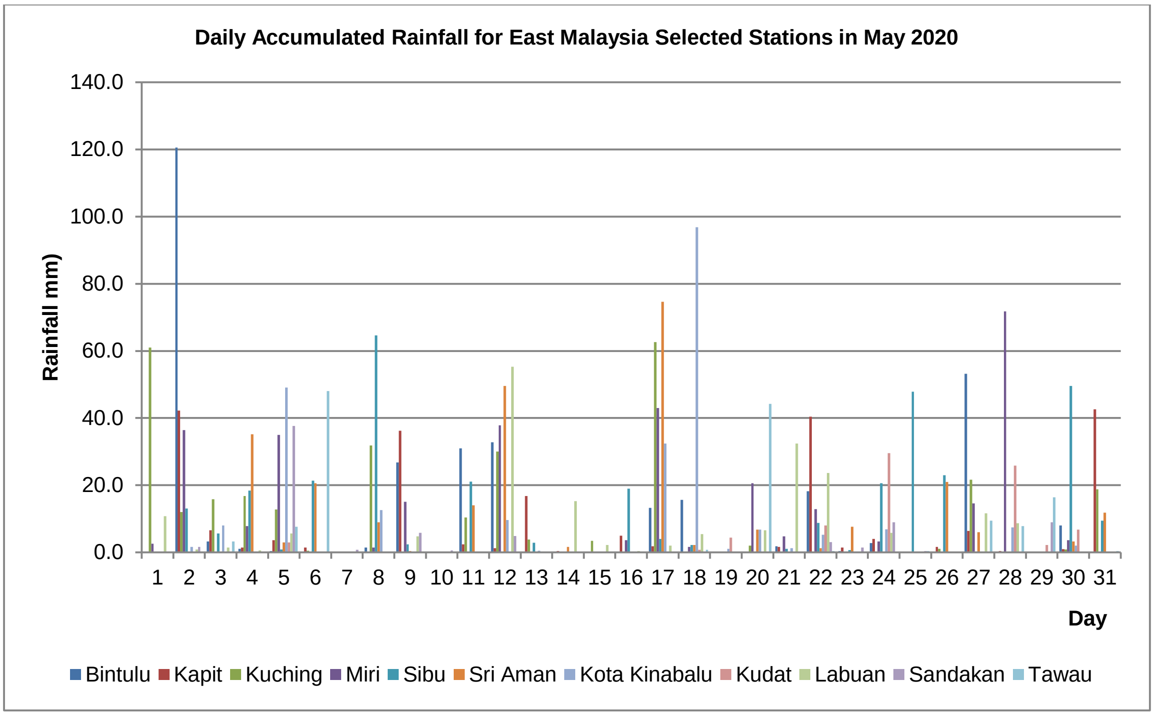


Figure 5f: Daily rainfall chart of selected meteorological stations in East Malaysia for May 2020

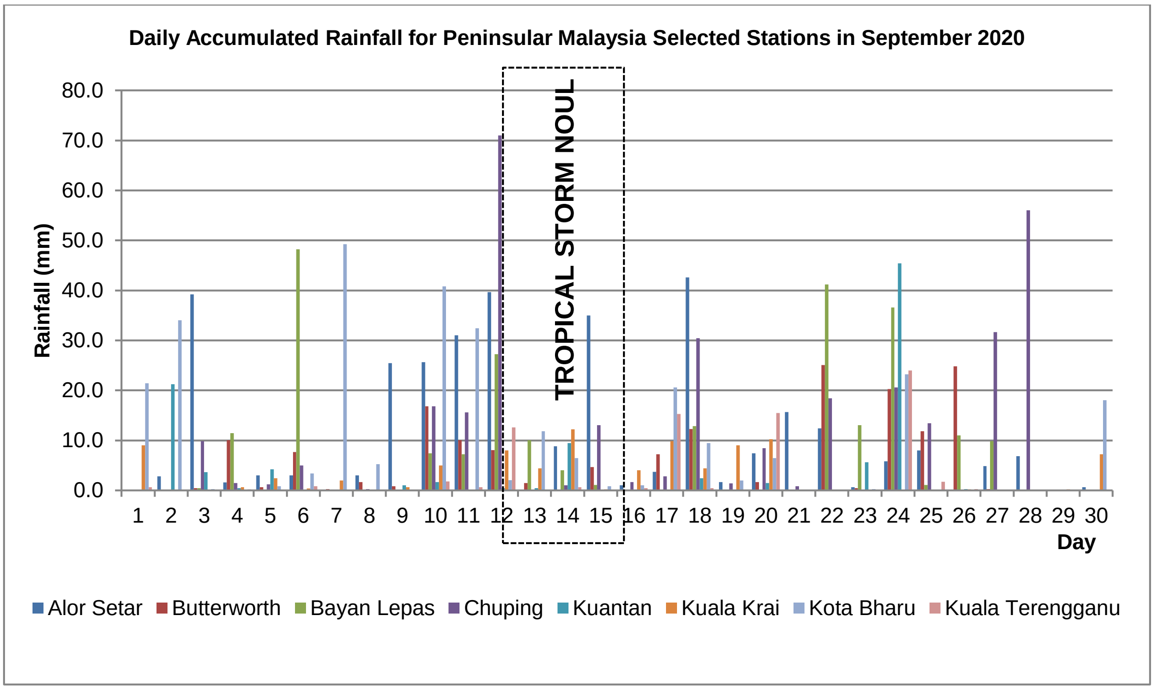


Figure 5g: Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for September 2020

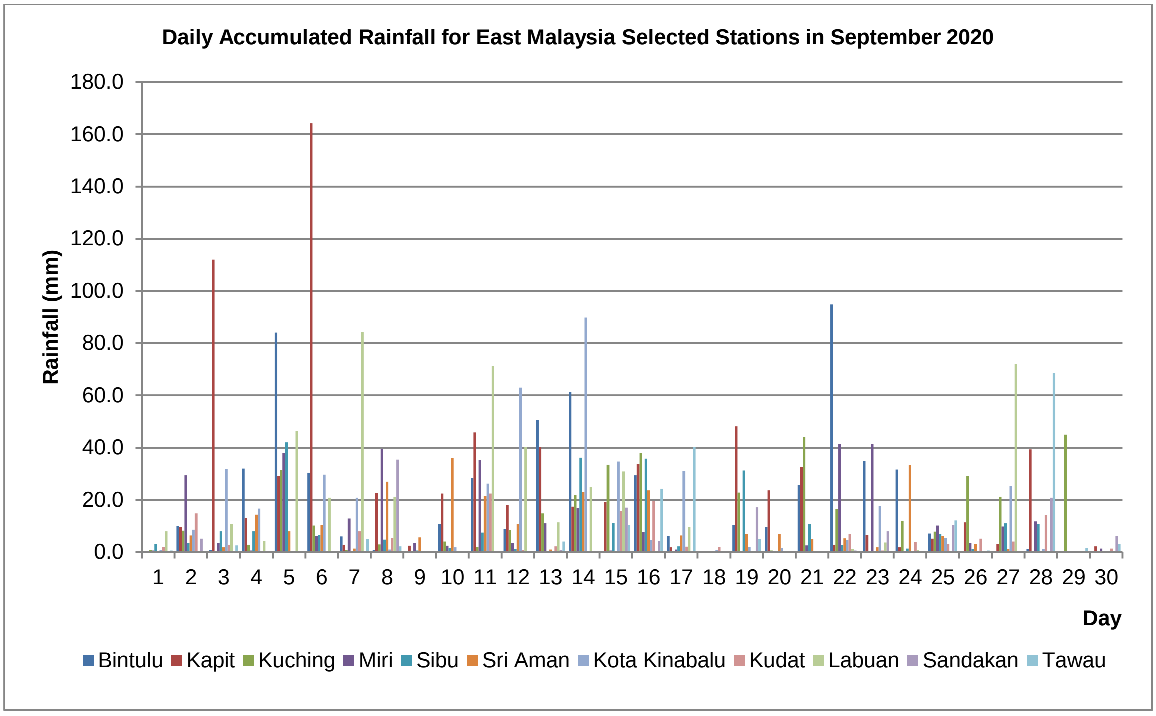


Figure 5h: Daily rainfall chart of selected meteorological stations in East Malaysia for September 2020

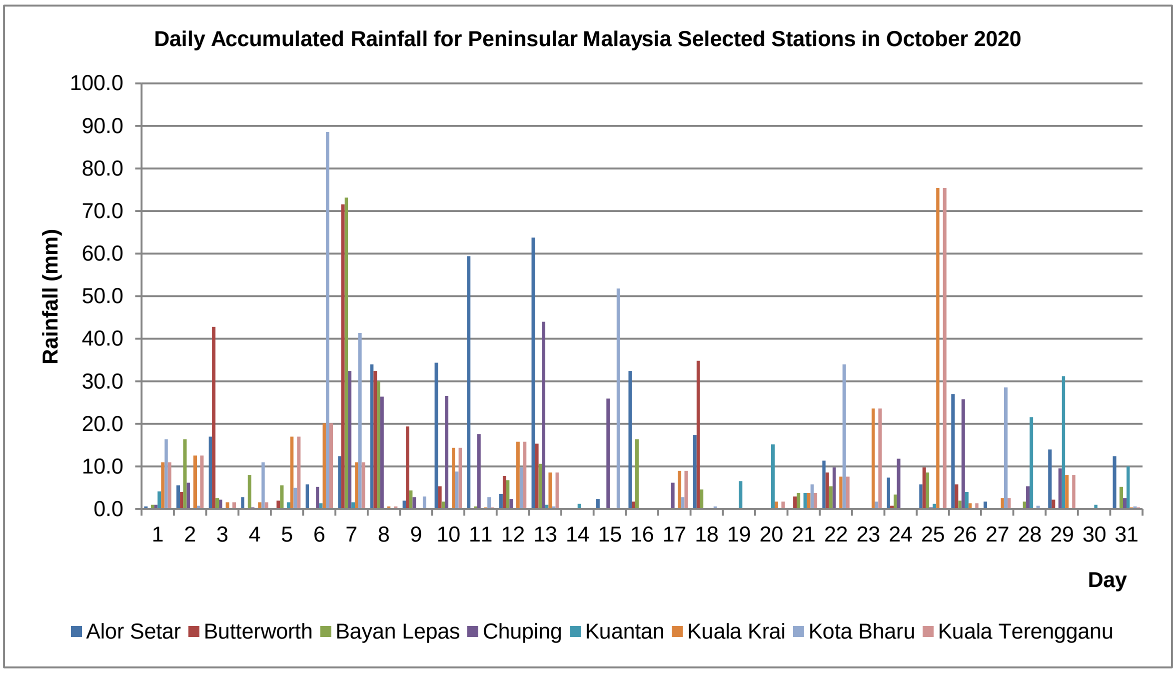


Figure 5i: **Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for October 2020**

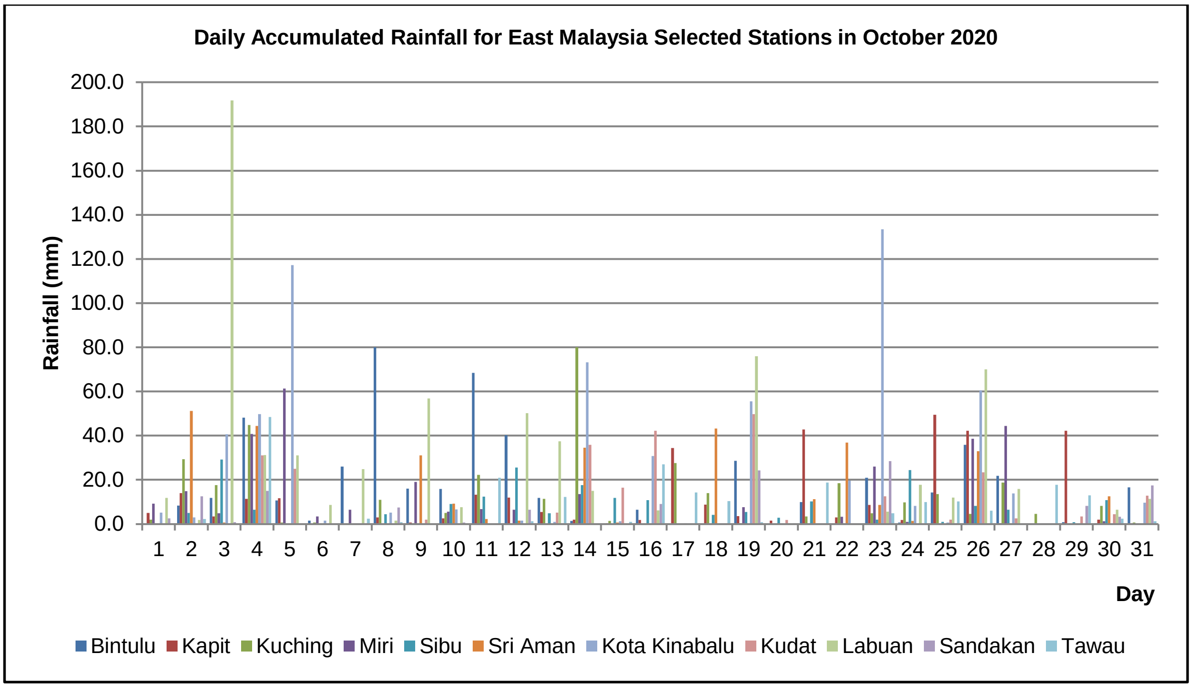


Figure 5j: **Daily rainfall chart of selected meteorological stations in East Malaysia for October 2020**

2. Hydrological Assessment (highlighting water-related issues/impact)

(a) Flash flood in Kajang on 18 July 2020 & Kuala Lumpur on 10 September 2020

Flash flood in Malaysia represents more than 90% of total flood events. Since 2001, in average 190 flood events occurred every year. Normally, the flash flood concentrates along the west coast of Peninsular Malaysia covering 9 states, nevertheless there was several flash flood events in Sabah and Sarawak. In the year 2020, a numbers of flash flood recorded, however two flash flood events gave major impact to the peoples and properties. The flash occurred on 18 July 2020 at Kajang Town Centre and 10 September 2020 at Kuala Lumpur City Centre.

(i) Flash Flood in Kajang Town, 18 July 2020

Kajang town and its surroundings are among the fastest growing urban areas in the Sungai Langat basin, located in the State of Selangor about 30 km south of Kuala Lumpur city center. Sungai Langat is located in the southern part of Selangor and north of Negeri Sembilan. The length of Sungai Langat is 78 kilometers and the catchment area is 2,350 square kilometers. Sungai Langat starts from the Titiwangsa mountains on Mount Nuang and it flows west to the Straits of Melaka. The main tributaries of Sungai Langat are Sungai Semenyih, Sungai Labu and Sungai Beranang. There are two dams in the upper reaches of the Langat river, namely the Semenyih Dam with a catchment area of 56.7 square kilometers and a langat dam of 41.1 square kilometers.

Flooding in some places in the city is a very common problem while pollution in rivers and drainage systems in this area is getting worse day by day. The area has grown exponentially in recent years where agricultural land has been transformed into residential, commercial and industrial uses.

On Saturday, 18 July 2020, there was very heavy rain in the afternoon to night which resulted in a huge flash flood in some areas in the Hulu Langat district. Heavy rain occurred twice (2) times, the first is between 3:30 pm to 4:30 pm and the second is between 6:15 pm to 8:00 pm.

The weather warning status in Hulu Langat district on the day of the incident is as **Figure a-1** and **Figure a-2**.

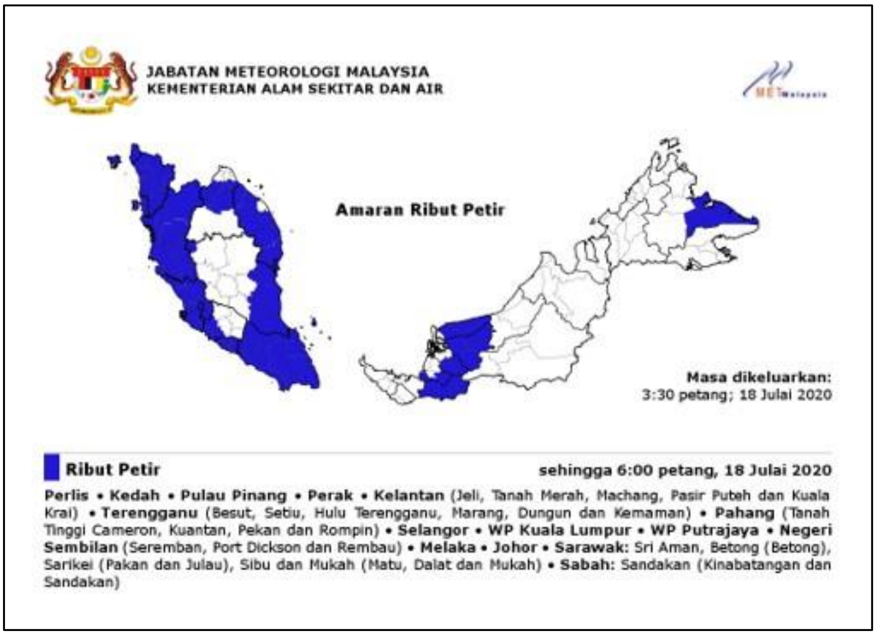


Figure a-1: Thunderstorm warning in 18 July 2020, 15:30 by MET Malaysia

Figure a-2: Thunderstorm warning on 18 July 2020, 17:35 by MET Malaysia

Based on the Malaysian Meteorological Department (MET Malaysia) rain radar observations, the rain started at a moderate level at 3.30 pm. The rainfall rate then increased until the peak of the rainy season at 6.30 pm and stopped at 11.30 pm. Based on radar images during peak rainfall, the estimated rainfall readings are 20-50mm per hour for a period of l2 hours. The radar images are shown in **Figure a-3**.

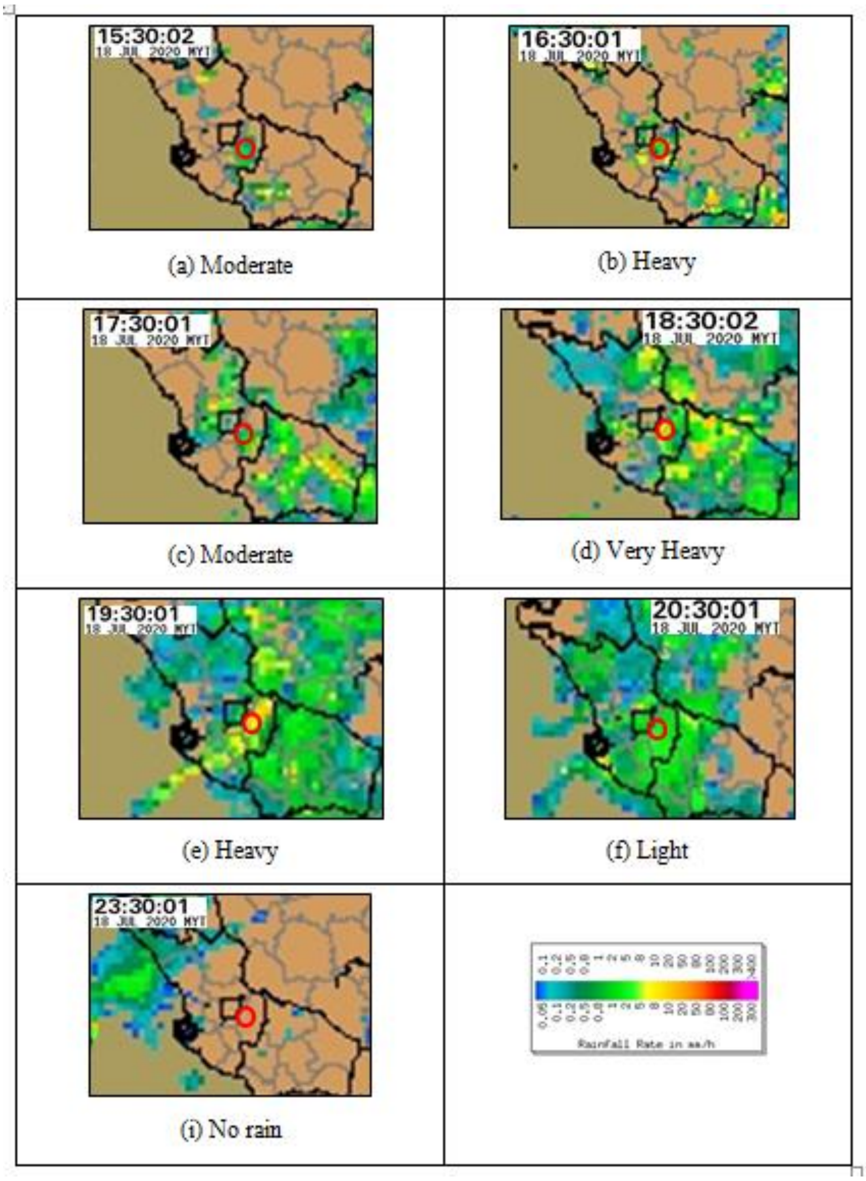


Figure a-3: Rain radar image on 18 July 2020 for the period 15:30 to 23:30

Rainfall Record and Analysis

Rainfall depth for five rainfall station in the Langat river basin was used for the analysis. The maximum rainfall in various time duration (1hr, 2hr, 3hr, and 6hr) is tabulated in **Table a-1**. The table shows four stations recorded more than 100mm in 6hr rainfall which is Sg. Kantan station give maximum reading at 195.5mm. This reading is estimated to be equivalent to 260 years of return period. Apart from that, Kajang station has also recorded the second highest reading with an estimated 100 year return period. In addition to this reading, West Country stations have recorded very unusual rainfall for the first 2 and 3 hours with an estimated return period of more than 100 years return period, respectively. These readings explained the unusual rainfall occurred in the Langat river basin caused very worse flood.

Table a-1: Maximum rainfall and the return period recorded on 18 July 2020 from 2.00 pm to 12.00 am

Station Name	District	Maximum Rainfall				Return Period (Year)			
		1-hr	2-hr	3-hr	6-hr	1-hr	2-hr	3-hr	6-hr
Kg.Pasir	Hulu Langat	19.0	35.5	40.5	54	<2	<2	<2	<2
Batu 9 Sg.Raya	Hulu Langat	52.5	75.0	79.0	103.0	<2	2	2	4
Sg Kantan	Hulu Langat	71.0	111.0	146.0	195.5	5	28	91	> 100
Kajang	Hulu Langat	74.5	112.5	135.5	167.5	8	34	62	100
West Country	Hulu Langat	86.0	142.0	150.0	157.5	18	>100	>100	68

River Water Level Analysis

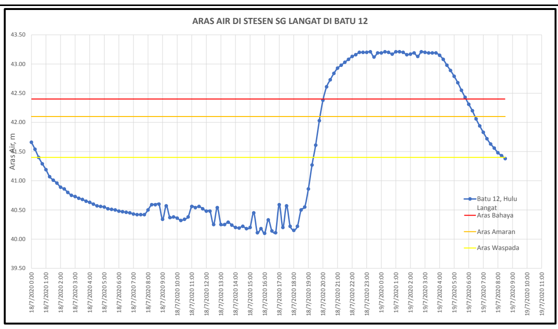
There are numbers of water level station along the Langat river, however, only 5 stations located in the area of flooding. The lists of water level stations are:

- Batu 12 station
- Batu 9 station
- Sg Kantan station
- Kajang station
- West Country station

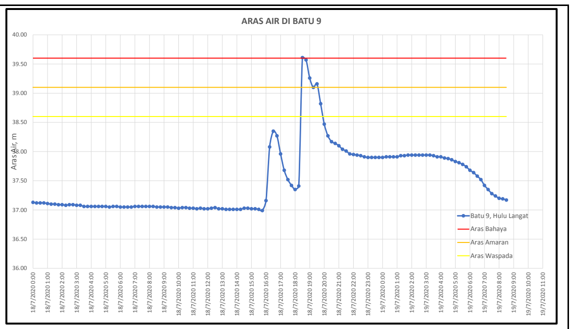
The graph of the water level for each station is plotted in **Figure a-4**.

Based on **Figure 4**, Kajang and West Country Water Level stations recorded the highest level readings above the danger levels of 1.2m and 1.21m, respectively. Meanwhile, Batu 12 station at the upper part of Sungai Langat recorded 0.81m from the danger level. Sg Kantan Station and Batu 9 Station only hit the danger level. Based on this record, is proven the areas that experience severe flooding are in Kajang Town and West Country areas.

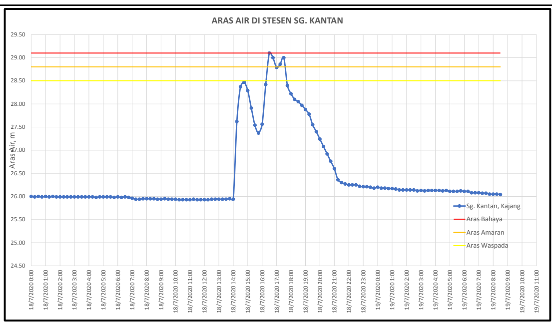
To analyse the response of the river flow, it can be observe through the time period of the warning level increase to danger and danger level to the highest level. The calculation The show that Batu 12 station, Batu 9 station and Sg Kantan station have a very short response rate of about 15 minutes. West Country station recorded a time of about 30 minutes while Kajang station recorded a time of 2 hours. The rising duration less than 1 hour is very short for early flood warning announcements. However, for Kajang station the rising time period shows a relatively good for the early warning system.



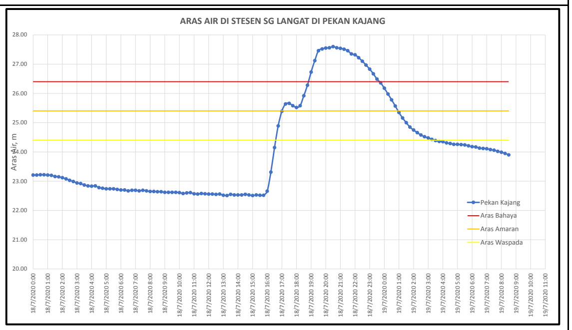
Batu 12 Station



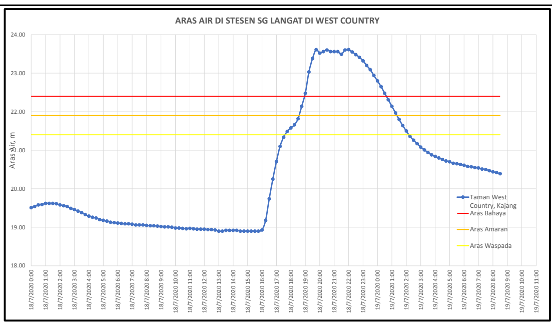
Batu 9 Station



Sg. Kantan Station



Kajang Station



West Country Station

Figure a-4: Water level hydrograph for 5 stations in Langat river basin

Flood Impact

The flooding occurred from 3:30pm to 9:30 due to the extraordinary heavy rain resulting river water level overflow. The river flow in the Sungai Langat could not accommodate the water capacity from the upstream and make it worse when drainage systems at the downstream sub catchments also overflow.

The flood events had very significant impact to the peoples which is more than 1000 houses and business building affected. It also reported many vehicles have submerged during the flood and cause significant losses.

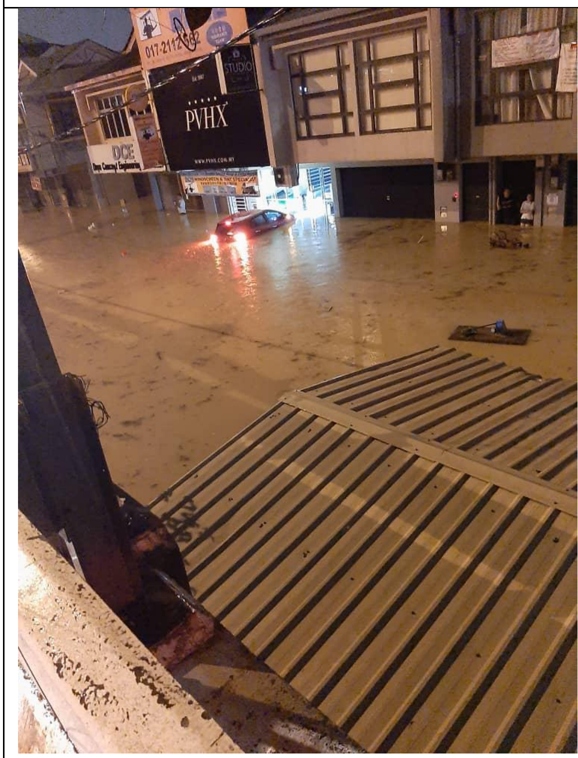
The earliest recorded flood areas were around Kajang Town, Taman Indah, Sungai Chua, Jalan Mendaling, Jalan Reko MRT, Shun Nam Gong Temple, Taman Sri Indah, Taman Sri Reko, Taman Pasir Emas, Desa Bunga Raya, Taman Kajang Baru, Taman Seri Emas, Taman Mahkota, front street of Masjid Teras Jernang, Jalan Persiaran Kemajuan (at junction 3 JAIS), Jalan Persiaran Pusat Bandar (in front of Shell), Jalan Persiaran KWSP (KTM UKM to Sungai Tangkas), Taman Sri Jambu and Taman Goodwill. The average depth of the area affected by the flood is 0.1 - 1.2 meters.

Meanwhile, Kampung Batu 10 Jalan Cheras recorded flood at 4:30pm and the average flood depth is 0.1 - 0.9 meters. Around 5:30pm, floods start occurred in Kg Sungai Sekamat, Kampung Sungai Jernih, Kampung Asrah and Kampung Batu 14 due to the same cause as the floods in the previous areas. The average depth of the area affected by the flood is 0.1 - 1.2 meters. The **Figure a-5** shows some flood images during the flood events.

Kajang Water level Station before overflow

Famous 'Satay Stall" at Kajang Town

Flooding in resiendtial area at Taman Pasir Emas



Flooding in Kajang Town

Flood water in the resident house at Taman Seri Emas

Figure a-5: Flood images in the flooding area

(ii) Flash Flood in Kuala Lumpur City Centre, 10 September 2020

Kuala Lumpur is a capital city of Malaysia where located in the Klang Valley. There is more than 4 million peoples live in the this area lead to very urbanized city with the high rise building, business park, banks, higher institutions and many others activities. Among the important features located in the Klang Valley is Kuala Lumpur, the national capital, Shah Alam, the capital of Selangor, Petaling Jaya, several major highways, all of the country's urban light rail transport and many others. In spite of its importance and major flood mitigation projects, the catchment has been experiencing frequent floods causing hardship to the local population and significant damages to the economy.

The Sungai Klang Basin (see **Figure a-6**) has an area of about 1,280 sq. km., which encompasses the Federal Territory of Kuala Lumpur, parts of Hulu Langat, Kuala Langat, Gombak, Sepang, Petaling, and Klang districts in Selangor. The municipalities that fall within the basin boundaries include Petaling Jaya, Subang Jaya, Klang, Kajang, Shah Alam, Selayang, and Ampang Jaya.

Sungai Klang originates from the Main Range about 25 km. northeast of Kuala Lumpur at an altitude of approximately 1,330 m. The river valley falls westerly to eventually to meet the sea at the Straits of Malacca. En-route, it is fed by 11 main tributaries. The main Sungai Klang has a length of approximately 120 km.

About 70 percent of the area is currently developed for residential, commercial, industrial, and institutional. The upper basin area above the existing dams (i.e., Klang Gates and Batu Dams) is mountainous with fairly steep slopes and still covered by tropical jungle. The middle and lower reaches are made up of the urban areas of metropolitan Kuala Lumpur, Shah Alam Municipality, and the townships of Selayang, Ampang Jaya, Subang Jaya, Petaling Jaya, and Klang. The main tributary system at the upper reach of the Sungai Klang Basin includes that of Batu, Gombak, and Upper Klang. Except for Gombak, the other two upper reaches were dammed for flood mitigation and to a lesser extent water supply purposes. The confluences of Batu with Gombak, and Gombak with Klang just downstream are at the heart of Kuala Lumpur. At this point, the surface slope turns milder from about 1:300 to nearly 1:1000 as it flows through the city at its middle reach. The main tributaries of Sungai Klang include the following:

(i) Sungai Gombak
(ii) Sungai Jinjang
(iii) Sungai Keroh
(iv) Sungai Kemunsing
(v) Sungai Ampang
(vi) Sungai Kerayong
(vii) Sungai Kuyoh
(viii) Sungai Penchala
(ix) Sungai Rasau
(x) Sungai Damansara
(xi) Sungai Rasah

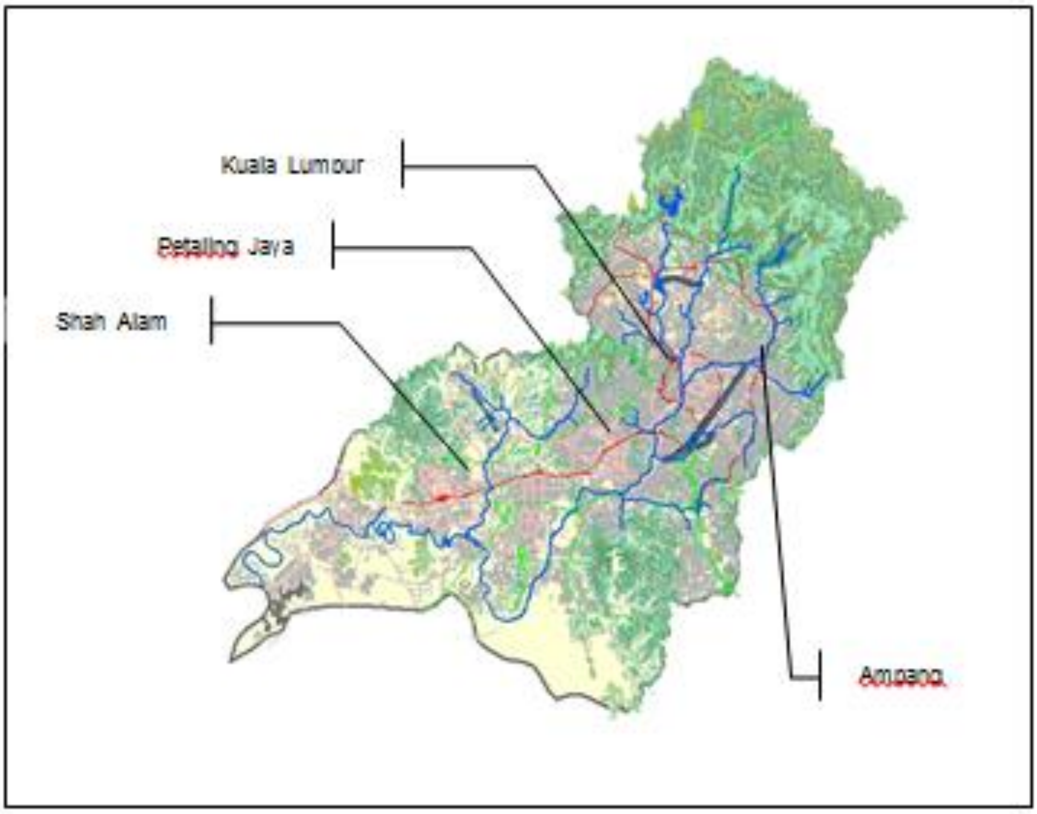


Figure a-6: The Klang River Basin

On 10 September 2020, there was a flash flood that hit the capital city of Kuala Lumpur. The flash flood occurred between 2:30 pm and 6:00 pm, when most peoples returned to their homes from work. The floods have caused many major roads around Kuala Lumpur to be severely congested. This congestion was exacerbated when the SMART Tunnel System was fully operational at Stage V Mode i.e. excess river water was drained into the flood reservoir pond and through the entire SMART tunnel.

The weather warning from Malaysian Meteorological Department during the day of the flood is as **Figure a-7**, **Figure a-8** and **Figure a-9**.

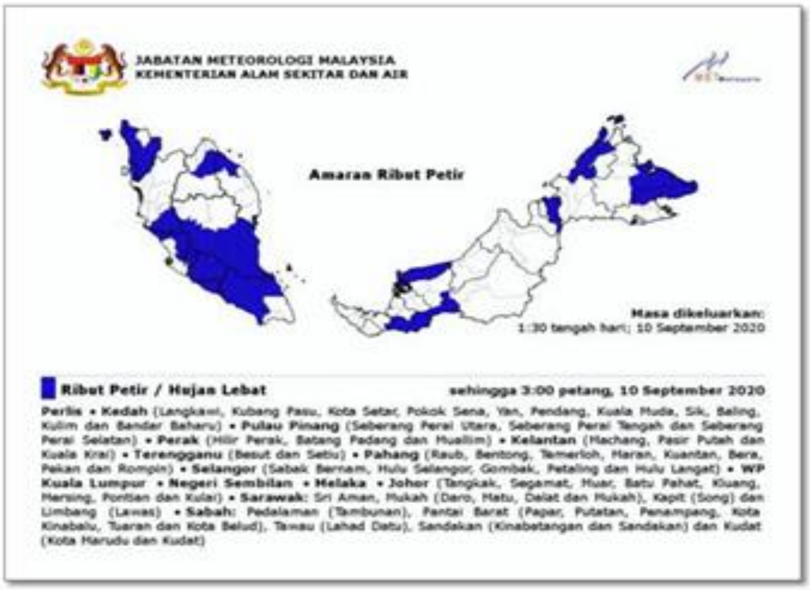


Figure a-7: Thunder storm warning at 10 September 2020, 1:30 pm

Figure a-8: Thunder storm warning at 10 September 2020, 2:15 pm

Figure a-9: Thunder storm warning at 10 September 2020, 4:00 pm

Rainfall Record and Analysis

There are more than 30 rainfall stations have been set up in the Klang river basin to record the amount of rainfall throughout the area. As this rain incident is concentrated in the central area to the upstream of Klang river basin. A total of 11 rainfall stations were used to conduct rainfall analysis represent the sub-basin area of Sg. Klang and Sg. Gombak. **Table a-2** shows heavy rainfall concentrated in the upstream area of Sg. Klang where the highest amount of rainfall was recorded at Gombak Simpang 3 Station with a reading of 197mm within 6 hours which is more than 100 years return period. Gombak Barrage rainfall station also recorded very high rainfall of 180mm in 5 hour which is more than 100 years return period. **Figure a-10** shows rainfall isohyetal map on 10 September 2020 for 6 hours rainfall duration. The rainfall pattern shows heavy rain concentrated in the Sg. Gombak area with rainfall almost 200mm.

Table a-2: Maximum rainfall between 1hr to 6 hr duration

Station Name	Daerah	Maximum Rainfall (mm)					
		1 hr	2 hr	3 hr	4 hr	5 hr	6 hr
Kg. Kuala Seleh		35.5	54.0	74.5	99.0	117.50	119.0
Jinjang		48.5	70.0	82.0	99.5	127.5	129.0
Air Panas		43.5	71.0	89.5	106.0	122.0	122.5
Lembah Keramat		39.5	77.5	111.5	118.5	119.5	119.5
Kolam Takungan Batu		48.5	74.5	88.0	127.5	152.5	155.0
JPS Wilayah	Kuala Lumpur	45.5	81	94	112	118	118.5
Gombak Simpang 3		63	93.5	137	177.5	197	198
Gombak KM 16		47	67.5	81	99.5	115	116.5
Sentul		51	83	102.5	108.5	124.5	125.5
Gombak Barrage		57	98	116	160	180	181
Jln Tun Razak Sg Bunus		56	110.5	132.5	141	142	142.5

Table a-3: Return Period for several rainfall duration

Station Name	District	Return Period					
		1 hr	2 hr	3 hr	4 hr	5hr	6 Jam
Kg. Kuala Seleh		<2	<2	2	8	20	17
Jinjang		<2	<2	2	5	19	16
Air Panas		<2	<2	4	7	14	11
Lembah Keramat		<2	3	15	15	12	10
Kolam Takungan Batu		<2	2	3	24	58	52
JPS Wilayah	Kuala Lumpur	< 2	3	5	11	12	10
Gombak Simpang 3		2	8	56	> 100	> 100	> 100
Gombak KM 16		<2	<2	2	5	9	8
Sentul		<2	4	9	9	16	14
Gombak Barrage		<2	11	19	> 100	> 10[illegible]	> 100
Jln Tun Razak Sg Bunus		<2	25	46	47	38	31

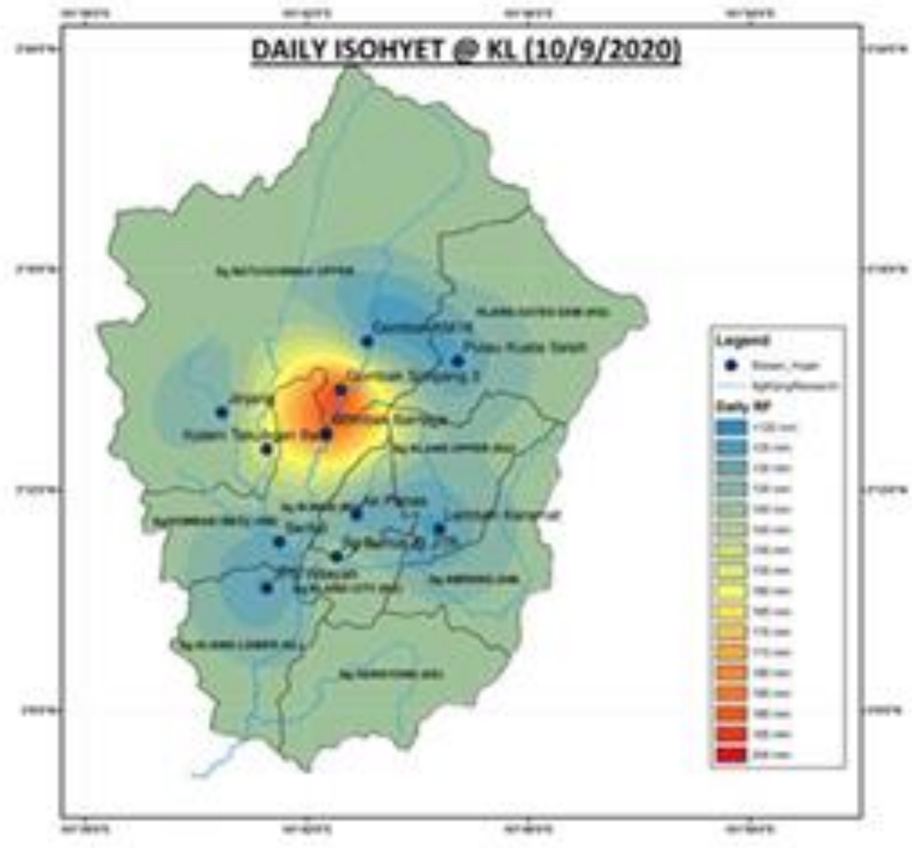


Figure a-10: Isohyet map for 6 hour rainfall

River Water Level Analysis

The flood that occurred on 10 September 2020 was in the centre area of Kuala Lumpur near to the confluence of Sg. Gombak and Sg. Klang. Heavy rainfall is more concentrated in the sub-basin of Sg. Gombak, by that the water level station in the Sg. Klang recorded lower flood water level. **Figure a-11** is a hydrograph at Tun Perak Station, downstream of Sg. Klang near the confluence of Sg. Gombak. It shows that the water level has exceeded the danger level by 0.5 meters. The hydrograph also shows the river level rise from the normal level to highest level in 2 hours and receding to normal level in 1 hour later.

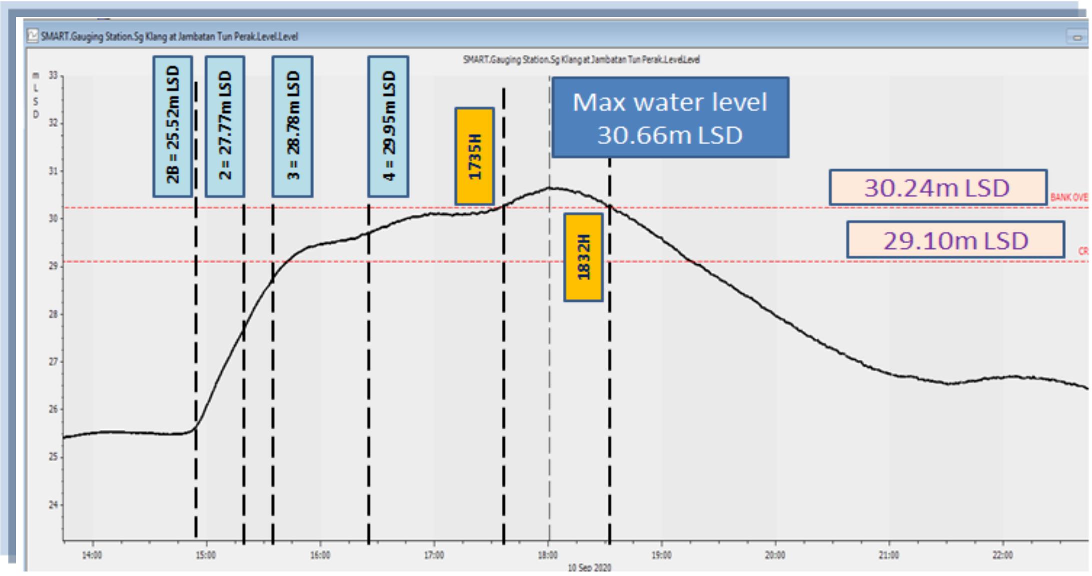


Figure a-11: Hydrograph at Sg. Klang @ Jambatan Tun Perak

SMART Tunnel Operation

Kuala Lumpur Flood Mitigation (KLFM) programme includes several components of flood mitigation infrastructure along the Sg. Klang, Sg. Gombak and Sg. Kerayong. During the flood's, KLFM flood mitigation infrastructure was fully functional which consisted of flood water diversion to the ponds, operating flood pumping and diverting flood water to the SMART Tunnel. Thus, the impact of the floods has been reduced.

Flooding also not only due to heavy rainfall, the failure of the urban drainage system to accommodate the high amount of rainfall caused by obstacles in the drainage system and under design of the drainage size due to existing drainage systems was built more than 30 years ago where recently the rainfall and climate pattern changes

SMART Tunnel only manages to divert river water from the upstream of Sg. Klang for make sure not all the flood water pass through the city of Kuala Lumpur. At the time of the flood, the SMART Tunnel was operating at full capacity where 2 flood ponds and the tunnel that normally used for traffic were closed for flood water storage. Thus, only a small part of the river water of Sg.

Klang flowed to Kuala Lumpur City Center. Due to the heavy rainfall concentrated in Sg Gombak and rainfall at the city center itself, the high water flow in Sg Gombak has caused it to overflow and inundated at surrounding area. The flood depth recorded between 0.1 to 0.9 meters. **Figure a-12** shows the SMART operating level according to Mode 2B to Mode 4. SMART has been activated to Mode 2B at 2.50pm, Mode 2 at 3.20pm, Mode 3 at 3.35pm and Mode 4 at 4.40pm, Keroh Diversion was activated at 2.25pm and Gombak Diversion was activated at 2.22pm.

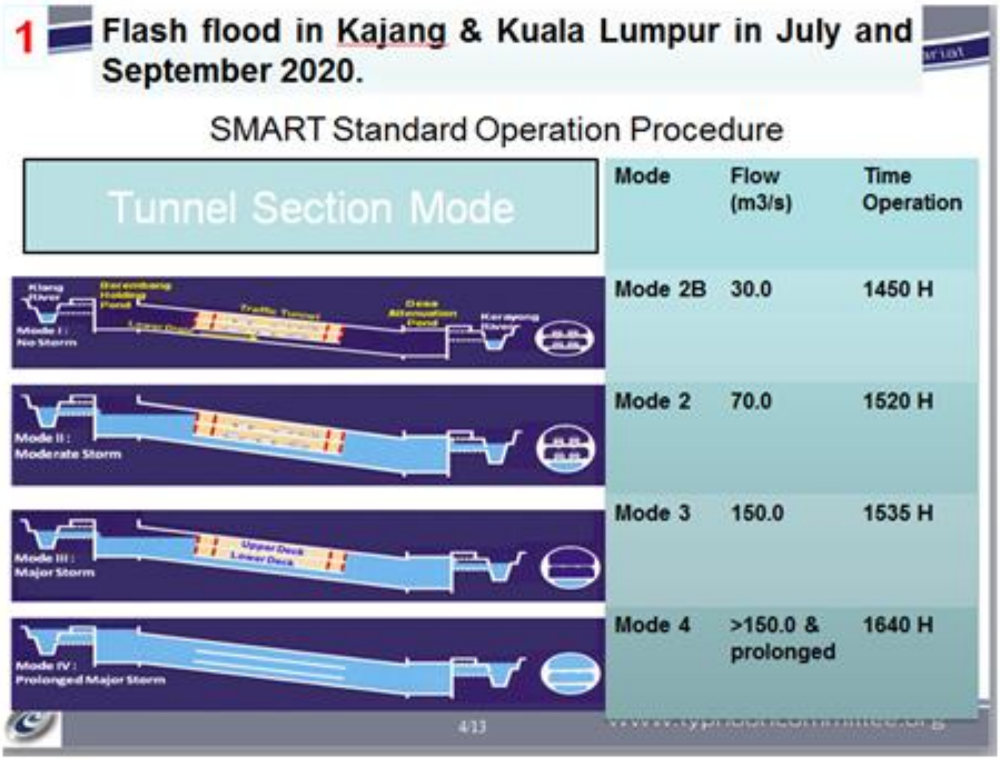


Figure a-12: SMART Tunnel Standard Operation Procedure for flood diversion

Flood Impact

Flash floods in some places in WPKL are due to prolonged heavy rains (more than 3 hours). This extraordinary rain caused the existing drainage system not be able to accommodate surface runoff.

A total of 30 houses were affected and 315 people from 75 families in Kg Baru were affected transferred to the temporary Evacuation Center at the Sultan Sulaiman Club, Kg Baru. In the same time, more than 10 vehicles stuck in the flood, 10 shops flooded around Jln Melaka and Jln Tun H S Lee, more than 10 houses flooded in Kg Perik, Kg Baru including primary school in Kg Baru.

Figure a-13 shows the flood bulletin in the newspaper and **Figure a-14** shows flood images at some area in Kuala Lumpur City Centre.

NEW STRAITS TIMES

PERFECT STORM

SURPRISES AS PARTIES UNVEIL CANDIDATE LISTS FOR SABAH POLLS

Figure a-13: Newspaper cutting during flood 10 September 2020

Figure a-14: Flood images at several location in Kuala Lumpur City Centre

(b) Enhancement of Hydrological Data Management For DID Malaysia

Adoption Of AQUARIUS Program For Managing Hydrological Data

DID operates around 1500 active stations across 14 states of Malaysia. As in most organisations, management of the collected data has evolved over time, and throughout DID there are a number of independent systems and databases used to collect and store hydrological data. DID current operation utilises TIDEDA software tools for the centralised hydrological data management. Data are collected across the states/territories using a variety of data collection methods and telemetry products. Each state/territory is responsible for copying data from its manual or telemetry system into local Tideda files. The Tideda data are then transferred to centralised Tideda files in Kuala Lumpur using the Tideda Client tools called TdServer. A centralised team enters the gauging results, prepare ratings, and generally manage the archive data. DID requires a software system that over time will allow all data to be managed in a single server, and a plan that will migrate data centrally stored in Tideda format into the new AQUARIUS system, and enable integration of other non-Tideda data sources.

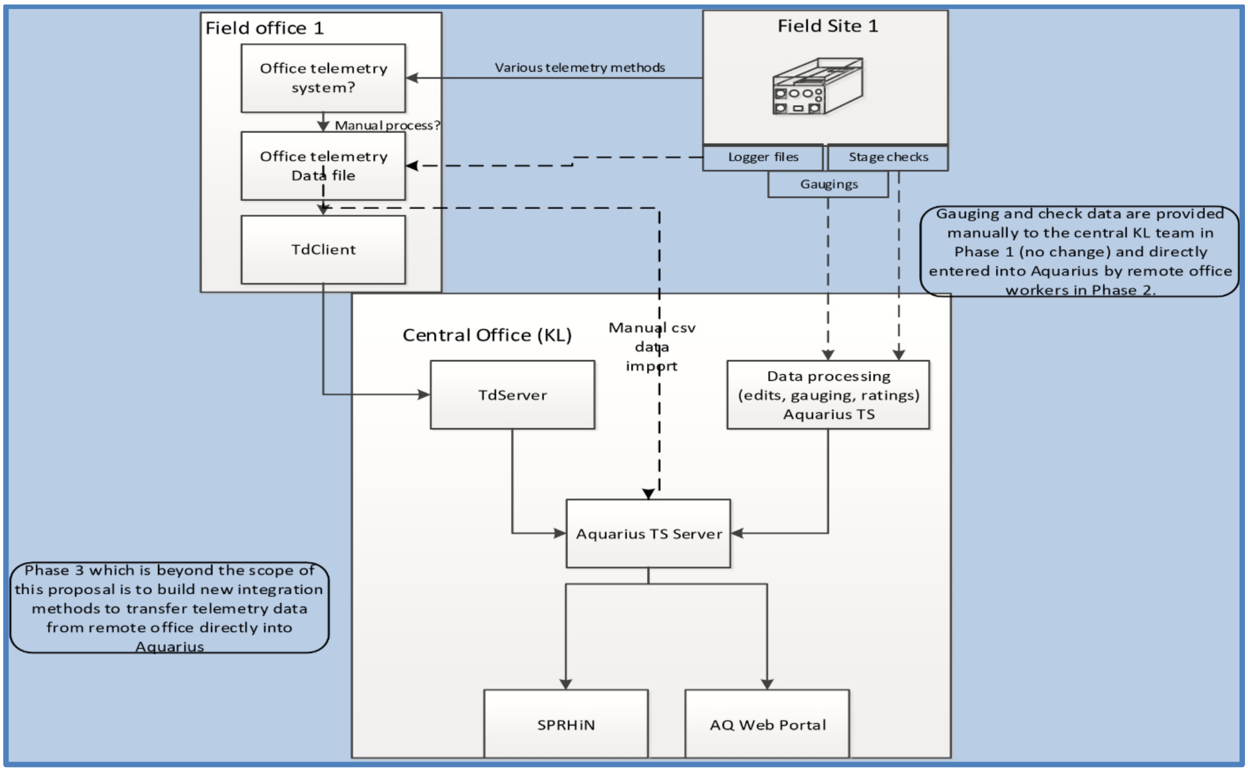


Figure b-1 : DID HDM Server Architecture

Benefits and Advantages

The following are key advantages of the AQUARIUS Program compared to TIDEDA. AQUARIUS provides a centralized data management using industry standard databases leads to improved data integrity. It is fully network enabled, with distributed data management including data approval and access levels, and granular user-data management which leads to enhanced data security. A Comprehensive data management through more data types being supported, including discrete data, location data and a large range of metadata. Together with time series data, many related metadata are directly managed, including data quality grades, data flags, data comments and data approval levels. Raw data is always and persistently stored and never deleted. AQUARIUS Program equipped with an advanced and more comprehensive data manipulation tools, data history management and data corrections including roll-back and undo facilities. An intuitive, web-based, user interfaces allowing much more granular data manipulations and operate in a network environment leads to increased efficiencies.

Approaches

DID concern was expressed about how likely it will be that all states fully adopt working with the new system (AQUARIUS). In order to mitigate this risk, DID was proposing that the adoption of AQUARIUS be split into 3 phases as described below.

Phase 1 will cover the Migration of the centralised TIDEDA databases to AQUARIUS. This phase requires migration of the centralised Tideda databases to AQUARIUS Time-Series, training of centralised staff as well as setting up a data mapping tool to automatically transfer ongoing TIDEDA data received by TdServer into AQUARIUS. Migration tools have been developed to transfers Tideda data, gauging results and ratings into AQUARIUS. At the end of this phase, data are still updated from the remote offices in the same manner as they always have been, but all centralised data management operations will be undertaken within AQUARIUS.

In Phase 2, Field Operators from all remote office champions will be trained to enter field visits data in AQUARIUS TimeSeries. They will learn how to manually import CSV data, and how to manage basic time series. The intent is that the remote office champion will teach other personnel in their office. At the end of this phase, staffs at remote office level are able to enter site information directly into AQUARIUS, manually import CSV data files directly into AQUARIUS as well as conduct basic editing of time series data using AQUARIUS.

The Scope for Phase 3 is to use integration methods to automatically transfer state telemetry data into AQUARIUS Time-Series. In order to minimise manual import of CSV data from remote office operations, new methods to transfer data to AQUARIUS directly via remote office telemetry systems must be developed. AQUARIUS provides defined application programming interfaces (APIs) and a data ingestion tool (AQDAS) to assist with data integration.

After all the enhancement works have successfully completed, DID way forward is to enhance hydrological data distribution method to customers. Our target is a fully automated data distribution system where customer will be able to apply, assign price and invoice, pay on-line and receive data. The customer will no longer require dealing at the counter, leads to better efficiency, time consuming and safety. We hope to help support the community to win the battle against the Covid-19 pandemic.

Figure b-2: Data Collection at Remote Sites

Figure b-3 : Training For Centralised Staff And Field Operators

(c) Hydrological Instrumentation Updates for Malaysia

Review and update Hydrological Procedure

For decades, DID Malaysia the national hydrological agency has been consistently developing hydrological stations throughout Malaysia to collect and obtain data for water resources assessment, planning, development, early flood warning and river monitoring purposes. A lot of investment has been made every year for development and maintenance of these stations. Thus, it is very important that the stations are design and build according to international standard and best engineering practices.

To date, DID Malaysia have 35 hydrological procedures that include various hydrological disciplines. Some of these hydrological procedures were published 40 years ago. Since then, there are many changes with respect to technology advancement, standard guideline, best practices and working environment. DID has been working to review and update two (2) HP's, which are Hydrological Procedure No. 21: Evaporation Data Collection Using U.S. Class 'A' Aluminium Pan and Hydrological Procedure No. 25: Stick Gauge for River Station.

(i) Hydrological Procedure No. 21: Evaporation Data Collection Using U.S. Class ‘A’ Aluminium Pan

In order to standardize the evaporation pan design and measurement used in DID hydrological station, DID has developed “Hydrological Procedure (HP) No. 21: Evaporation Data Collection Using US Class ‘A’ Aluminium Pan” in 1981 (Department of Irrigation and Drainage Malaysia, 1981).

Evaporation pan equipment

1. Evaporation pan with 1210 mm internal diameter and 255 mm height, made from No. 20 gauge aluminium plate as shown in **Figure c-1**.
2. Fixed point gauge
3. Graduated measuring can for measuring purposes
4. Storage tank to supply water to replace the evaporated water at the station
5. A standard daily rain gauge installed at least 1.5m away from the pan to measure the daily rainfall.

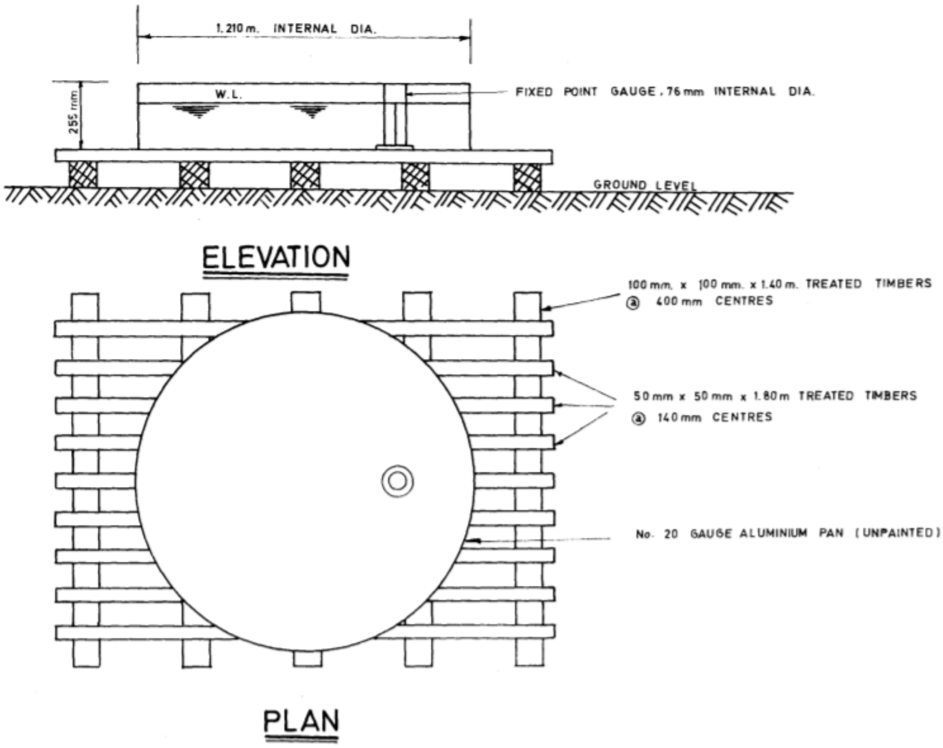


Figure c-1 : Evaporation pan dimension and components (DID, 1981)

The evaporation pan system described above is the manual system in which the measurement and data collection are carried out manually. So far there are no standard and procedure available for an automatic evaporation system in DID to be made as guidelines.

(ii) Hydrological Procedure No. 25 Stick Gauge for River Station(1982)

The stick gauge is used by DID to obtain water level compared to mean sea level at river station. To ensure uniformity of stick gauge installations in river station, Hydrological Procedure No. 25: Standard stick gauge for river station was established in 1982 (Department of Irrigation and Drainage Malaysia, 1982).

General design and assembly

- DID have adopted a standard 2 m length for general application. If the range of water level exceeds 2 meters, several successive stick gauges of standard 2-m length are installed.
- The standard 2 m length stick gauge consists of two graduated plastic plates of 1 m length each screwed on a 2200 x 250 x 40 mm treated timber backing.

Figure c-2: Stick gauge at hydrological station

Approaches

(a) Review and study the standard and operating procedures for best engineering practices. Several organizations have been identified as reference such as World Meteorological Organization, Bureau of Meteorology (BOM) Australia (2020), U.S. Geological Survey (USGS) Publication, other local government agencies and manufacturers.

(b) Site visit

In reviewing and studying the types of evaporation pans and stick gauges with the concept and recommended designs to be kept as simple and economical as possible. Site reconnaissance and investigation has been carried out based on different site conditions.

There are five (5) evaporation station locations, six (6) water level stations that were selected and one Malaysia Meteorological Department station at Cameron Highland was chosen for highland evaporation condition. The various site conditions for the selection of the evaporation station as follows:

(i) Steep slopes
(ii) Undulating slopes
(iii) Accessibility
(iv) Urban
(v) Rural

Map 1 in **Figure c-3** shows the location of the evaporation stations visited during the technical site visits.

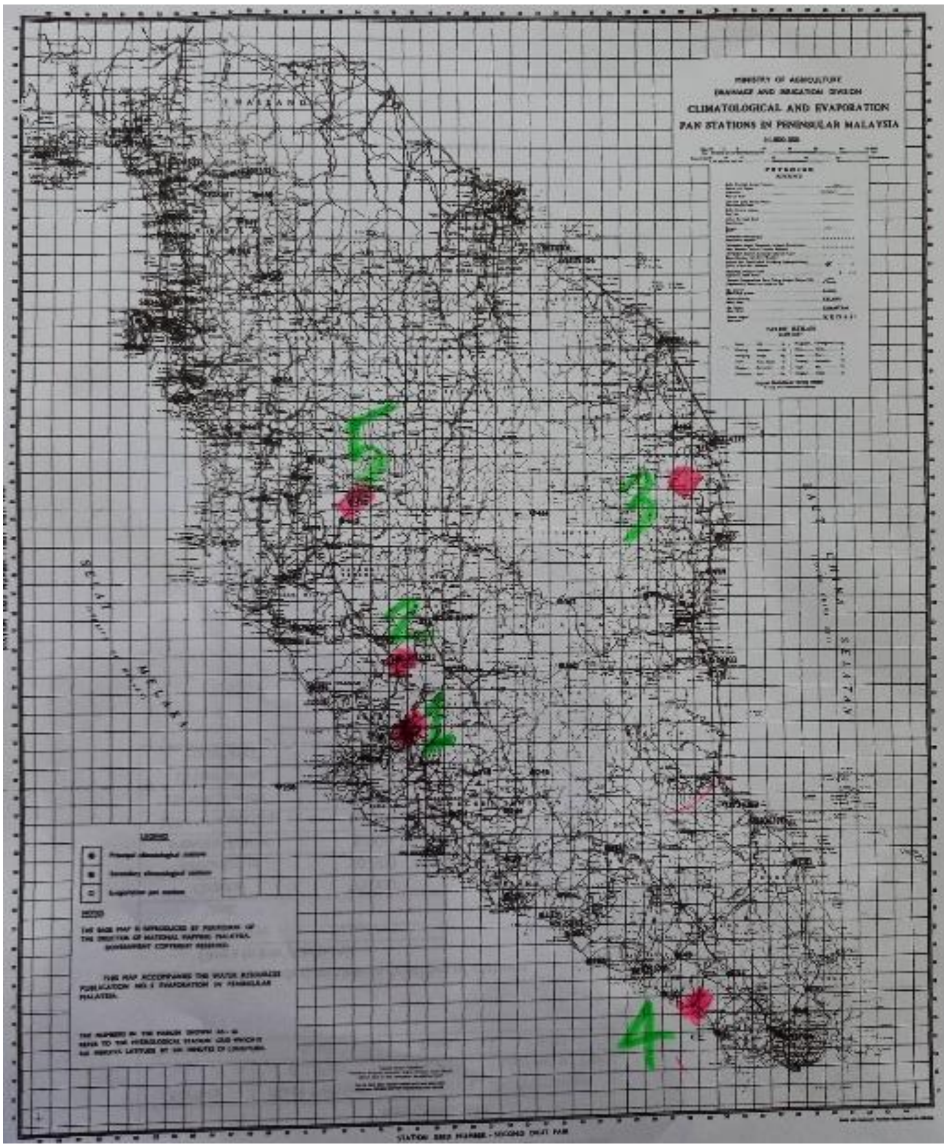


Figure c-3: Map 1 shows the location of the evaporation stations visited during the technical site visits

(c) Explore latest product and technology in the market

Engage with established manufacturers / distributors to understand the latest product availability especially for automated evaporation data collection.

(d) Establish standard guideline, publish technical paper and update new hydrological procedure for DID Malaysia

Scope of reviews

i. Updates on theory and calculation
ii. Design and selection of components, instrumentation, automation system and telemetry
iii. Operation and maintenance procedures
iv. Testing (factory acceptance test, site acceptance test, system acceptance test)
v. Calibration procedure
vi. Site Selection
vii. Minimum standard specification
viii. Existing issues and recommendation

(iii) Rainfall Tipping Bucket Calibration - ISO 17025: 2017 Certification Inter-laboratory comparison

ISO 17025 is the international standard for testing and calibration laboratories. It's a set of requirements those laboratories use to show that they operate a quality management system and that they are technically competent to do the work. One of the essential requirements for ISO 17025: 2017 is to demonstrate competency and validate a laboratory's measurement process by comparing results of a reference laboratory and other participant laboratories. The aim of the interlaboratory comparison is to allow the participating calibration laboratories to check the performance of their gravimetric calibrations of Tipping Bucket Rain Gauge.

Participating laboratories

The licensed Manufacturer, Vanguard Electronics Sdn Bhd and DID are the only participating laboratories. However, since the original calibration certificate was used as the first calibration by the manufacturer, this original calibration data was regarded as from Manuf 1 laboratory, the second calibration data was from DID, and then the final or third set of data was from the Manuf 2 (original manufacturer again).

Evaluation criteria

Evaluation criteria are based on SP4 of SAMM, referenced to APLAC PT 002, Issue No. 6, dated 03/08, Testing Inter-laboratory Comparisons and APLAC PT001, Issue No. 5, Dated 03/08, Calibration Inter-laboratory Comparisons for the following evaluation criteria:

i. Evaluating the results of calibrations using the 'z-score'

$$z_i = \frac{x_i - \bar{x}}{s}$$

where, |z| ≤ 2 Satisfactory

2 < |z| < 3 Questionable

|z| ≥ 3 Unsatisfactory

ii. Evaluating the results with the uncertainties of measurements using the 'En-ratio' $E_n = \frac{LAB - REF}{\sqrt{U_{LAB}^2 + U_{REF}^2}}$

where, a) | En | ≤ 1: satisfactory (the result and the reference value agree

b) | En | > 1: unsatisfactory (the result and reference value do not agree)

Evaluation Result

The results of the z-score and the calibration values of the three participating laboratories are schematically shown in **Figure c-4** as follows:

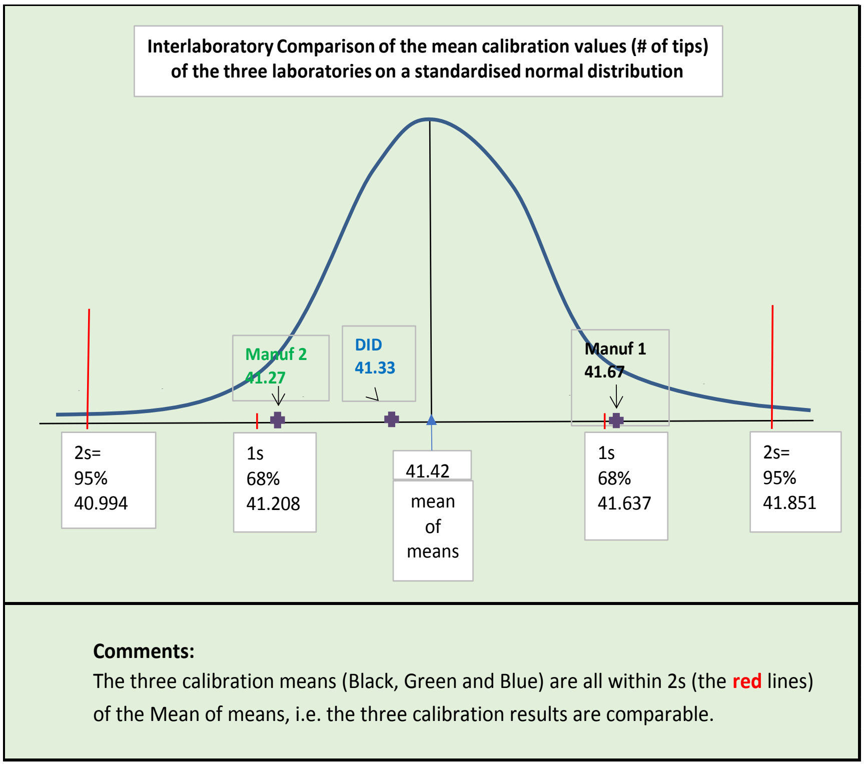
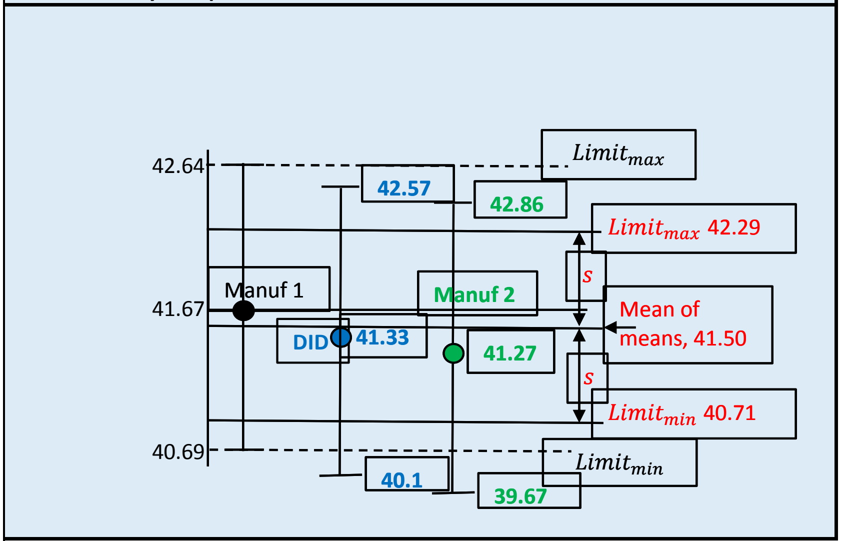


Figure c-4: Schematic representation of the calibration results of the participating laboratories

The results of the En-Ratio and the calibration values of the three participating laboratories are schematically shown in **Figure c-5** as follows:

Figure 2: showing schematically the results of Calibrations in relation to the En-Ratio Interlaboratory Comparison between DID and Manufacturer 1 as reference lab.



Explanation: The abovementioned diagramme shows that both the mean values of DID **(blue)** & Reference Laboratory (Manuf 1) (**black**) are within 1 std dev (1s) **(red)** of the Mean of means of 41.50 tips **(red)**, denoting the En-Ratio of (DID/Manuf 1) is below or equal to '1', concluding both calibration results are comparable.
Meanwhile, the mean of the Manuf 2 **(green)** **also falls within the 1 std dev (1s)** **(red)** of the Mean of means. Hence, Manuf 2 / Manuf 1 calibration results are also comparable.

Figure c-5: Results of the En-Ratio and the calibration values of the three participating laboratories

Discussion

Between the three laboratories, there seems to be equally good comparability and agreement between the results of DID and the two reference values. **Figure 1** also showed good comparability of the ‘z-score’ values between the three results, the z-scores being much smaller than the limit of ‘2’, indicating good accuracy of results and tendency towards the Central-Limit-Theorem (CLT). This would mean that DID’s calibration process has both high accuracy and high precision.

In overall, this inter-laboratory comparison between DID and the manufacturer’s laboratory has confirmed that DID has both the precision and accuracy of measurement for calibration of Tipping Bucket Rain Gauge, complying with the requirement of SAMM Policy 4 (or SP4).

(d) Drought Monitoring Updates

Dry Weather and Water Availability from January to March 2020 in Malaysia

Drought is a natural phenomenon and an integral part of climate variability. Monitoring and forecasting drought events are crucial for water resource management. There is no concrete definition on the term "drought", considering the vast difference in the various discipline approaching its degree of occurrence and also in which context it is defined (e.g meteorological drought, hydrological drought, agricultural drought, socio-economic drought and ecological drought). One of these approaches is the meteorological drought, where the events are characterized by rainfall below the average for a spatial extend during a certain period of time. Another indicator can be used in the drawdown of dam water level (storage) and river water level.

Peninsular Malaysia has a low rainfall distribution in January to May each year. During the El-Nino in year 2016 incident, low rainfalls from January to March affected the storage of dams located in the northern states of Peninsular Malaysia, which are Timah Tasoh Dam, Pedu Dam, Ahning Dam, Muda Dam, Beris Dam, Padang Saga Dam and Bukit Merah Dam.

In 2020, several dam locations in the northern states of Malaysia have recorded days without rain between 11 to 48 days from mid-December 2019 to 5 February 2020 which resulted decreasing of dam storage.

The Department of Irrigation and drainage have developed Info Kemarau website, mainly to monitor the drought impact to river level and dam level. Based on the drought annual report, there are two states affected during a dry event in the year 2020 which are the state of Kedah and Melaka. However, the Malaysia Meteorological Department has announced that the droughts occurred due to hot and dry weather. The condition of drought that hit these two states will be discussed in subsequent sections. **Figure d-1** shows the location of State of Kedah and Melaka in Peninsular Malaysia.

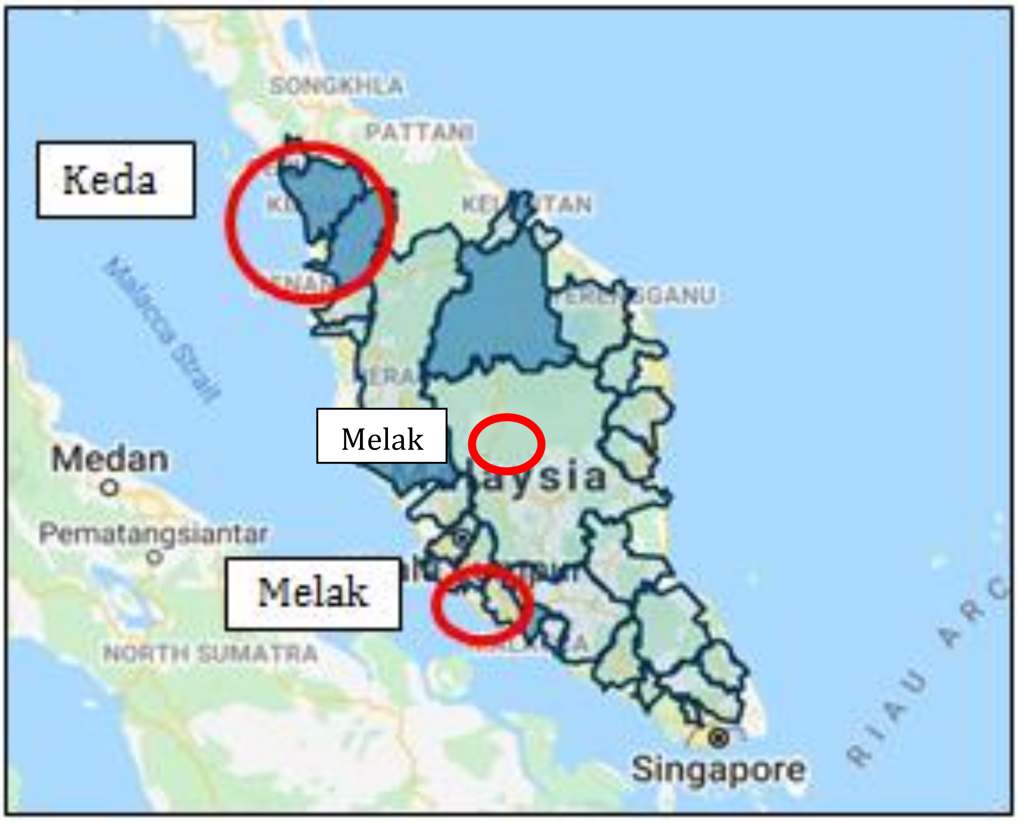


Figure d-1: The locations of State of Kedah and Melaka

Rainfall Status

The State of Kedah is located in the northern part of Peninsular Malaysia. Malaysia has experienced in year 2020 of hot and dry weather in State of Kedah. The reading of rainfall recorded shows that it is below than the average long term recorded. **Figure d-2** illustrates that the rainfall recorded value in year 2020 is below than the long term (LT) recorded especially in month of January, February and April 2020. The critical month is in February 2020, due to the lowest reading of rainfall recorded compared to in month of January and April. The amount of rainfall recorded in February 2020 is 71mm, while in 2014 is 6mm, only 8% from rainfall value in February 2020.

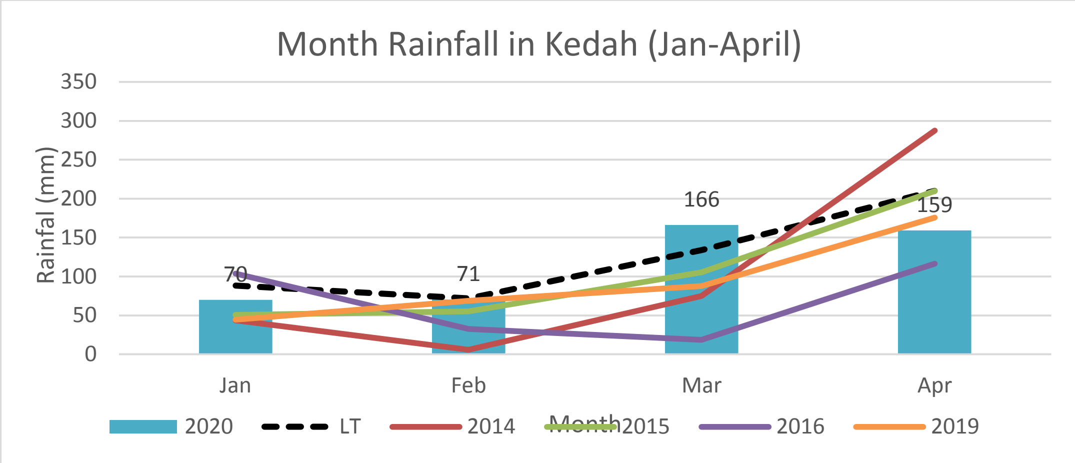


Figure d-2: Monthly Rainfall in Kedah from January to April 2020

The State of Melaka covers a total area of 1664 km^2 with almost urbanised city. The geographical location of State of Melaka is located in southern part of Peninsular Malaysia. **Figure d-3** shows the rainfall pattern recorded in Melaka State from January to April 2020 and compared to Long term recorded. In **Figure 3** illustrates that the rainfall recorded from January to April 2020 are below the long-term rainfall recorded. The rainfall trend shows almost similar in Kedah rainfall recorded. This shows that drought pattern considered a globalised impact while localised trend for heavy rainfall.

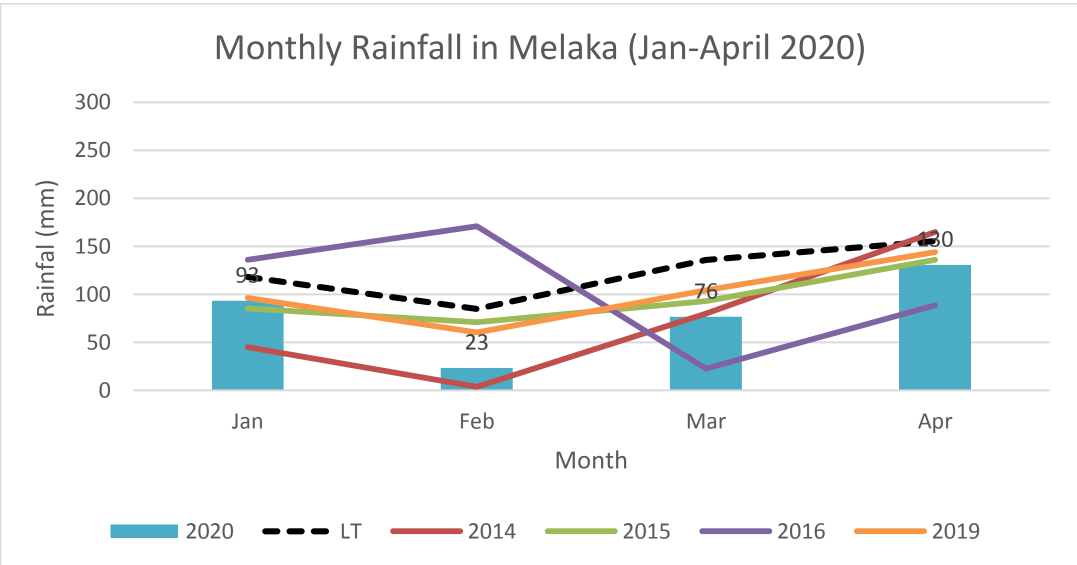


Figure d-3: Monthly rainfall observation in Melaka from January to April 2020

In next section will discuss on the impact of hot and dry weather condition into water availability storages, for example dam.

Dam Status

Referring to January to April 2020, it shows a decreasing amount of rainfall within the first three months. Beris and Pedu Dam are located in State of Kedah while Durian Tunggal in State of Melaka. **Figure d-4** and **Figure d-5** shows the significant impact of rainfall pattern in the water availability of dam storages.

In **Figure 4** shows that the dam water level is decreasing in Beris Dam (level from 81.95m to 78.09m) from January to March 2020. Meanwhile, in **Figure 5** illustrates the Pedu dam similar decreasing trend in Beris Dam with of 2.82m, with recorded level from 86.31m to 83.49m. The alert level in dam operation is a level before reaching the Critical Level (where critical actions will be taken in accordance to the Standard of Operation during critical mode).

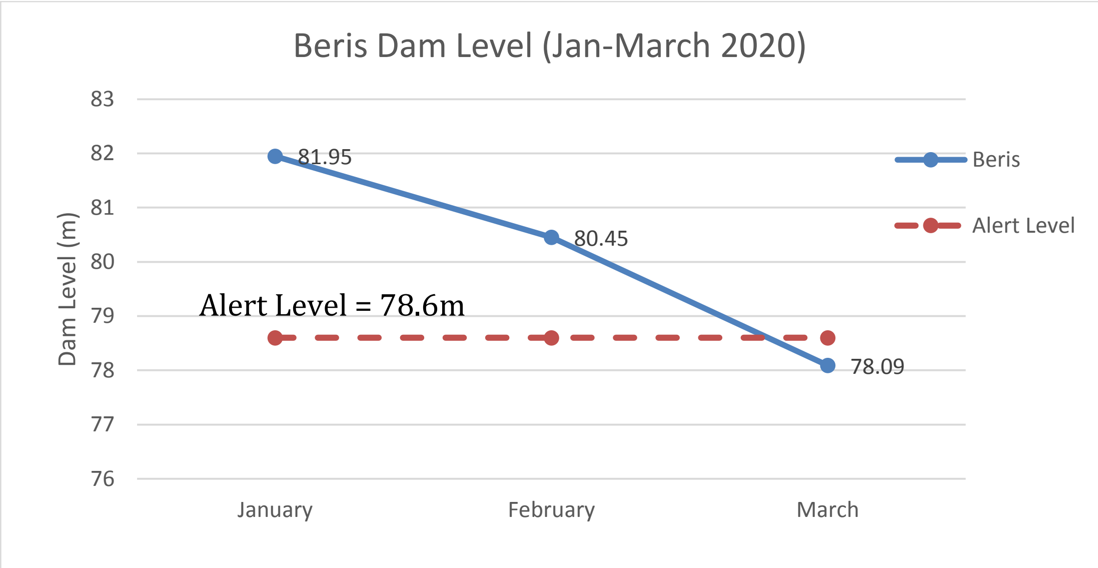


Figure d-4: The Water Level in Beris Dam from January to March 2020

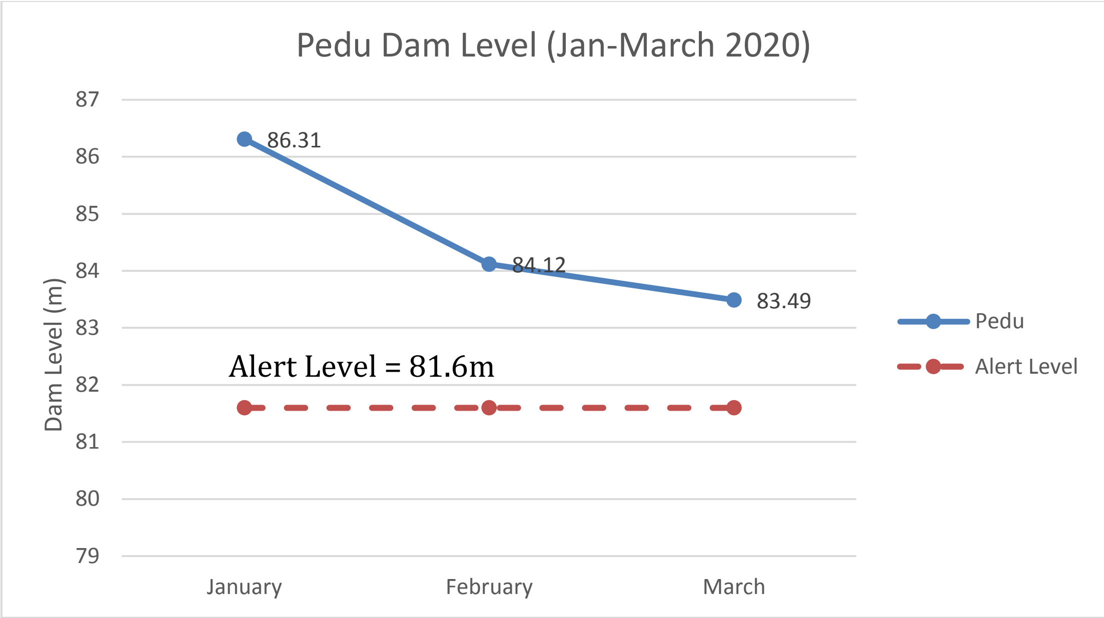


Figure d-5: The Water Level in Pedu Dam from January to March 2020

In **Figure d-6** shows that the dam water level in State of Melaka, Durian Tunggal Dam covering total area of 1664 km^2. In **Figure 6**, it illustrates a critical decreasing of dam water level down to danger level. According to dam operation, water rationing procedure will be activated once dam water level reaches its danger level threshold. The reading of dam level has shown in **Figure 6** that the dam level sharply drops from 24.84 m in January, 23.78 m in February and 23.58 m in March.

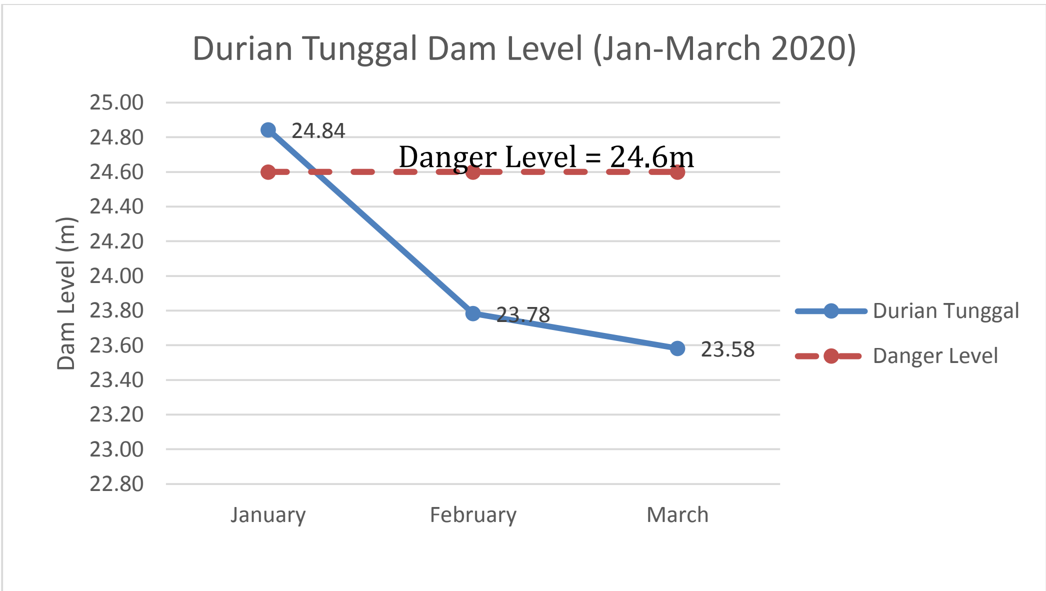


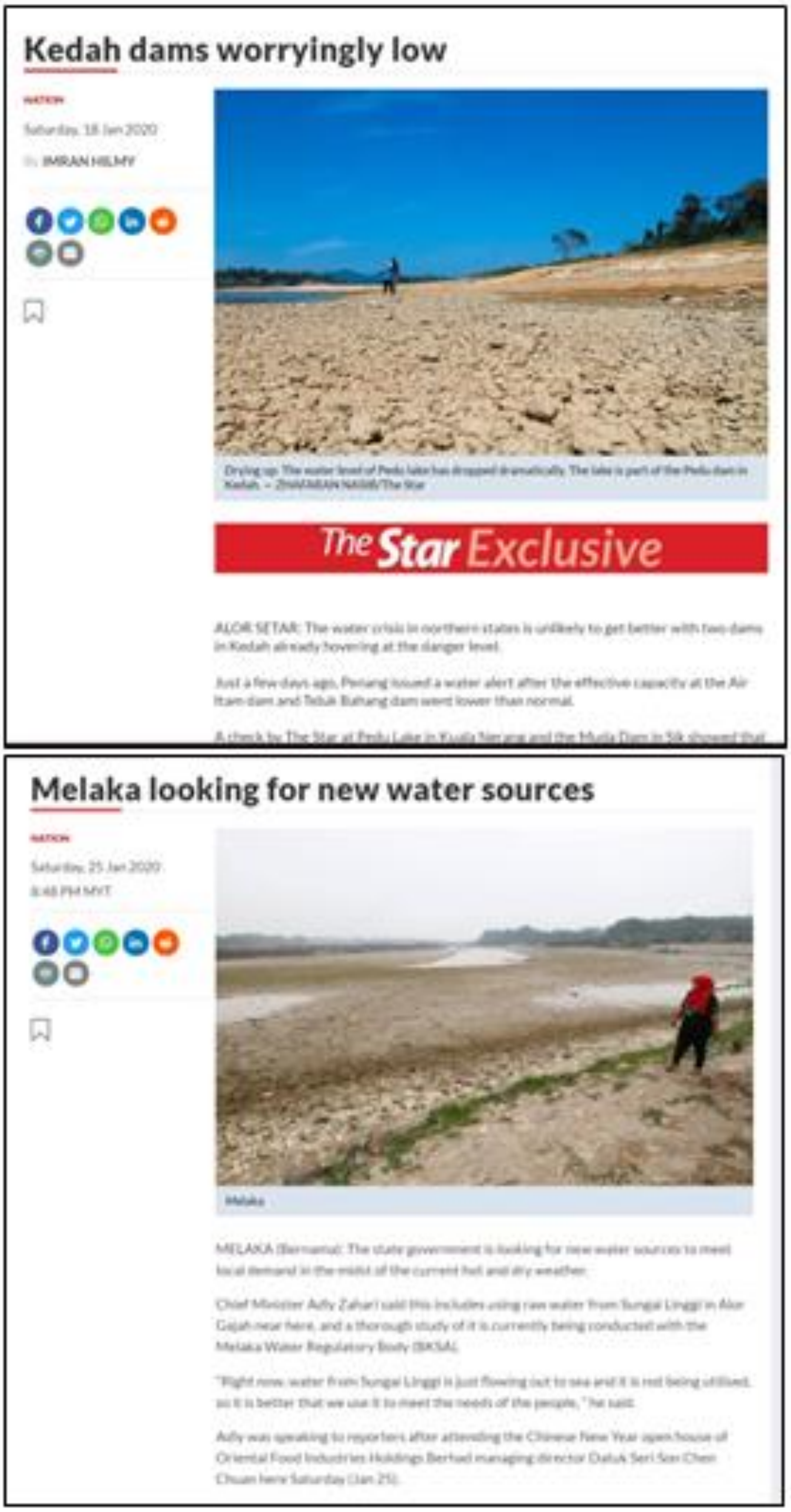
Figure d-6: The water level in Durian Tunggal Dam from January to March 2020

Impact of Drought in Kedah and Melaka

The drought events early this year have affected most of the population in Melaka and northern states in peninsular Malaysia, see **Figure d-7** based on newspaper cutting. For State of Melaka, the state government have to imposed water rationing to 62.8 percent for residential and commercial areas in Melaka Tengah, Alor Gajah and Jasin districts. The total number of people affected is approximately half a million in population due to the water availability have plunged to a critical point of storage.

While in the northern region of Peninsular which in State of Kedah, the Meteorological Department had to carry out cloud seeding activities within Kedah and neighbouring states e.g State of Penang. Kedah is considered as granary area for Malaysia. The main production of this state is the rice industry for the country. Therefore, state of Kedah demanding tremendous volume of raw water for the irrigational purposes.

In the next section, Malaysia is requesting an expert attention on the expertise, knowledge sharing and knowledge transfer on any topic of water resources syllabus from Typhoon Committee members especially from China/Korea/Japan.



Kedah dams worryingly low

NATION

Saturday, 18 Jan 2020

By IMRAN HILMY

Drying up: The water level of Pedu lake has dropped dramatically. The lake is part of the Pedu dam in Kedah. – ZHAFARAN NASIB/The Star

The Star Exclusive

ALOR SETAR: The water crisis in northern states is unlikely to get better with two dams in Kedah already hovering at the danger level.

Just a few days ago, Penang issued a water alert after the effective capacity at the Air Itam dam and Teluk Bahang dam went lower than normal.

A check by The Star at Pedu Lake in Kuala Nerang and the Muda Dam in Sik showed that

Melaka looking for new water sources

NATION

Saturday, 25 Jan 2020

8:48 PM MYT

Melaka

MELAKA (Bernama): The state government is looking for new water sources to meet local demand in the midst of the current hot and dry weather.

Chief Minister Adly Zahari said this includes using raw water from Sungai Linggi in Alor Gajah near here, and a thorough study of it is currently being conducted with the Melaka Water Regulatory Body (BKSA).

"Right now, water from Sungai Linggi is just flowing out to sea and it is not being utilised, so it is better that we use it to meet the needs of the people," he said.

Adly was speaking to reporters after attending the Chinese New Year open house of Oriental Food Industries Holdings Berhad managing director Datuk Seri Son Chen Chuan here Saturday (Jan 25).

Figure d-7: Impact of drought in State of Kedah and Melaka

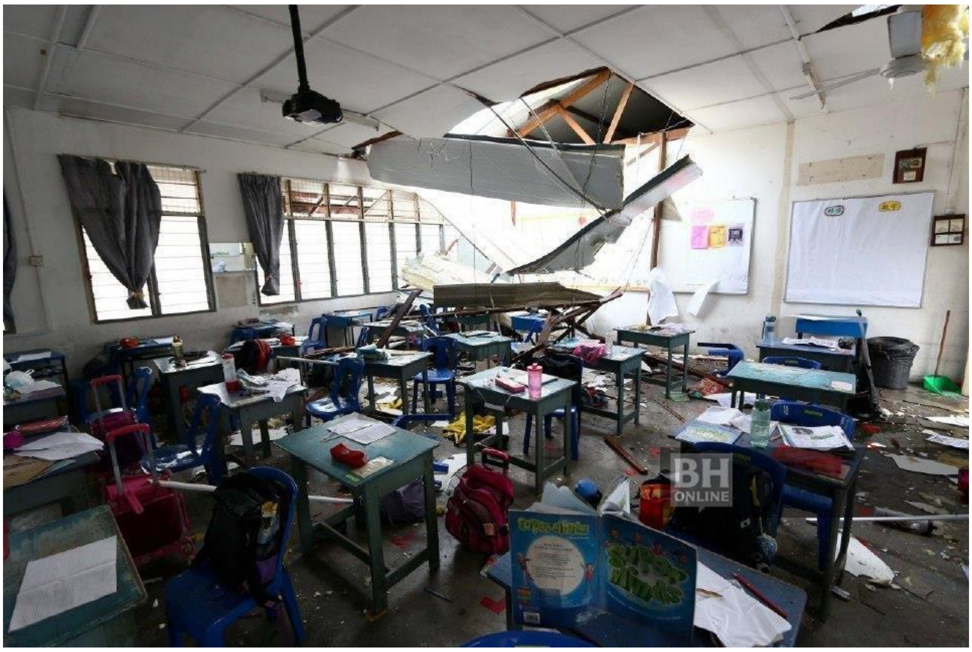
3. Socio-Economic Assessment (highlighting socio-economic and DRR issues/impacts)

Tropical storm and typhoon activities generally pose a very minimal threat to Malaysia, particularly Peninsular Malaysia. However, the tail-end of the typhoon triggers the sudden change in rainfall rate at that period and may bring about storm and strong wind, and heavy rain which resulted in flooding. For example, Tropical Storm Pabuk and the tail-end of Typhoon Lekima in 2019 inflicted significant damage to a few states in Peninsular Malaysia.

In October 2020, the National Disaster Management Agency (NADMA) finalized the National Risk Register Report, which compiles past disaster events, rating the risk of natural hazards and projecting the future hazard trends. Even though storm and other wind related events have been categorized as low impact disaster, observation has shown increasing number of events which caused impact in terms of mortality, damage to infrastructure and disruption of services. This is of much concern especially during the inter-monsoon season whereby frequent thunderstorm events occur. The number of storm occurrences that caused structural damage have spiked significantly; in 2020, there were 2,192 storm events compared to 856 in the previous year. For mortality, 2019 recorded four (4) deaths due to falling objects, falling trees and road accident during the heavy storm downpour. Meanwhile, only one (1) casualty was recorded for 2020.

Most of the damage to buildings observed was caused by localized storm event and largely concentrated to small buildings and structures, in which a majority are non-engineered buildings. Structural failures due to the storm and strong winds are usually roofs and truss which stems from missing or poorly installed fasteners, insufficient fasteners and sub-standard roof-sheathing and nails. It is also a concern when storm also affects critical infrastructures such as school and health facility.

Storm causing damage to a house in Kedah



Damaged classroom after the roof was blown away by a storm

In order to reduce the impact of storm and wind related hazard to the people as well as properties, it is crucial to put in place a suitable disaster risk reduction plan. Focus is given to poor residential areas, vulnerable groups, and protection of critical infrastructure. One of the approaches taken by the Government is to provide compassionate assistance (monetary) to the affected people to enable them to repair their homes and build back better.

For instance, in 2019, the Government spent RM430,000 to assist the families whose houses were damaged and this amount increased to RM760,000 in 2020. Besides monetary assistance, non-structural support were also provided which entails awareness, weather early warning system, as well as utilization of local knowledge especially for states in the northern part of Peninsular Malaysia which are exposed to stronger winds given its open and flat terrain, and large granary areas.

4. Regional Cooperation Assessment (highlighting regional cooperation successes and challenges)

NIL.

II. Summary of progress in Priorities supporting Key Result Areas

1. AOP4: Radar Integrated Nowcasting System (RaINS)

MET Malaysia is implementing and operationalising the Radar Integrated Nowcasting System (RaINS) since August 2017 for continuous weather monitoring purposes. RaINS is operationalised by integrating the reflectivity data from 12 radar stations across Malaysia and blending the data with the Numerical Weather Prediction (NWP) data of MET Malaysia. This technology was adopted from the Short-range Warning of Intense Rainstorms in Localized System (SWIRLS) developed by Hong Kong Observatory (HKO) and tuned in-house for optimal results in Malaysia.

RaINS uses an optical flow algorithm and backward semi-Lagrangian advection scheme to track the movement of radar echoes up to 3 hours in advance, based on past radar echoes. This approximation works well within a short period and the problem of growth and decay in thunderstorm cells are tackled by blending with NWP data.

Various enhancements have been made to RaINS nowcasting system during 2019 and 2020. Phase correction has been added to remove location errors of

NWP-generated reflectivity field. The Short-range Warning of Intense Rainstorms in Localized System (SWIRLS) has also been upgraded from SWIRLS-2 (2012) to the latest COMMUNITY-SWIRLS (COM-SWIRLS) radar advection system. Thereafter, the domain of RaINS has been extended to cover the Andaman Sea, Celebes Sea and Sulu Sea using the larger domain NWP data. Consequently, severe weather warnings from squall-lines could be issued earlier.

Verification of RaINS is performed using the Fractions Skill Score (FSS), Probability of Detection and False Alarm Rates (POD/FAR) as well as visual comparison between radar observation and nowcasts. Thanks to a systematic archiving system of past RaINS data and verification codes, the performance of RaINS during each severe weather episode can be determined quickly. In general, RaINS is reasonably accurate between 1.5 - 3 hours lead time.

In addition, the RaINS web-based Graphical User Interface (GUI) is enhanced with various reflectivity thresholds to quickly identify regions of severe rainfall. Also, mouse-over scrolling is added to better observe predicted evolution of radar echoes over Malaysia in the next 3 hours. The enhanced GUI is available to the public.

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

MET Malaysia will continue to collaborate with HKO to further improve the accuracy of RaINS for extreme weather events. MET Malaysia has submitted the proposal to Typhoon Committee Trust Fund (TCTF) requesting the budget for RaINS project to be included in the AOP for 2021.

Priority Areas Addressed:

Meteorology

a. To mitigate against the damaging impacts of typhoons for the betterment of quality of life through scientific research, technological development and operational enhancement

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

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2. Annual Operating Plan for Working Group of Hydrology (AOP2, AOP4, AOP5, AOP6)

(a) AOP2 : Application of Hydrological Data Quality Control System in TC Members - Malaysia

Department of Irrigation and Drainage (DID) manage hydrological data from over 2,000 hydrological stations across the country to provide 75,000 data years of data for public users such as engineering consultants, contractors, other government agencies, researchers and university students. These hydrological data are used for the purpose of research, planning, design, development and management of national water resources.

DID has experienced in hydrological data management for over 75 years. The hydrological data quality control has improved over the years along with the development of technology. Currently, hydrological data quality control has become priority in every stages of data management process starting from station network planning until data dissemination to customers. Two latest approaches for hydrological data quality enhancement in DID are explained below.

(i) Development of Hydrological Procedure No. 28 (HP 28)

In 2019, DID has formally developed our own approach of data checking and screening through the implementation of Hydrological Procedure (HP) No. 28 – Checking Procedures for Raw Hydrological Data Before Archived to Database of Water Resource and Hydrology Management Division. HP 28 is used by State Offices as initial checking procedures before data are sent to DID Headquarter for final checking and cleaning.

In general, HP No. 28 involved three main components:

i. To develop a standardised set of Hydrological Procedures, routine or practices for guiding the data quality checking and screening hydrometric data (Rainfall, Water Level & Stream Flow).

ii. To develop a standardised set of Hydrological Procedures, routine or practices for guiding the data rectification of hydrometric data (Rainfall, Water Level & Stream Flow).

iii. To develop a program or tools for automation of the procedures for data quality checking, screening & rectification.

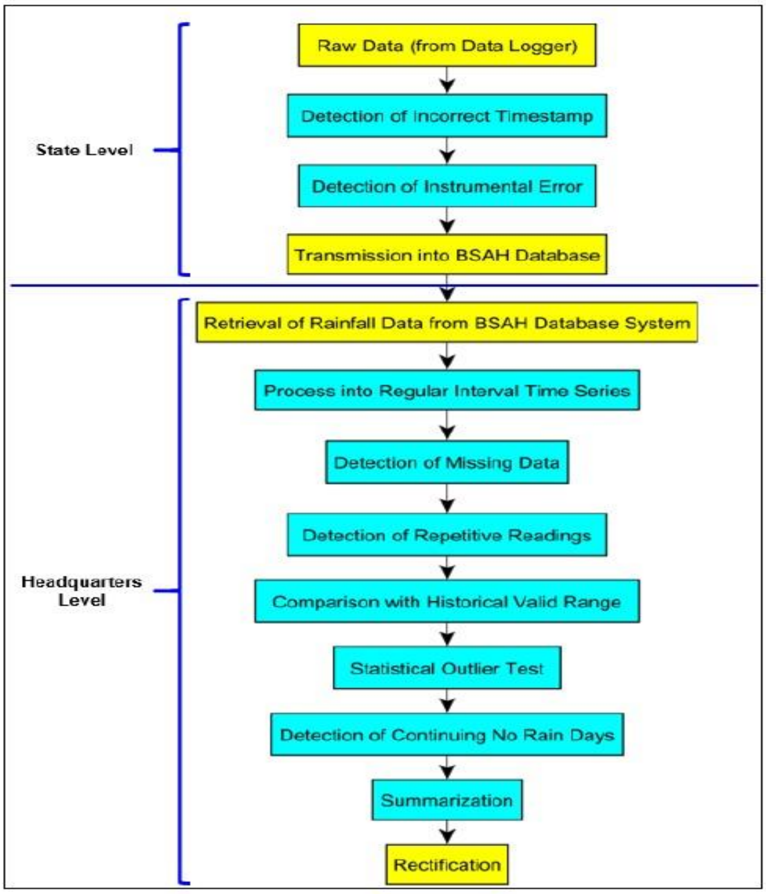

Figure a-1 : Rainfall data quality checking and screening procedure

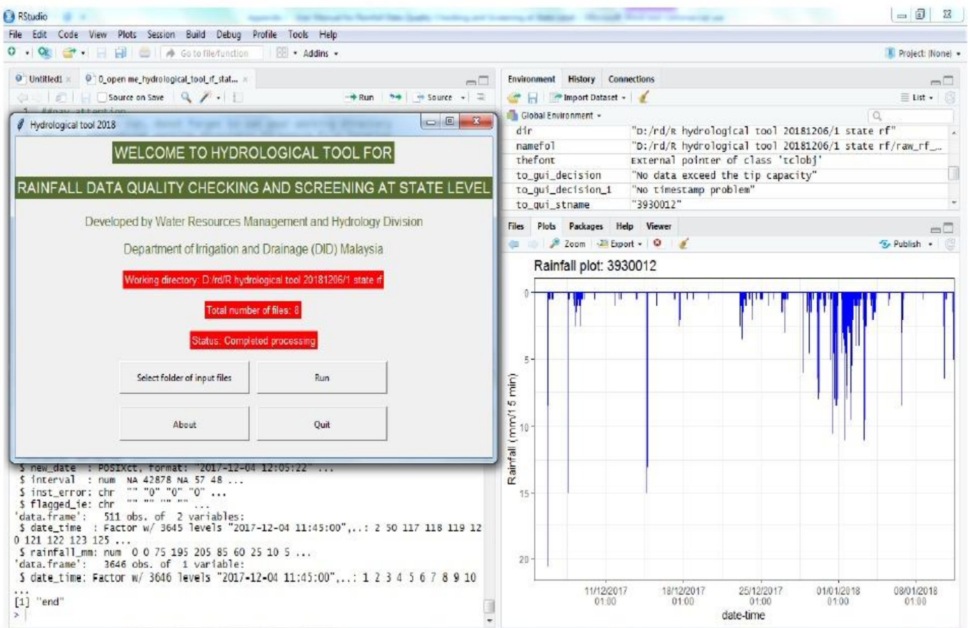

Figure a-2 : Water Level Data Quality Checking and Screening

HP No. 28 were applied to raw data before archived into DID database which is carried out at State Level and historical data sets in database which is carried out at Headquarters Level. **Table a-1** below shows main benefits of HP No. 28 implementation compared to previous approach.

Table a-1: The advantages HP28

No.	Item	Current Practice	Hydrological Tools
1	**Raw data before archived into database**	• Manual checking & editing/correcting the raw data, prior to conversion into DID database format	• Automatic inspection, flagging & immediate rectification of potential errors originating from instrumentation: i. Correction of the time stamp ii. Detection and correction of instrument error prior to conversion into DID database format.
	Time spent (per station)	• 15-20 mins (field officers) • 10 mins (data management officers)	• < 5 mins (field officers) • < 5 mins (data management officers)

2	**Hydrological data already archived into database**	• Archive the data received from State into BSAH database • Manual checking & editing the gaps & obviously erroneous data based on individual's experience & knowledge • No rectification is carried out	• Automatic inspection & flagging for potential errors originating from: i. Missing data ii. Repetitive readings iii. Outliers (PMP, statistical & historical valid range) iv. Continuing no rain days for further rectification (if required) • Flagging, monthly & annual summary to be reviewed by DID officers • Rectification could be carried out (RF: IDSW&ANN; WL: ANN&MLR)
	Time spent (per station)	• 10-15 mins (data quality checking)	• 5-10 mins (data quality checking) • 15-30 mins (data rectification)

(ii) Adoption of AQUARIUS Program to Replace TIDEDA

DID have been using TIDEDA (Time Dependant Data) since 1970s for the centralised hydrological data management (HDM). TIDEDA, in its current state, will be supported until 2020, but no new features are being developed and only bugs being fixed. DID decided to migrate to a newer HDM based on a thorough business analyses, benefits that AQUARIUS software will bring through its wide international user base and related advanced features with ongoing development efforts (compared to the TIDEDA system). AQUARIUS program equipped with an advanced and more comprehensive data manipulation tools, data history management and data corrections including roll-back and undo facilities. An intuitive, web-based, user interfaces allowing much more granular data manipulations and operate in a network environment leads to increased efficiencies.

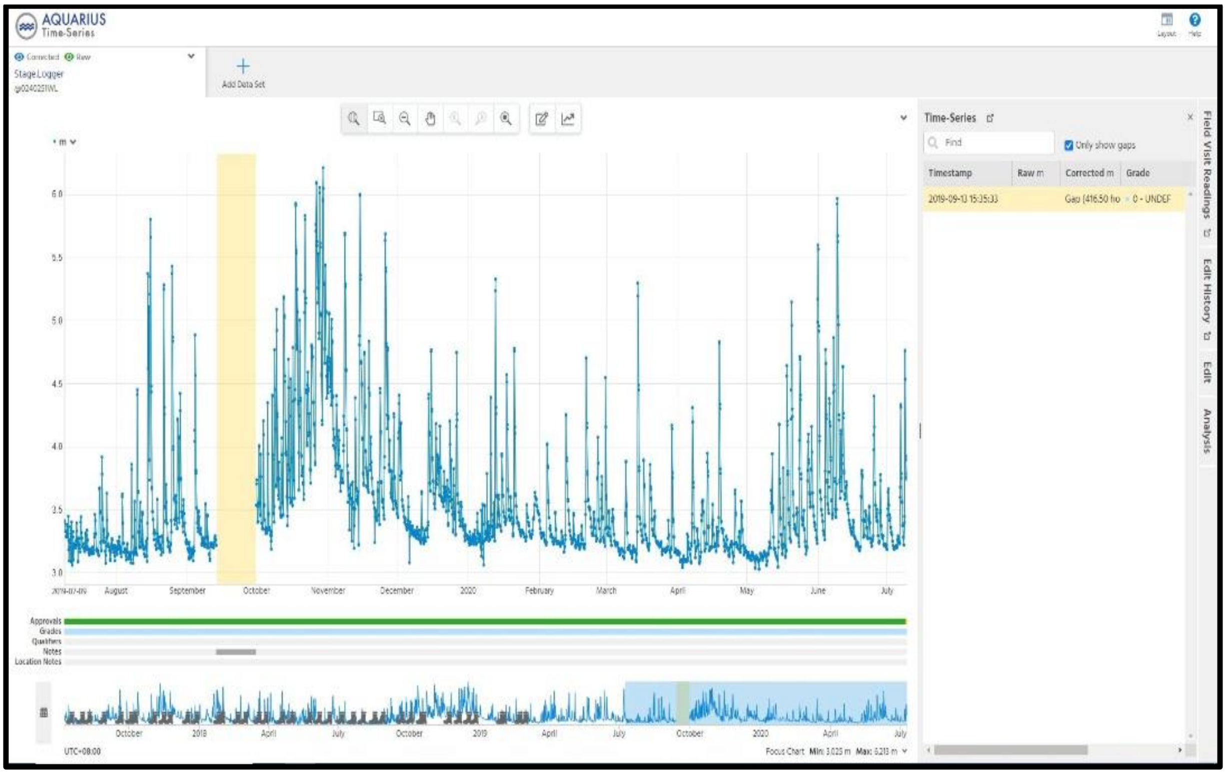

Figure a-3 : Water Level Data Manual Correction in Aquarius

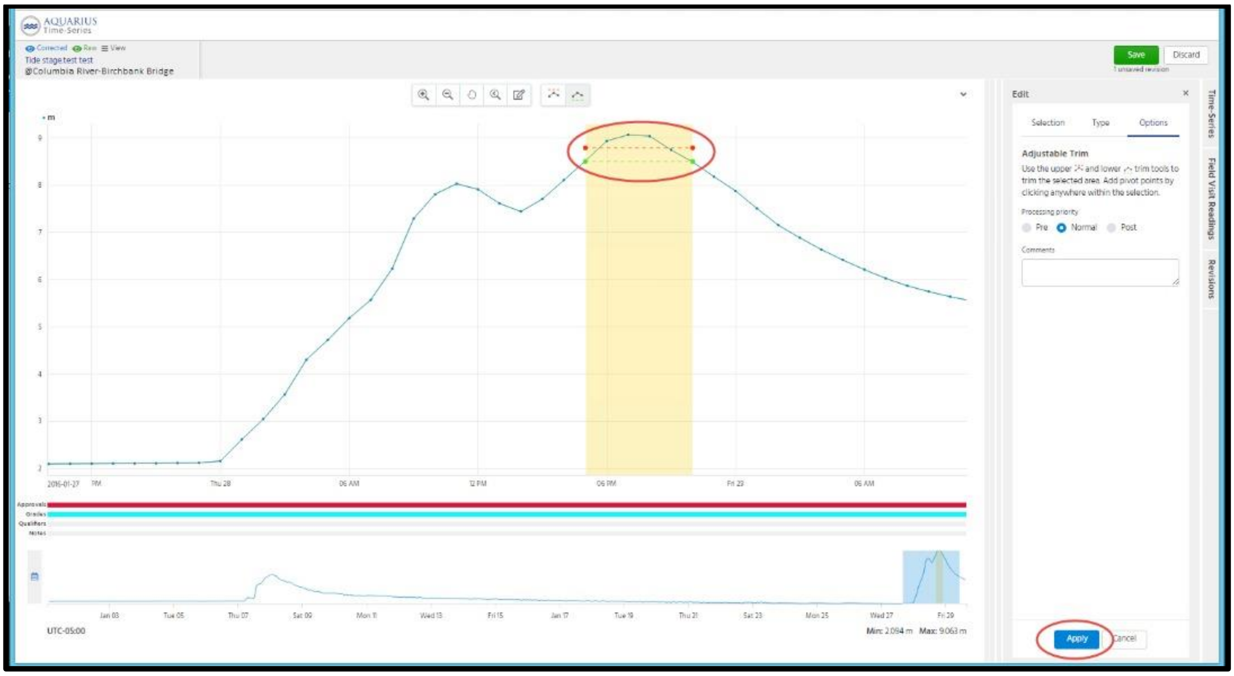

Figure a-4 : Data Correction Tools in Aquarius

With the new HP 28 and Aquarius in place, data checking and archiving process in DID has escalated to a new level in order to support new demands and future of hydrological data management. It is also anticipated that all stakeholders involved will benefit from actions taken by DID.

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

Priority Areas Addressed:

Hydrology

Hydrological data management is very crucial exercises and the automation for data cleaning not suitable for all types of data error. Therefore, checking by human with the advanced screening and gap analysis tool will help to expedite the process. The competence personnel must be developed and locate properly.

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(b) AOP4: OSUFFIM Phase-II: Extension of OSUFFIM Application in TC Members

Before the outbreak of Covid-19 widespread in Malaysia early Mac 2020, the project achieved significant progress result of development urban flash flood model. Two successful activities can be describes as below:

(i) Technical meeting and discussion between flood forecast model expert from DID and Sun Yat Sen University was carried out in 8th October 2019 until 13 October 2019. The model simulations result evaluated and come out the better solution method to improve the model accuracy.

(ii) On-site data collection was carried out in Penang river for 1 week between 25 November 2019 to 30 November. The detail activity is reported below.

Pulau Pinang covers an area of 1048km^2 and is located on the north-eastern region of Peninsular Malaysia. Sungai Pinang catchment area approximately 53.54km^2 and it is the largest, most build-up river in Penang Island. Sungai Pinang begins at the confluence between Sungai Air Itam and Sungai Air Terjun, at Dhoby Ghaut. From there, it flows southeast under Jalan Air Itam, then makes a gentle curve south of Gopeng Road. It passes through the Malay village north of Jalan Langkawi and then Lintang P. Ramlee. This is a low-lying area where Sungai Pinang is prone to flash floods. The river finally discharges to Selat Utara on the north east of the island as plotted in **Figure b-1**.

Figure b-1: The location of the OSUFFIM Pilot Project, Penang, Malaysia

A programme of data collection that carried out in the late of November 2019 were presenting from the Penang State DID, Pusat Ramalan dan Amaran Banjir Negara (PRABN) and Unit Pengurusan Maklumat (BSAH) and expert's from Sun Yat Sen University (SYSU), the delegate was lead by Prof. Yongbo Chen himself and assisted by a 2 postgraduate students.

To develop a rating curve, a series of gauging data was need to plot especially for low, medium and high condition. During 5 days programme, the team was able to collect 1 session low flow data as there was no rain. The equipment use is an Acoustic Doppler current profiler (ADCP). **Figure 2** shows the equipment itself and use during data collection.

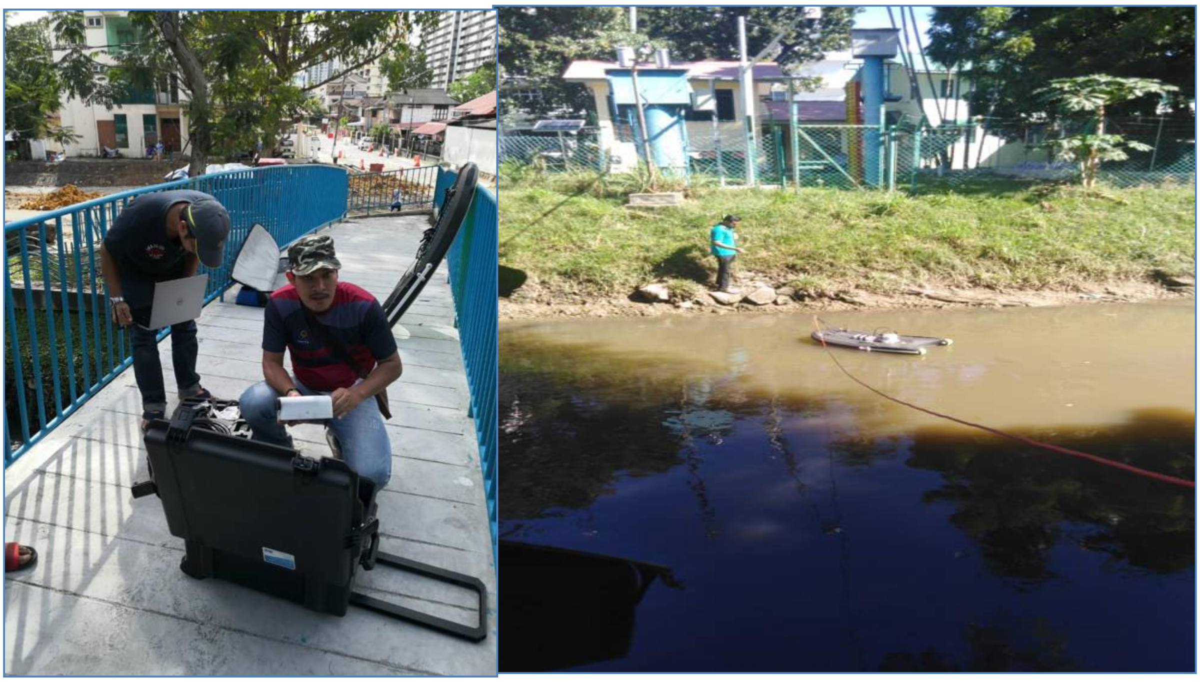

Figure b-2: Using ADCP to collect flow data

SYSU have identified 16 locations to obtain the cross-section data. The location is a shown in **Figure b-3**. The product for the cross section is the width and the depth of the river. The equipment use is a measuring tape, a staf and an electronic measuring meter. **Figure b-4** show an example river cross-section at Batu Lancang (Point no. 11).

It is planned that the parameter optimization and model finalization will be finish in November 2020. However since the covid-19 outbreak impacted to both countries, the programme is rescheduled to the next year, 2021. Meanwhile DID will collecting more hydrological data and latest cross- section information to be used for model improvement.

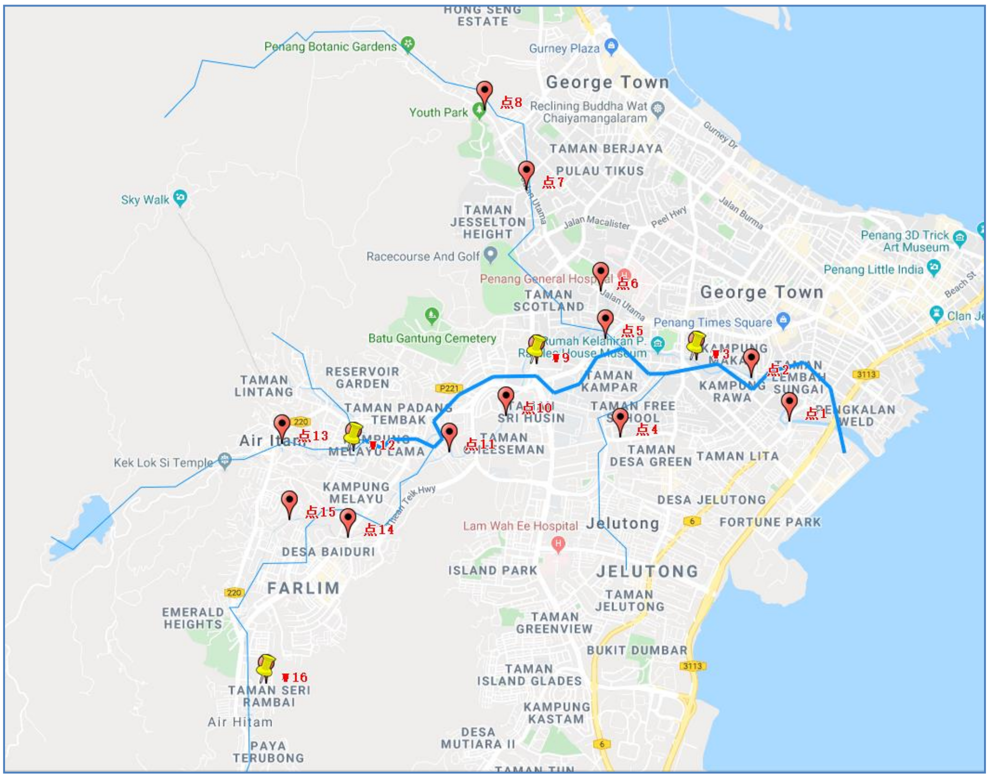

Figure b-3. 16th location points to obtain the cross-section data

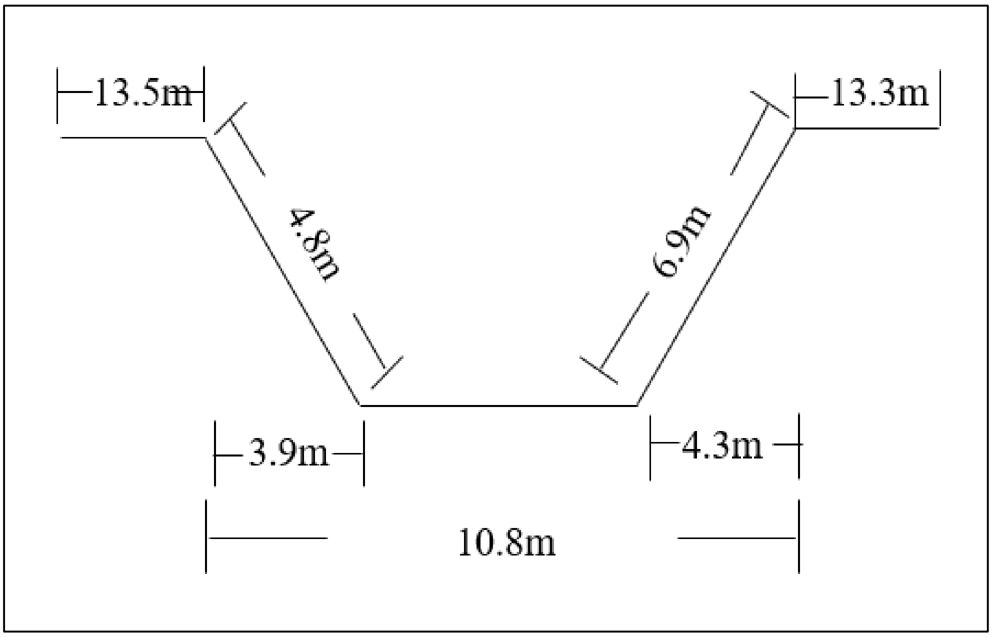

Figure b-4. The river cross section for the Batu Lancang (Observation point 11)

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

(i) The opportunities in the project is to gain knowledge transfer in the development of a hydrological model.

(ii) Sungai Pinang is a potential pilot study location as it is prone to flood and it is dense in populations

(iii) The current scenario related to Covid-19 which makes it difficult to implement physical projects

Priority Areas Addressed:

Hydrology

Ensure complete and consistent hydrological data in a various weather conditions. Hydrological data is a key input in flood modeling that has a significant impact on the accuracy of the flood forecast result.

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(c) AOP5: Impact Assessment of Climate Change on Water Resource Variability in TC Members

In cooperation with Hydrological Forecast Centre (HFC) and the Research Centre for Climate Change (RCCC) under the Ministry of Water Resource (MWR) of China the Training Workshop on RCCC Water Balance Model (WBM) was held on the 19-20 January 2019 and 27-29 December 2019. The training was prepared and delivered by Nanjing Hydraulic Research Institute (NHRI), Hydrology and Water Resources Department. This training course was attended by 2 officers did namely Mr. Muhamad Syukri Bin Mohamed Rodzi and Muhammad Hakim Bin Hasnul.

The principle training outlined is to assess the impact of climate change on water resource using RCCC-WBM, which is Water Balance Model developed by NHRI. The training session was facilitated by Professor Guoqing Wang from NHRI. The objectives of the training session are as follows :

i. Application of RCCC WBM in selected catchment in Malaysia and Vietnam
ii. Knowledge sharing on Water Resource Management in TC Member countries

On the other hands, there is additional experts' during knowledge sharing by the Water Expert from Nanjing China. The topics of knowledge transfer are as follows:

i. Development of Flood Forecasting System in China by Dr. Hou Aizhong from Hydrological Forecast Center, China.
ii. Quantifying Effects of Urban Land use Pattern on Flood Regime for a Typical Urbanized Basin: A Case Study in Qinhuai River Basin, China by Mingming Song (NHRI);
iii. The Trends of Water Resources and Water Usage in China During The Recent 20 Years, 1997-2016 by Jin Liu (NHRI);
iv. The Impact of Climate Change on Water Resource Variability in TC Members by Dr Zhenxin Bao (NHRI);
v. Introduction of the RCCC-WBM Model by Dr Xiongpeng Tang and Prof. Zhenxin Bao (NHRI)

Analysis Result for Study Area

(i) Muda River Basin

The catchments characteristic of Muda River Basin has been elaborated in the previous report of AOP5. In general, Malaysia has used a data from Muda River Basin from years 1970 until 1991 (the data more than 10 and 30 years is essential for model calibration and climate change impact assessment).

The outputs of RCCC WBM model are based on the input of data, model calibration, model validation and statistical performance.

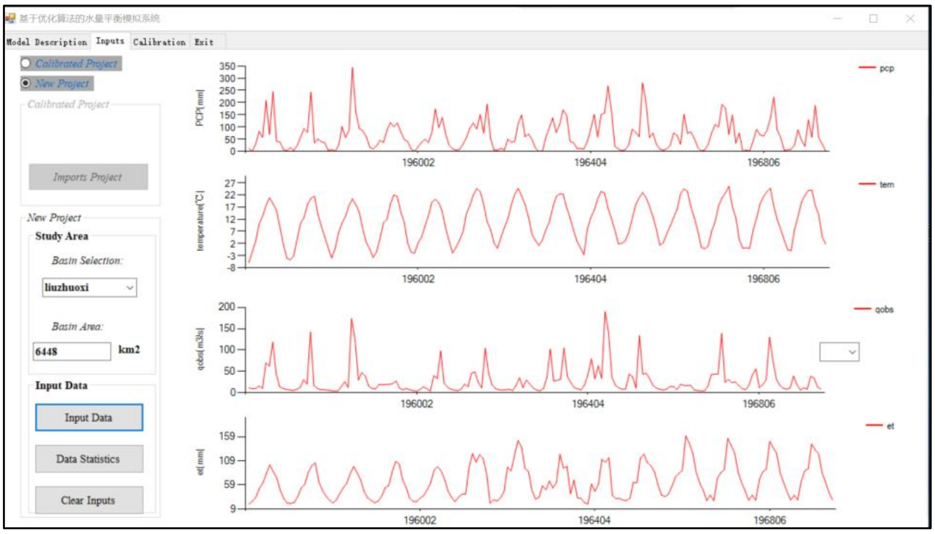


Figure c-1 : Analysis performance of input of data

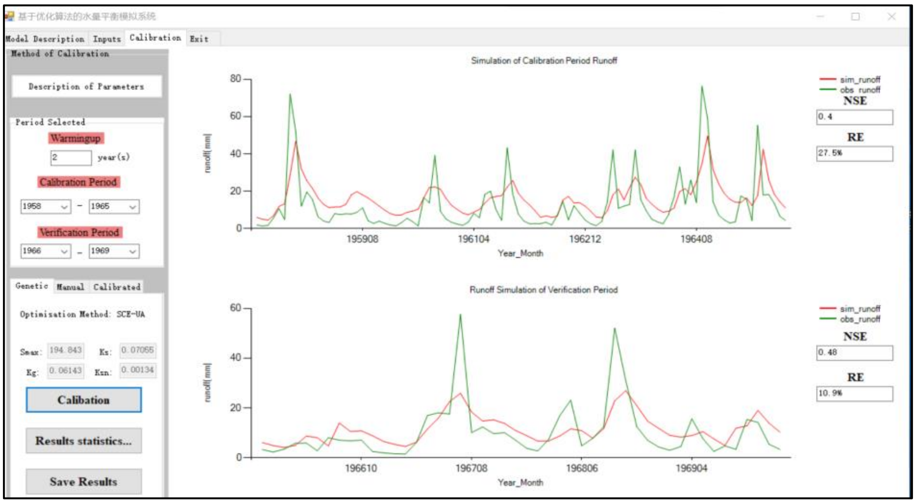


Figure c-2: Calibration Process (Auto or Manual)

The value of Nash–Sutcliffe efficiency (NSE) coefficient for both calibration and validation period more than 0.7 but for regulated flow in Muda River Basin, the best NSE for calibration is 0.49 and validation period is 0.77.

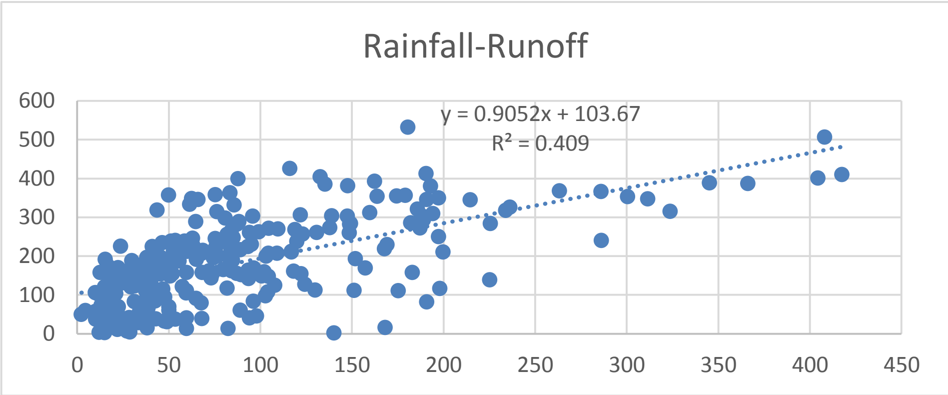


Figure c-3: Rainfall-Runoff Correlation for Muda River Basin

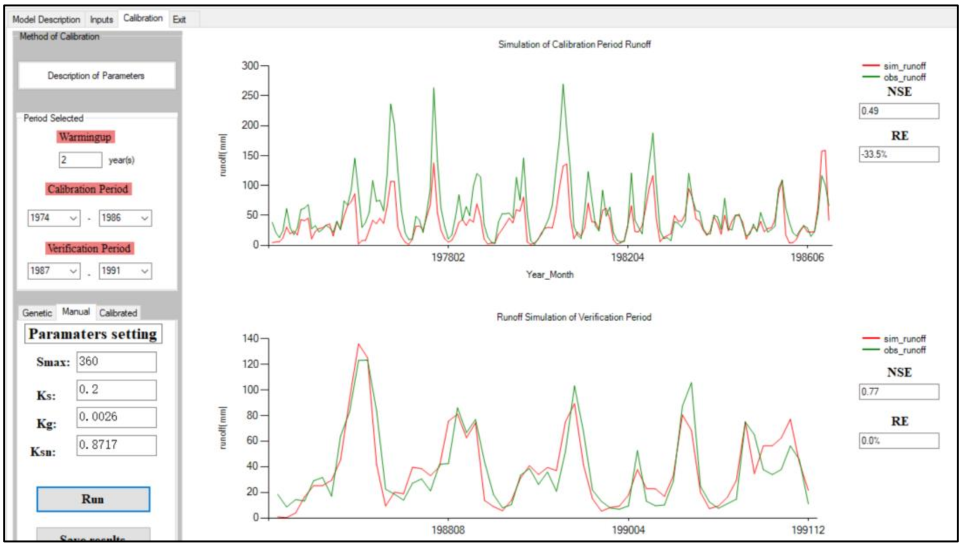


Figure c-4: Result for Calibration and Validation Period in Muda River Basin

(ii) Perak River Basin

Perak River is the second longest river in Peninsular Malaysia after the Pahang River. It has a length of about 450 km and a catchment area of 14,908 km^2, covering of about 71% of the total land area in Perak. There are six main tributaries in the Perak River Basin, which are Rui River, Temenggor River, Piah River, Pelus River, Kinta River and Bidor River.

The river begins at the center of the mountains at an altitude of more than 2,000 meters above sea level on the northern coast of Perak, which runs south before finally reaching the Straits of Malacca in Bagan Datoh.

The model output as below :

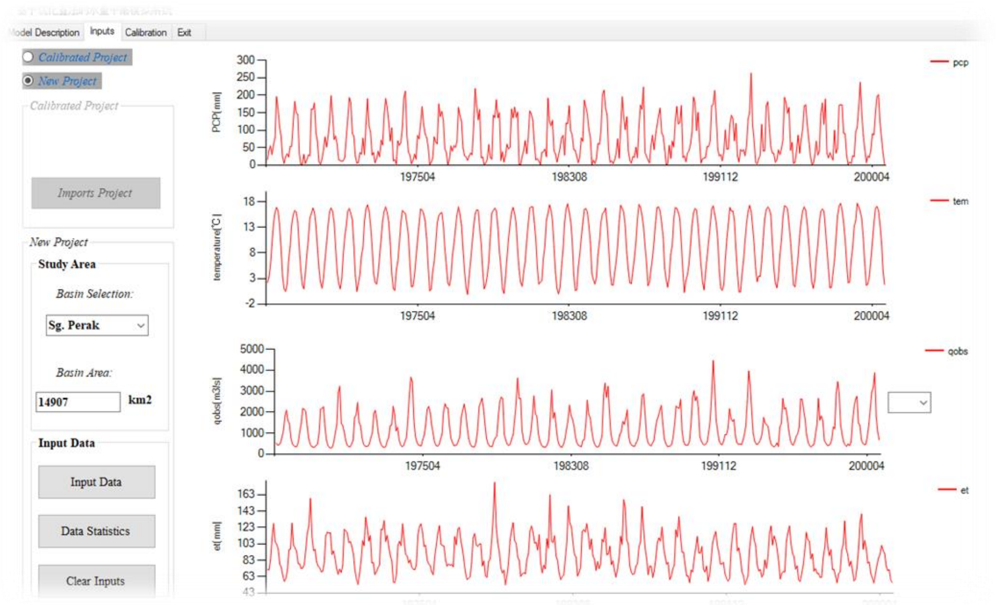


Figure c-5: Analysis performance of input of data fo Melaka river basin

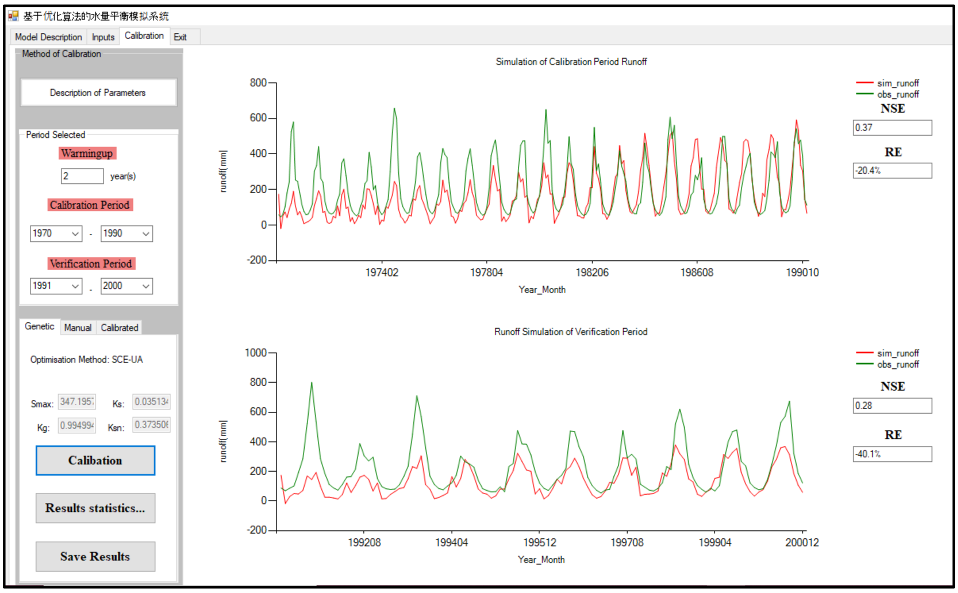


Figure c-6: Calibration Process (Auto or Manual)

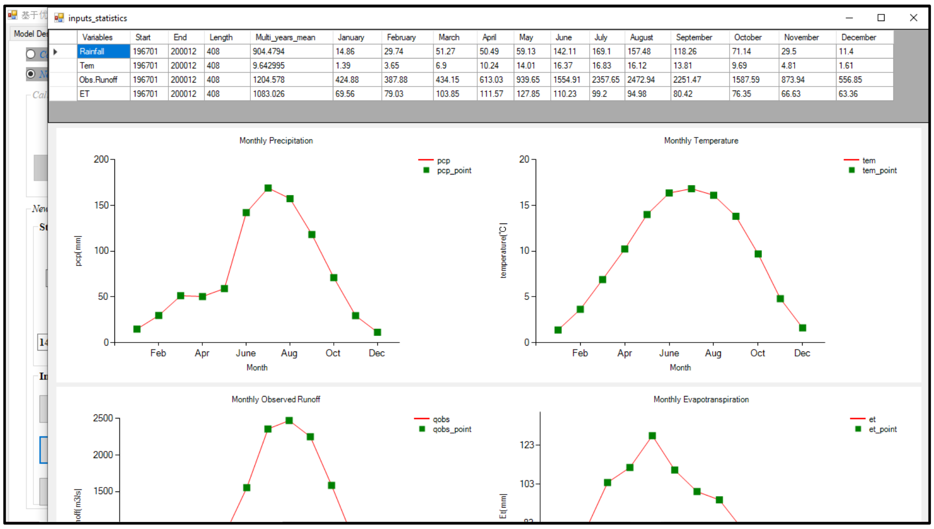


Figure c-7: Result for Calibration and Validation Period in Melaka River Basin

The maximum value of rainfall and river discharge is 99.7 mm and 523.33 m^3/s. The minimum value of rainfall and river discharge is 1.33mm and 3.33 m^3/s. Meanwhile the average value for rainfall and river discharge of Perak River Basin is 127.108 mm and 51.79 m^3/s respectively.

The statistical performances are as follows :

Biasness = Qsim – Qobs = 151.2928 – 20.08044 = <u>131.21236</u>

RMSE = ((total (simulated - Observed)^2)/number of data)^1/2 = <u>6.812</u>

The best value of NSE during calibration and validation periods is 0.37 and 0.28 respectively.

(iii) Melaka River Basin in Langkawi Island

The agricultural sector, which is mainly rice cultivation, is the main land use within the Melaka River Basin Langkawi which accounts for 65%, while 35% is forest reserve in the area. The Melaka river basin area excluded Padang Saga dam is 55 km^2. The Melaka River, Langkawi have in length of about 8.8 kilometers and river width of about 20 to 28 meters.

Major tributaries in the study area are Limbung River, Saga River, Bukit Hantu River and Ulu Melaka River.

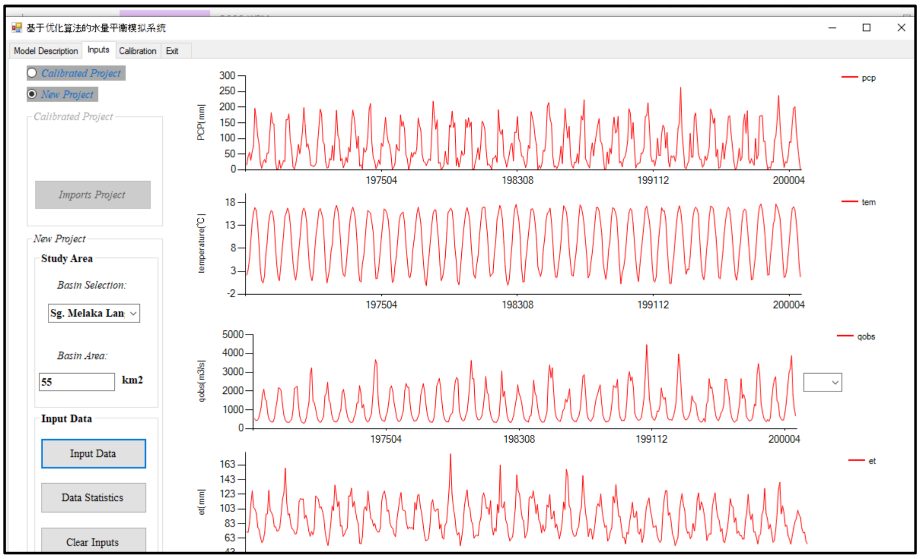


Figure c-8: Analysis performance of input of data fo Melaka river basin

The period of calibration data is from year 1970 to 1990 and the validation period is from year 1991 to 2000.

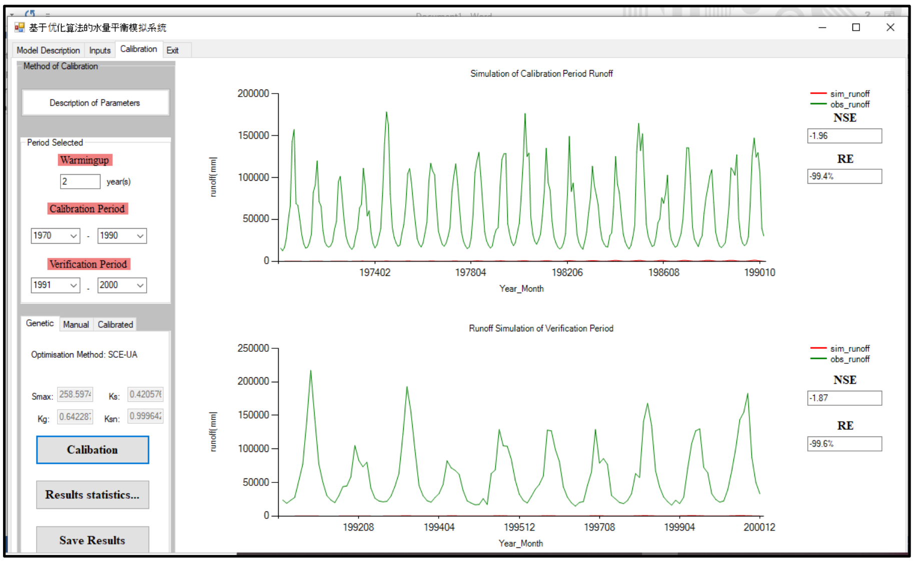
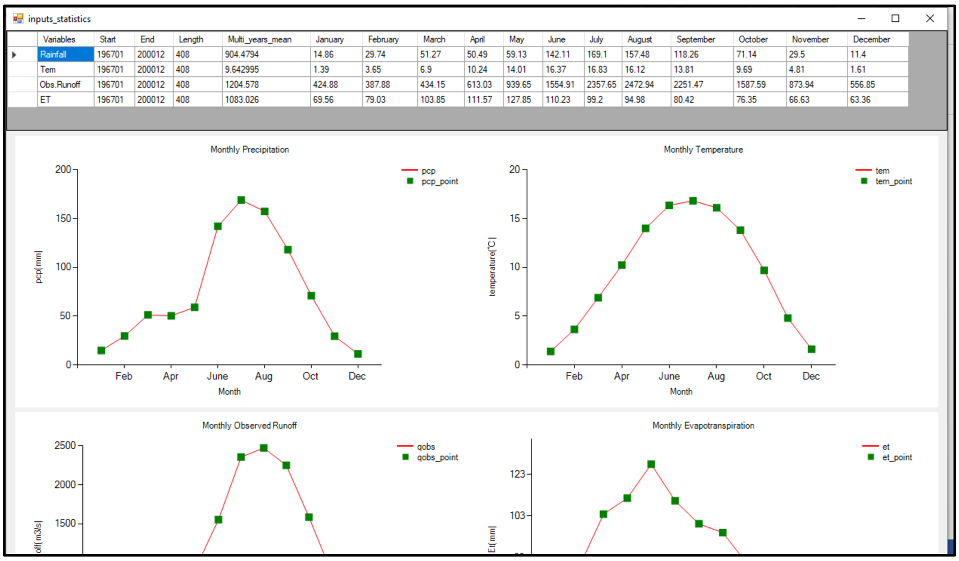


Figure c-9: Calibration Process (Auto or Manual)



	Variables	Start	End	Length	Multi_years_mean	January	February	March	April	May	June	July	August	September	October	November	December
▸	Rainfall	196701	200012	408	904.4794	14.86	29.74	51.27	50.49	59.13	142.11	169.1	157.48	118.26	71.14	29.5	11.4
	Tem	196701	200012	408	9.642995	1.39	3.65	6.9	10.24	14.01	16.37	16.83	16.12	13.81	9.69	4.81	1.61
	Obs.Runoff	196701	200012	408	1204.578	424.88	387.88	434.15	613.03	939.65	1554.91	2357.65	2472.94	2251.47	1587.59	873.94	556.85
	ET	196701	200012	408	1083.026	69.56	79.03	103.85	111.57	127.85	110.23	99.2	94.98	80.42	76.35	66.63	63.36

Figure c-10: Result for Calibration and Validation Period in Melaka River Basin

The maximum value of rainfall and river discharge in Melaka river basin is 1150mm and 458.3 m^3/s. The minimum value of rainfall and river discharge is 1.5mm and 4.1 m^3/s. Meanwhile the average value for rainfall and river discharge of Perak River Basin is 135.7mm and 183.2 m^3/s respectively.

The statistical performances are as follows :

Biasness = Qsim – Qobs = 183.23 – 44.679 = <u>138.55</u>

RMSE = ((total (simulated - Observed)^2)/number of data)^1/2 = <u>7.19</u>

The best value of NSE during calibration and validation periods is 1.96 and 1.87 respectively. The result justification of this catchment is the catchment characteristics of Melaka river basin which has been influenced by the dam operation in upper stream. Therefore, the selection of data input has to be analysed by using unregulated catchment.

Participant Group Photos during the workshop:

Figure c-11: Group of members from 19-20 January 2019 (left) and 27-29 December 2019 (right)

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

Priority Areas Addressed:
Hydrology & Water Resources

The water balance analysis is mainly to estimate the value of water availability in any selected river basin. On the other hand, in hydrology perspective, the water availability is a key element in water resources either for drought and flood forecasting estimation. Therefore, a few proposal for knowledge transfer from among water expert in TC members or its China Water Expert to Malaysia Water Resources Management sector especially among those water resources manager at state level. List of proposal for future knowledge transfer are as follows:

i. Off-line Water Balance Software via RCCC program has been implemented in 2019;
ii. Looking forward real time software for water balance operation in any selected river basin in Malaysia.

The outcome of this program is to provide a user-friendly software and in real time mode for state water manager. It shall be able to provide early warning operation during hot and dry weather condition for state water operation.

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(d) AOP6: Flood Risk Watch Project for Live - Saving

The implementation of AOP6 in Malaysia has started at the end of 2018 after MLIT submitted a proposal at the WGH meeting. In early January 2019, DID were managed a technical visit for MLIT with delegates from ICHARM and IDI, Japan to Malaysia. The objectives of technical visit 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 stations in the Sg. Kelang, Sg. Langat and Sg. Pinang. This is to make sure they understand and will identify the most suitable location for the establishment of a 3L water level station. At the end of this visit, IDI experts has agreed to consider to install 3L station at 2 locations, namely Sulaiman Bridge Station in Sg. Klang and Batu Lanchang station in Sg. Pinang.

	
Sulaiman Bridge Station	Batu Lanchang Station

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 station in Japan. A technical visit was held at the end of January 2020.

Both Departments have made a plan to hold further technical discussions to finalise all station 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 issues, 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 stations will be implemented in early 2021 and is expected to start recording and transmitting data in March 2021.

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

The challenges in implementing this 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 construction and data sharing involving 2 countries

(iii) The current scenario related to Covid-19 which makes it difficult to implement physical projects

Priority Areas Addressed:
Hydrology

Ensure complete and consistent hydrological data in a various weather conditions. Hydrological data is a key input in flood modeling that has a significant impact on the accuracy of the flood forecast result.

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3. IMPROVE DISASTER RISK REDUCTION FRAMEWORK INCLUDING WIND-RELATED HAZARD

The Government of Malaysia's Commitment Towards Supporting the Sendai Framework for Disaster Risk Reduction

No nation or community is immune to disasters be it natural, man-made, or biological as what we are facing at the moment – the deadly COVID-19 that have caused large-scale consequence globally in terms of economic and morbidity. Looking into the current increase in exposure, high level of inequality, rapid urban development and environment degradation, the risk of disaster may surge to dangerous levels. One way to reduce the impacts of disaster is to invest in bolstering resilience. Thus, the ultimate goal of the Government's commitment towards SFDRR is to ensure the system, community or society exposed to hazards are able to resist, absorb, accommodate, adapt to, transform and recover from its effects.

In order to achieve resilience, the government is doing its utmost to understand risks in all dimensions; guiding both public and private sectors to address disaster risks through strengthened risk governance; putting in place multi-hazard early warning systems; protecting assets; improving the safety and functionality of critical infrastructures and basic services; and strengthening disaster preparedness, in line with the 4 priorities identified under the SFDRR.

Some of the current efforts toward disaster risk reduction that can be highlighted are as follows:

(i) Establishment of a committee and task force to develop hazard and risk map for 5 types of hazards: geology, hydrometeorology, haze, hazardous materials and nuclear hazard.

(ii) Completing a preliminary study on national risk register to compile historical events in one repository system, and to rank disaster risks based on expert judgement;

(iii) Coordinate and conduct Community Based Disaster Risk Reduction (CBDRR) programme, simulation and disaster drill on a regular basis; and

(iv) Exploring risk transfer mechanism through insurance and other safety net initiatives.

It is important to note that the progress of implementation of this framework is reported annually through global and regional platforms, organized by the United Nations Office for Disaster Risk Reduction (UNDRR).

Malaysia will continue to commit and play an important role to mainstream disaster risk reduction aiming to reduce disaster risks, the loss of human lives, impact on livelihoods and critical infrastructure.

DRR policy and programmes needs to be integrated at all levels, vertically and horizontally in order to strengthen resilience of people, asset and the environment against disaster risk either natural or man-made .

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

To improve the assessment of the impact of wind related disaster namely tropical storm and typhoon for the reporting of country's Sendai Framework Monitor.

Priority Areas Addressed:

Disaster Risk Reduction

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