MEMBER REPORT
MALAYSIA

ESCAP/WMO Typhoon Committee
16th Integrated Workshop
(Video Conferencing)
2-3 December 2021

Table of Contents

I. Overview of tropical cyclones (TCs) which have affected/impacted Malaysia in 2021 .. 1

1. Meteorological Assessment 1
2. Hydrological Assessment 13

II. Summary of progress in Priorities supporting Key Result Areas 20

1. Radar Integrated Nowcasting System (RaINS) 20
2. Training Attachment on Radar Integrated Nowcasting System (RaINS) 2022 21

Identified opportunities/challenges, if any, for further development or collaboration: . 21

Priority Areas Addressed: 21

Meteorology 21

Hydrology 22

3. Annual Operating Plan for Working Group of Hydrology (AOP2, AOP4, AOP5, AOP6)........23

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

i) Study On Hydrological Data Trails Efficiency On Telemetry And Non-Telemetry Data Management System

Identified opportunities/challenges, if any, for further development or collaboration: 21

Priority Areas Addressed: 21

Hydrology 22

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

Identified opportunities/challenges, if any, for further development or collaboration: 30

Priority Areas Addressed: 30

Hydrology 30

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

Analysis Result for Study Area

(i) Muda River Basin........31

(ii) Perak River Basin........33

(iii) Melaka River Basin in Langkawi Island........35

Identified opportunities/challenges, if any, for further development or collaboration: 38

Priority Areas Addressed: 38

Hydrology 38

(d) AOP6: Flood Risk Watch Project for Live - Saving
Identified opportunities/challenges, if any, for further development or collaboration: 41
Priority Areas Addressed: 41
Hydrology 41

I. Overview of tropical cyclones (TCs) which have affected/impacted Malaysia in 2021

1. Meteorological Assessment

Twenty five TCs formed over the western Pacific, the Philippines waters, and the South China Sea (SCS) between November 1, 2020 and October 31, 2021. Eight of these TCs are observed within the Malaysian Meteorological Department's (MET Malaysia) maritime warning as illustrated in Figure 1. Depending on the placement of the TCs tracks over big bodies of water and the size of the rain bands, the arrival of these TCs may result in heavy rain or dry weather conditions.

The presence and movement of these TCs brought about storm surges over the Malaysia coastal areas bordering the SCS and Sulu Sea.

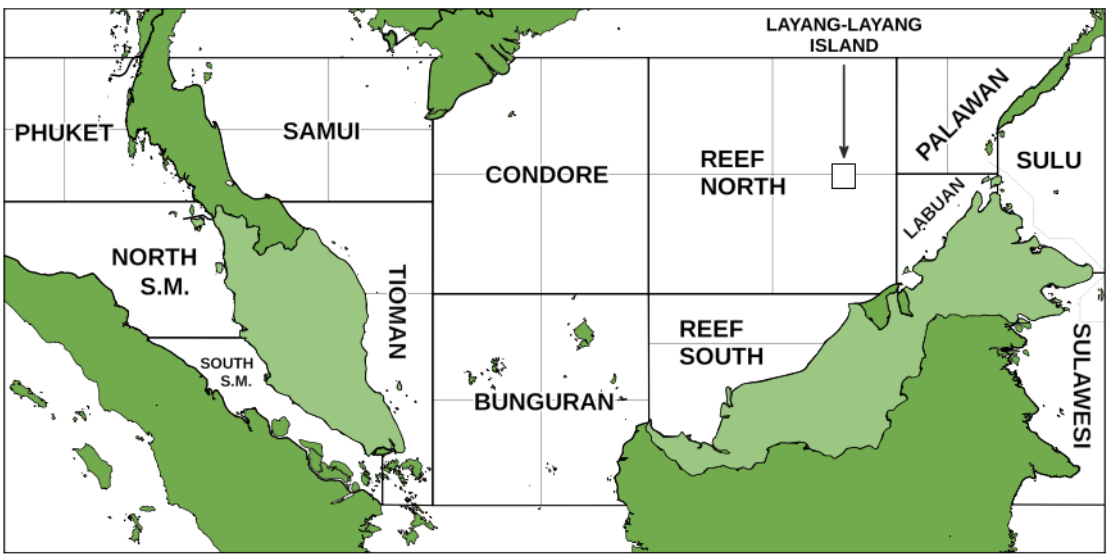
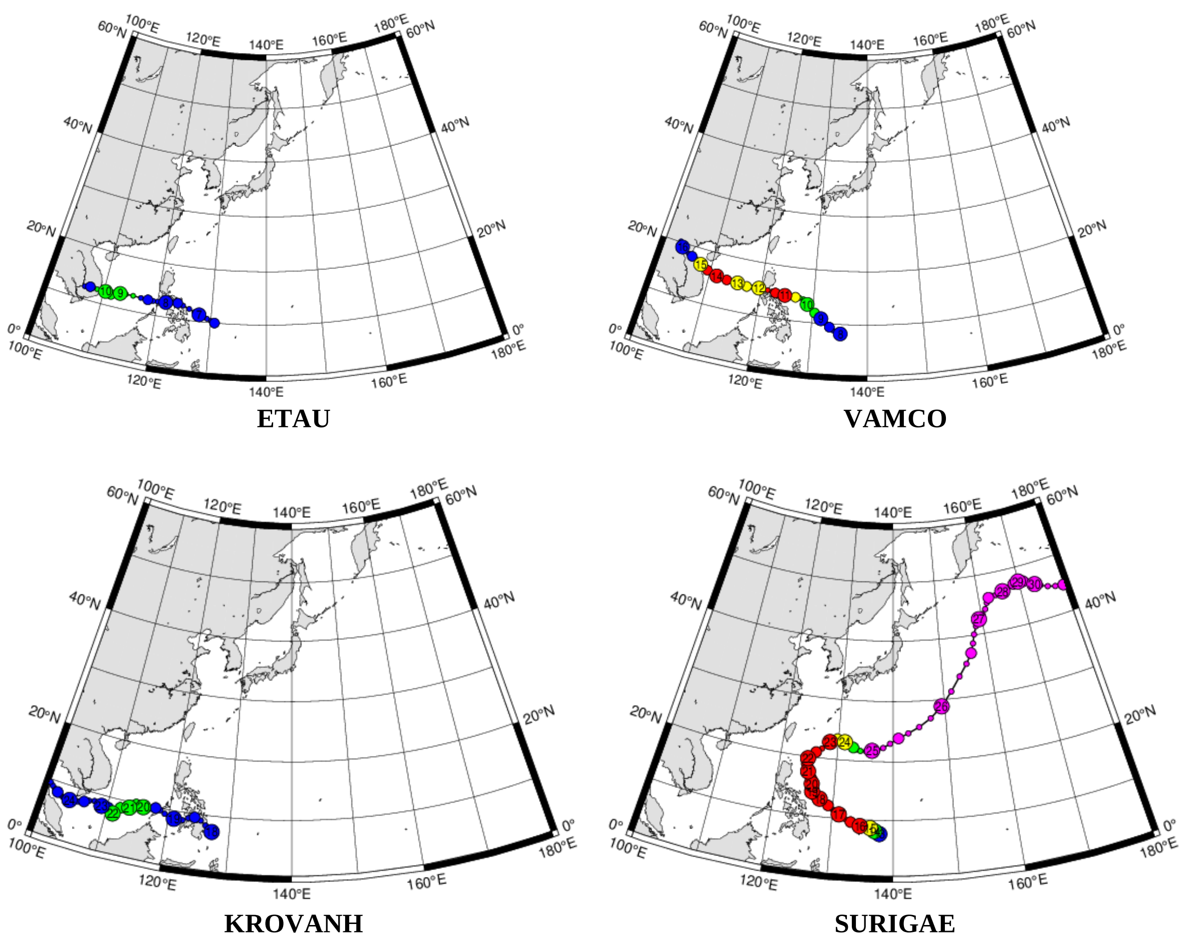


Figure 1 Malaysia's area of responsibility for maritime warnings

Table 1 List of typhoons and tropical storms with JTWC classification, date of birth and death and maximum wind from November 2020 to October 2021

No.	Tropical Cyclone	Category	Date		Maximum wind (knots)
			Birth	Death	
i.	Etau	Tropical Storm	8/11/2020	10/11/2020	45
ii.	Vamco	Typhoon	9/11/2020	15/11/2020	85
iii.	Krovanh	Tropical Storm	20/12/2020	22/12/2020	35
iv.	Surigae	Typhoon	13/4/2021	25/4/2021	120
v.	Conson	Severe Tropical Storm	6/9/2021	11/9/2021	55
vi.	Dianmu	Tropical Storm	23/9/2021	24/9/2021	35
vii.	Lionrock	Tropical Storm	7/10/2021	10/10/2021	35
viii.	Kompasu	Severe Tropical Storm	8/10/2021	14/10/2021	55

The trajectories of the typhoons and tropical storms closest to Malaysia are illustrated in Figure 2.



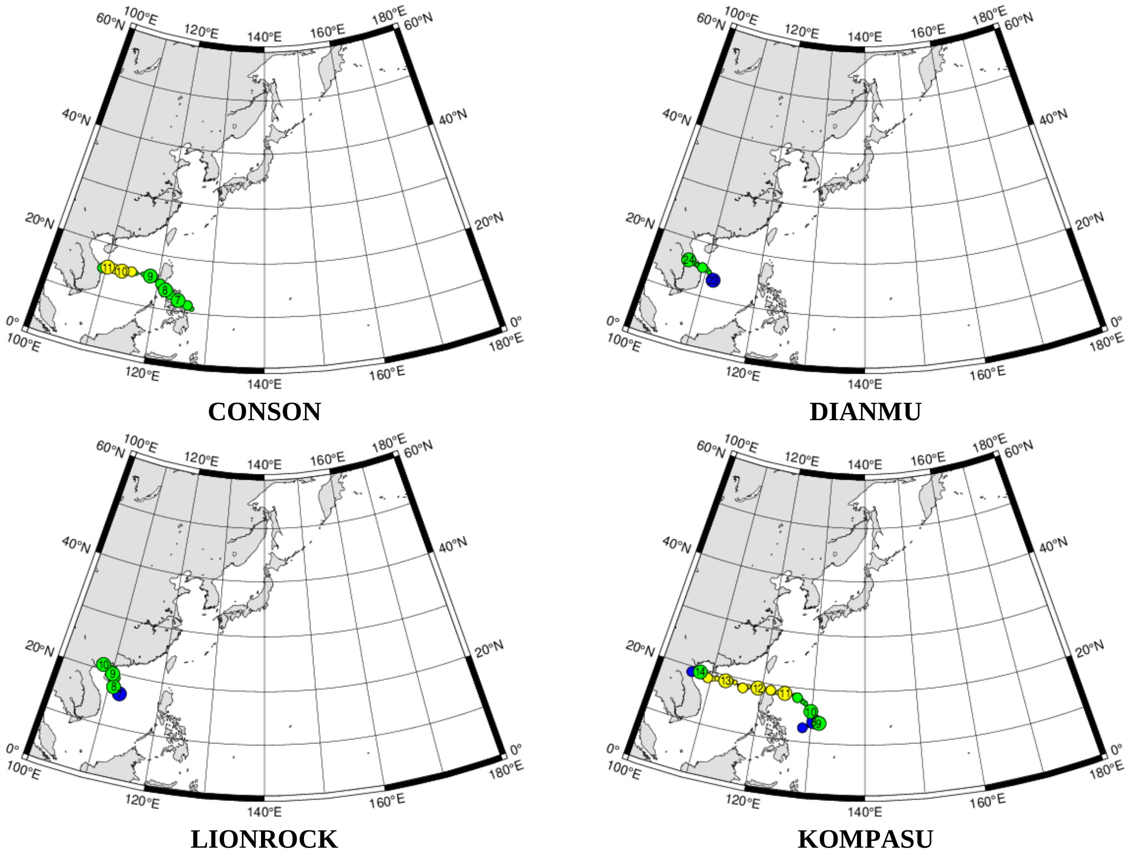
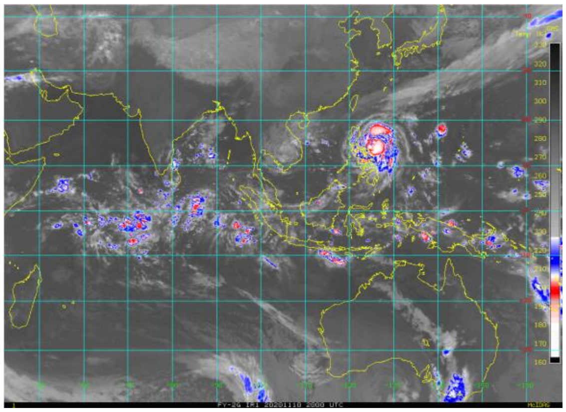


Figure 2 Traces of TCs relatively close to Malaysian waters from November 2020 to October 2021. Circled numbers represent the date on which TCs occurred.

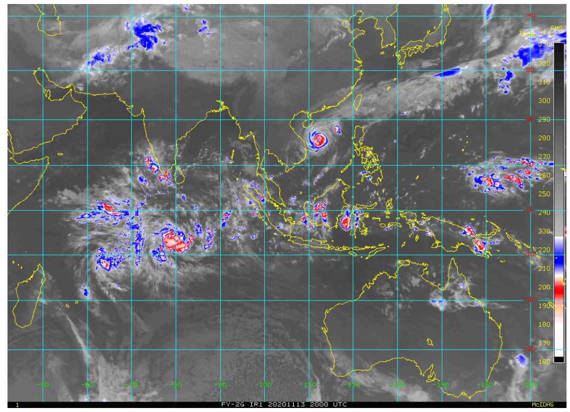
(Source: National Institute of Informatics (NII), Research Organization of Information and Systems (ROIS), Japan **(http://agora.ex.nii.ac.jp/digital-typhoon/latest/track)**

Due to the tail effect of TCs, the consequences of typhoons and tropical storms on the Malaysian region were restricted to rain and gust occurrences. The tail effect causes increasing afternoon convective weather over Malaysia, especially in northern Peninsular Malaysia, Sabah, and the Sarawak coast. Figure 3 depicts satellite photos of rain cloud clusters concentrated on the Malaysian region during TCs transits near Malaysia obtained from the FY-2G satellite channel.



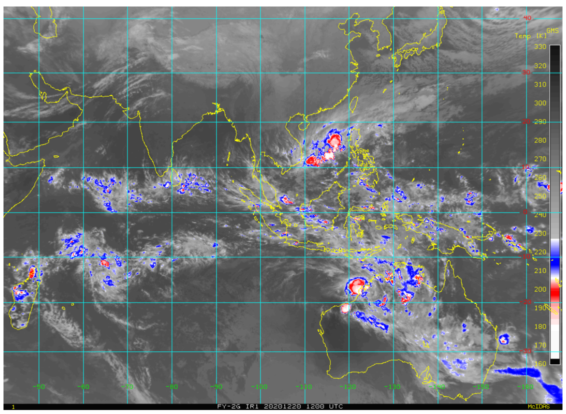
ETAU

Image produced by MET Malaysia on 20:00UTC 10/11/2020



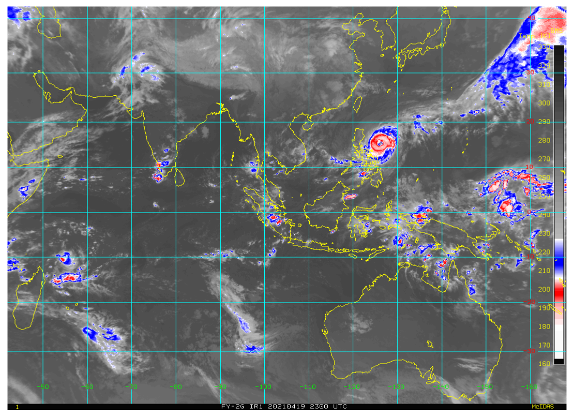
VAMCO

Image produced by MET Malaysia on 20:00UTC 13/11/2020



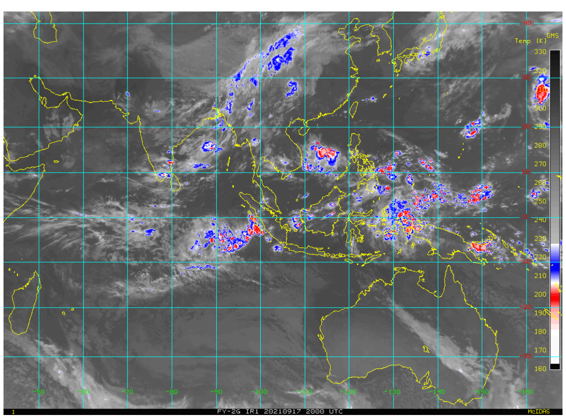
KROVANH

Image produced by MET Malaysia on 12:00UTC 20/12/2020



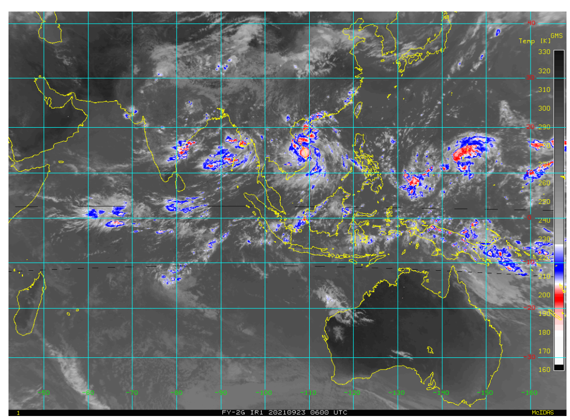
SURIGEA

Image produced by MET Malaysia on 23:00 19/04/2020



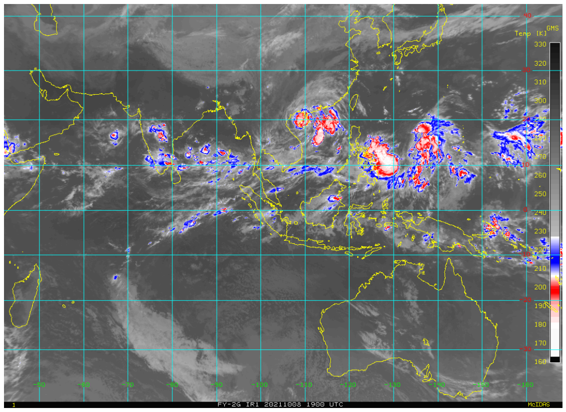
CONSON

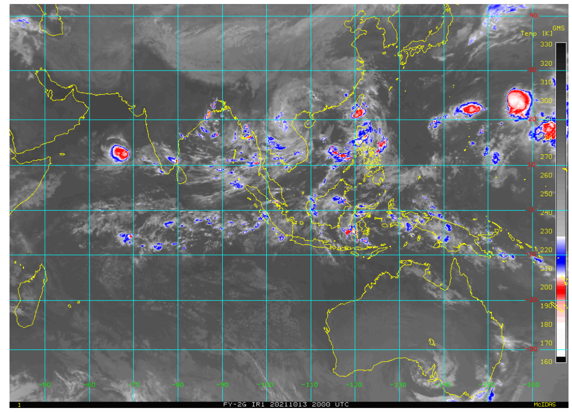
Image produced by MET Malaysia on 20:00UTC 17/09/2021



DIANMU

Image produced by MET Malaysia on 06:00UTC 23/09/2021



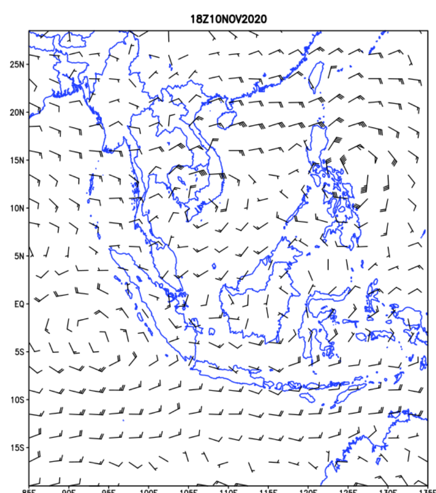


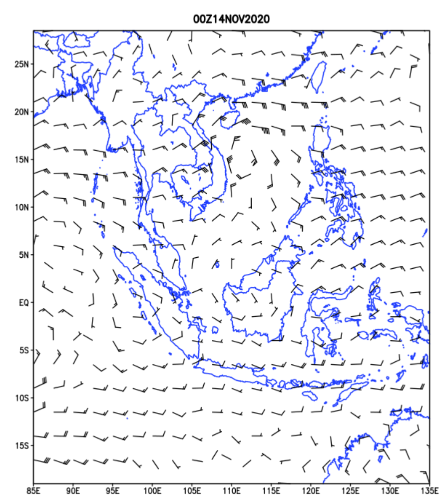
LIONROCK
Image produced by MET Malaysia on 19:00UTC 8/10/2021

KOMPASU
Image produced by MET Malaysia on 20:00UTC 13/10/2021

Figure 3 FY-2G satellite imageries showing the rain cloud clusters associated with some of the selected tropical storms and cyclones over the Malaysian region

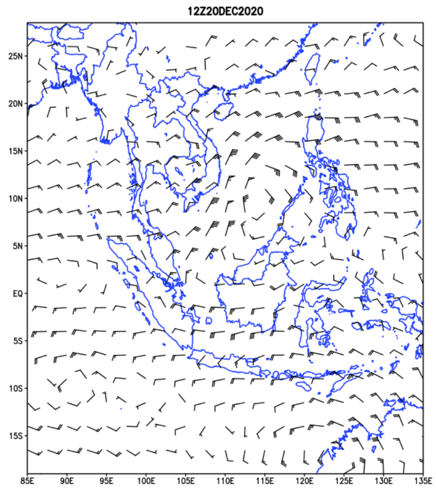
Typhoons and tropical storms are not the only factors contributing to the heavy rains in Malaysia, the monsoon wave has also brought heavy rains to parts of Malaysia. In addition to strong winds and heavy rains, high waves accompanied by storms also hit the coastal areas of Malaysia facing the SCS and 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.



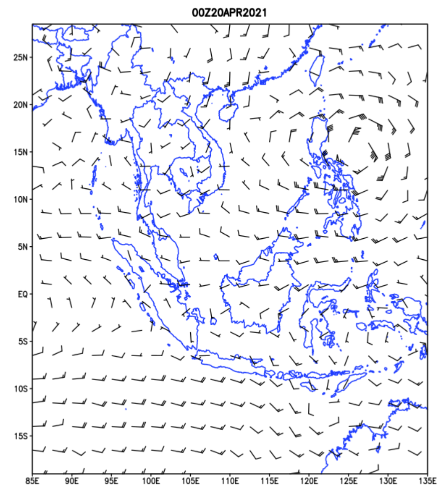


ETAU
Image produced by MET Malaysia on 18UTC 8/11/2020

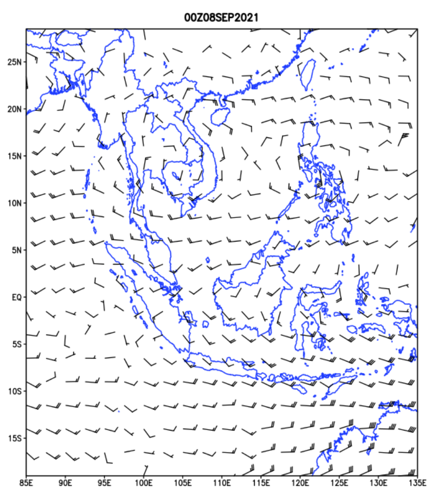
VAMCO
Image produced by MET Malaysia on 00UTC 14/11/2020



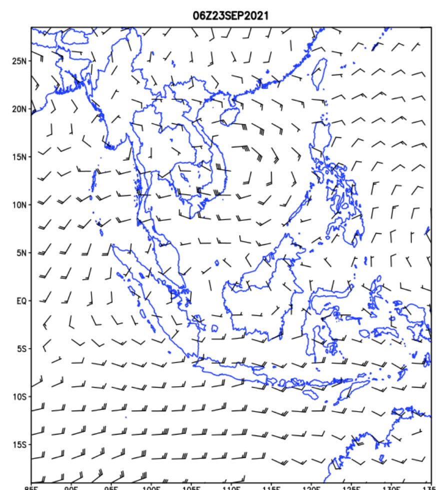
KROVANH
Image produced by MET Malaysia on 00UTC 20/12/2021



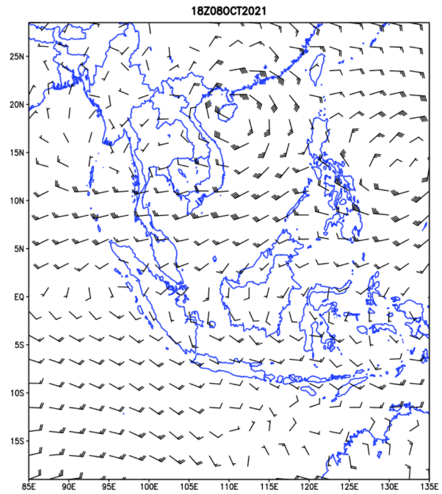
SURIGAE
Image produced by MET Malaysia on 00UTC 20/04/2021



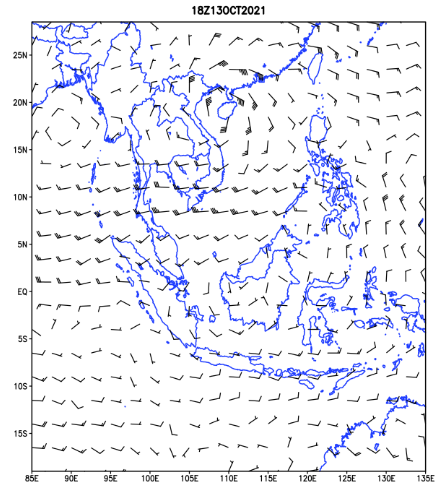
CONSON
Image produced by MET Malaysia on 00UTC 08/09/2021



DIANMU
Image produced by MET Malaysia on 06UTC 23/09/2021



LIONROCK
Image produced by MET Malaysia on 18UTC
08/10/2021



KOMPASU
Image produced by MET Malaysia on 18UTC
13/10/2021

Figure 4 850 hPa wind charts from the Global Forecast System showing wind patterns during the passage of typhoons and tropical storm

Daily precipitation charts of chosen meteorological stations within the northern and east coast of Peninsular and East Malaysia were utilised to delineate precipitation occasions actuated by the tail impact of TCs. The charts in November and December 2020, April, September and October 2021 covering the TCs occasions influencing the nation are shown in Figures 5a to 5j. Qualitative analyses of satellite imageries as well as daily rainfall charts revealed rain cloud bands associated with TCs over Malaysia. However, the rainfall charts of November and December 2020 clearly showed a significant amount of rainfall was observed over the east coast of Peninsular Malaysia. The enhanced rainfall intensity in East Malaysia happened over the same time as Tropical Storm Krovanh.

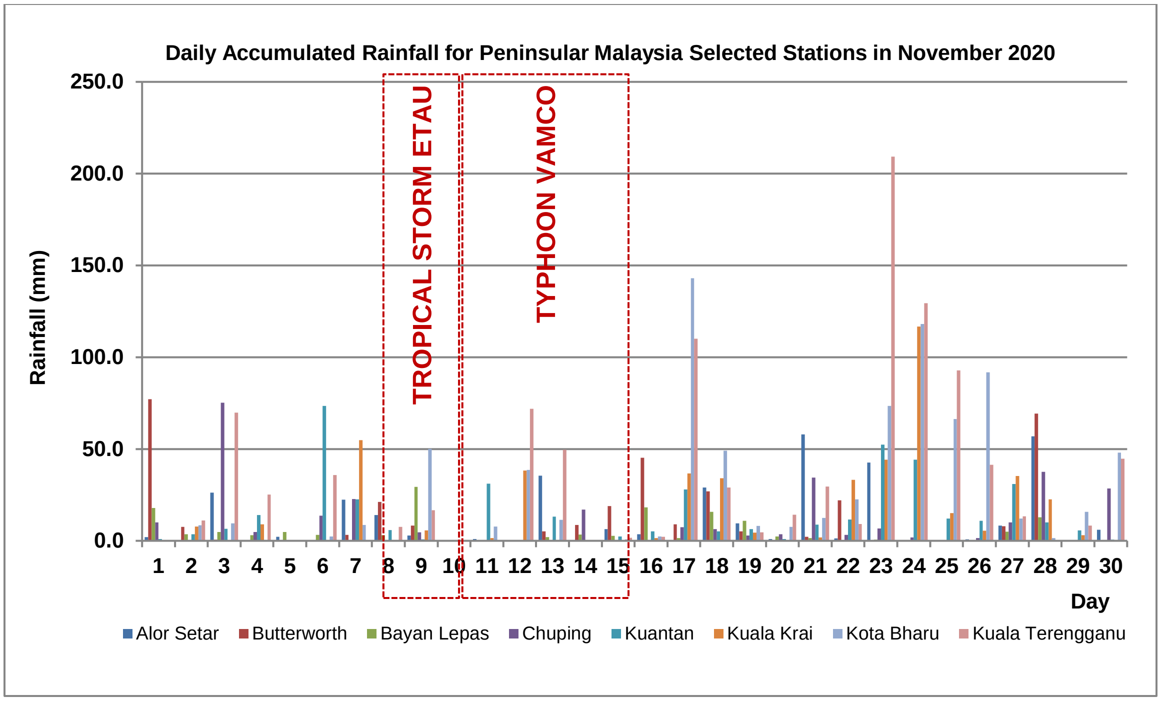


Figure 5a Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for November 2020

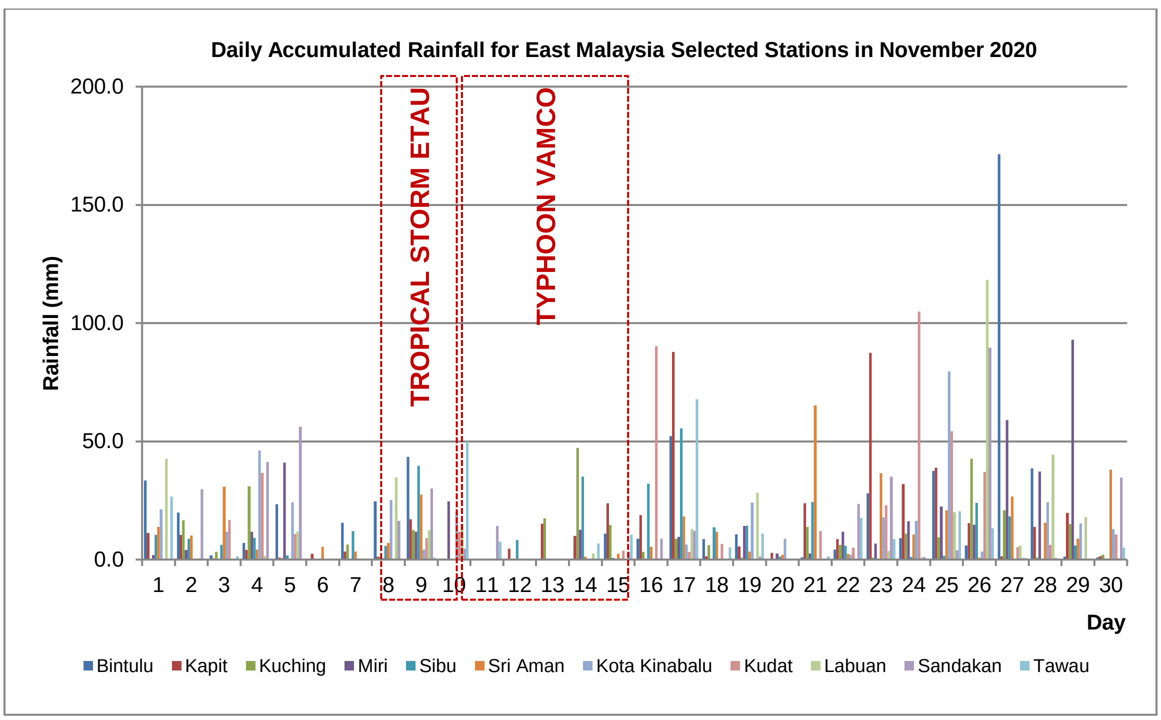


Figure 5b Daily rainfall chart of selected meteorological stations in East Malaysia for November 2020

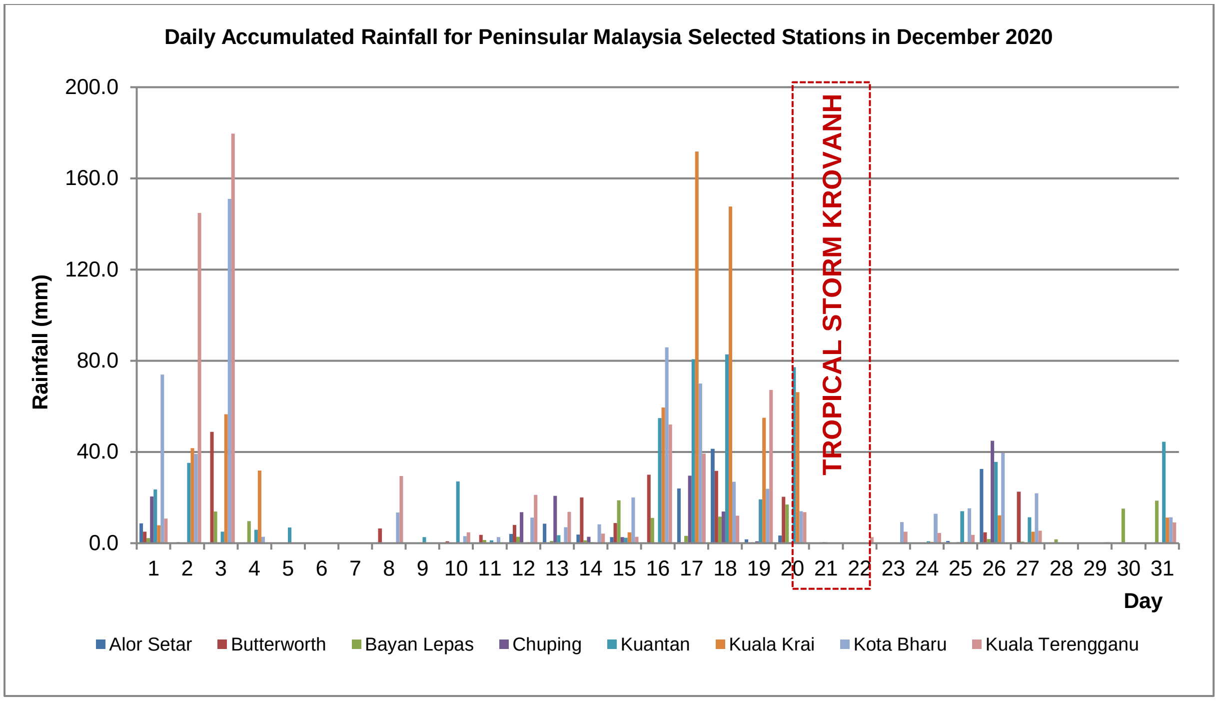


Figure 5c Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for December 2020

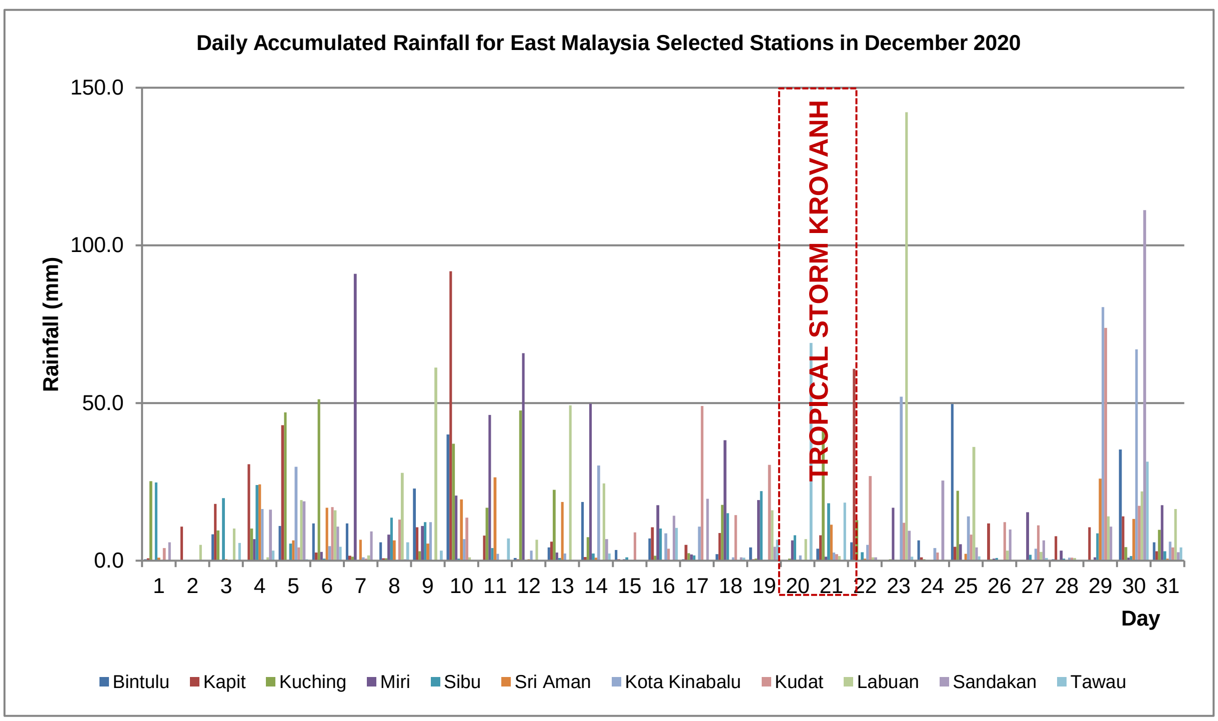


Figure 5d Daily rainfall chart of selected meteorological stations in East Malaysia for December 2020

On April 24, Typhoon Surigae made its first landfall and gradually weakened and affected the rainfall over northern and eastern parts of Peninsular Malaysia.

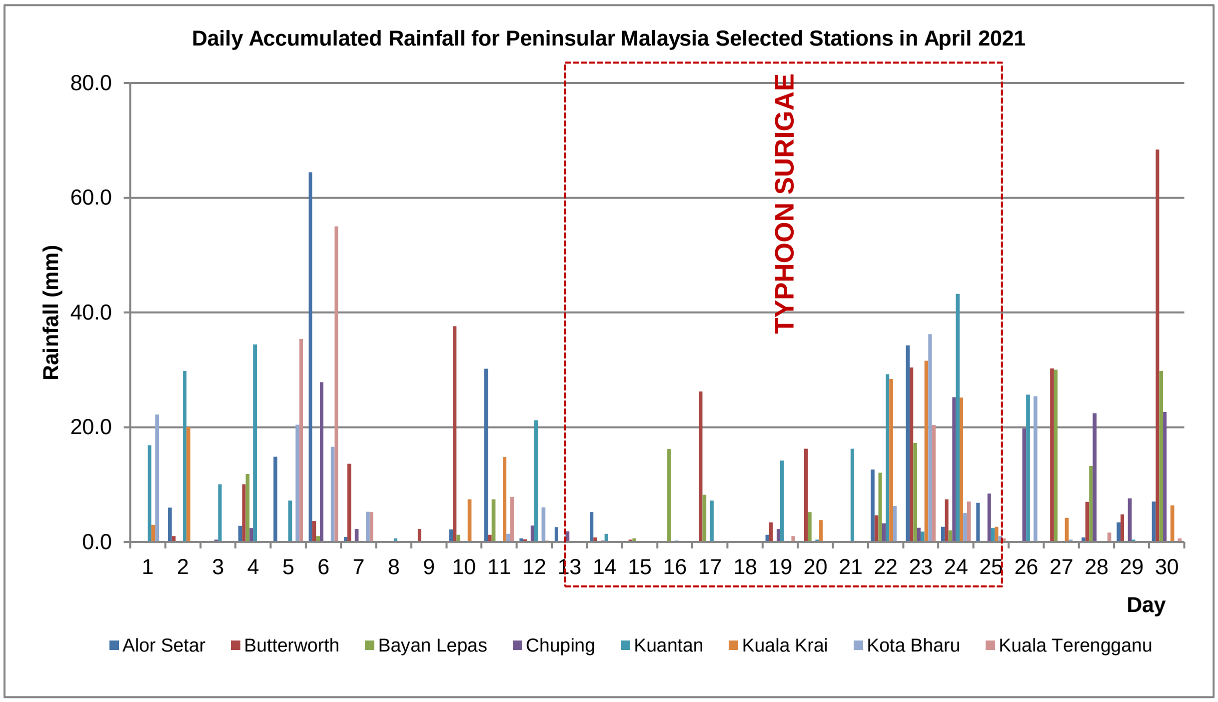


Figure 5e Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for April 2021

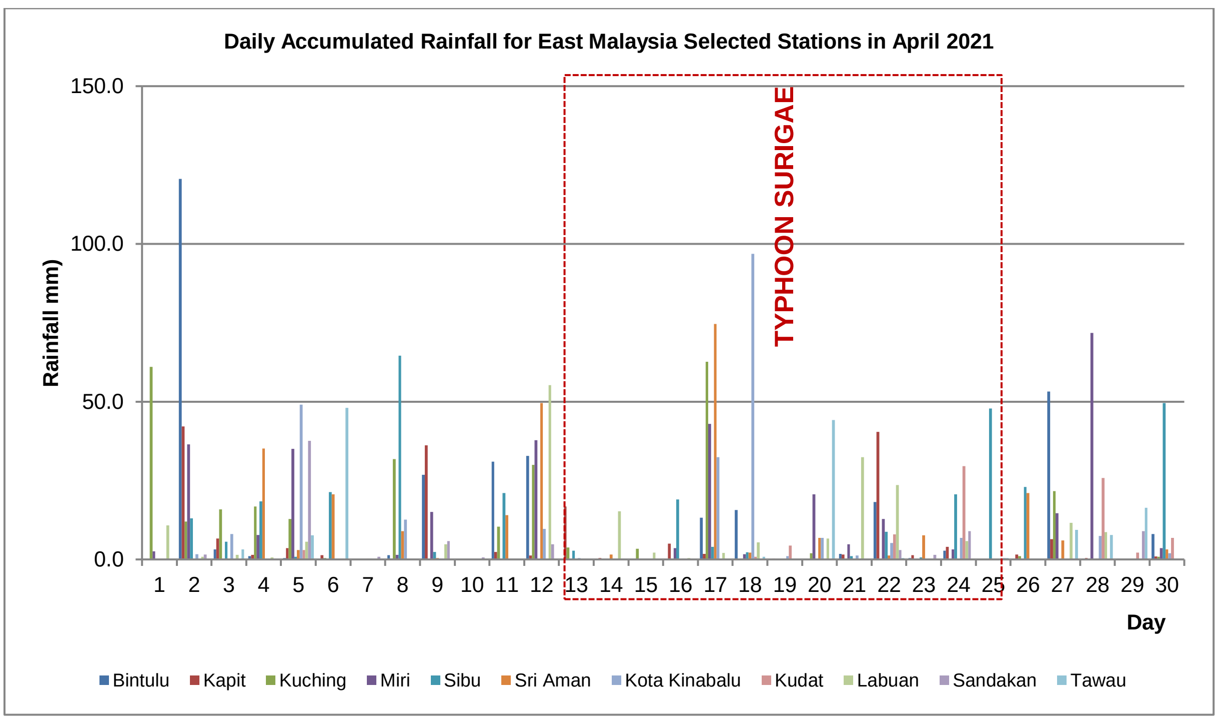


Figure 5f Daily rainfall chart of selected meteorological stations in East Malaysia for April 2021

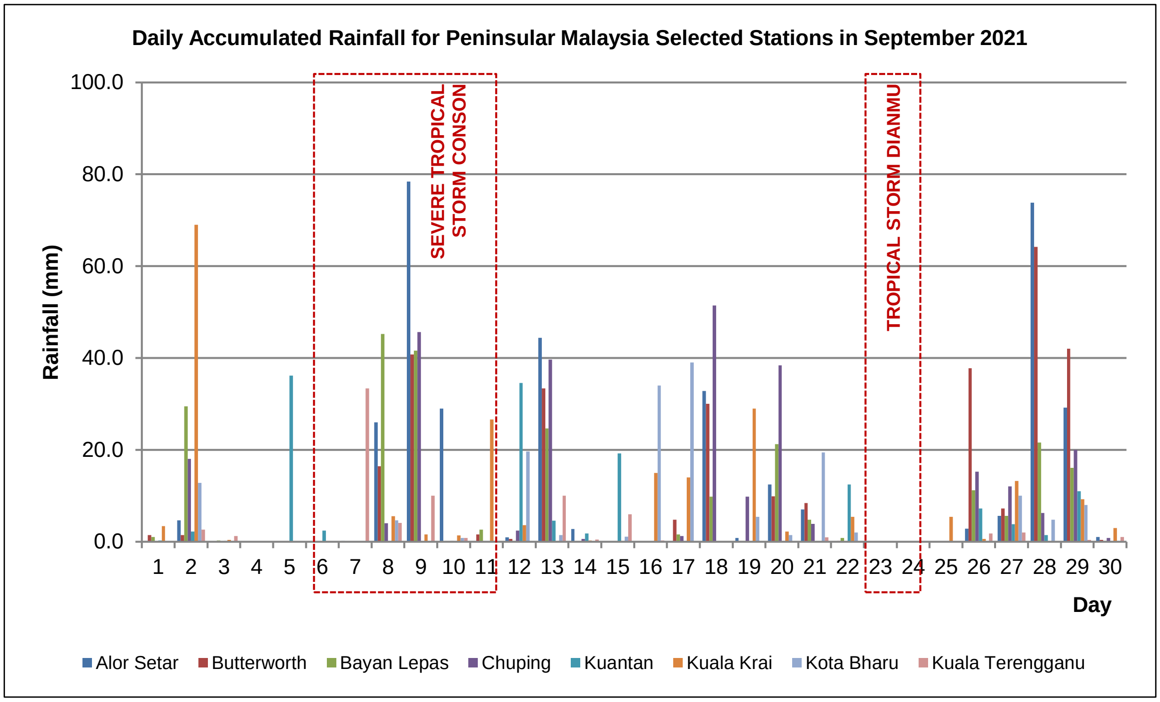


Figure 5g Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for September 2021

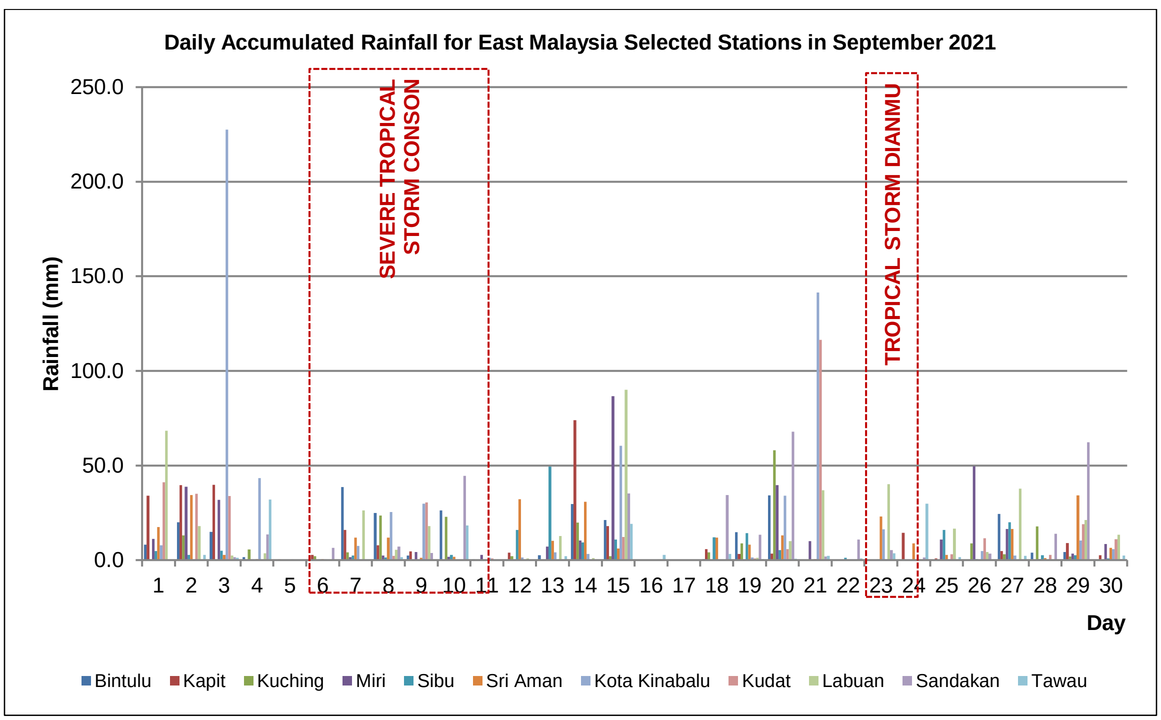


Figure 5h Daily rainfall chart of selected meteorological stations in East Malaysia for September 2021

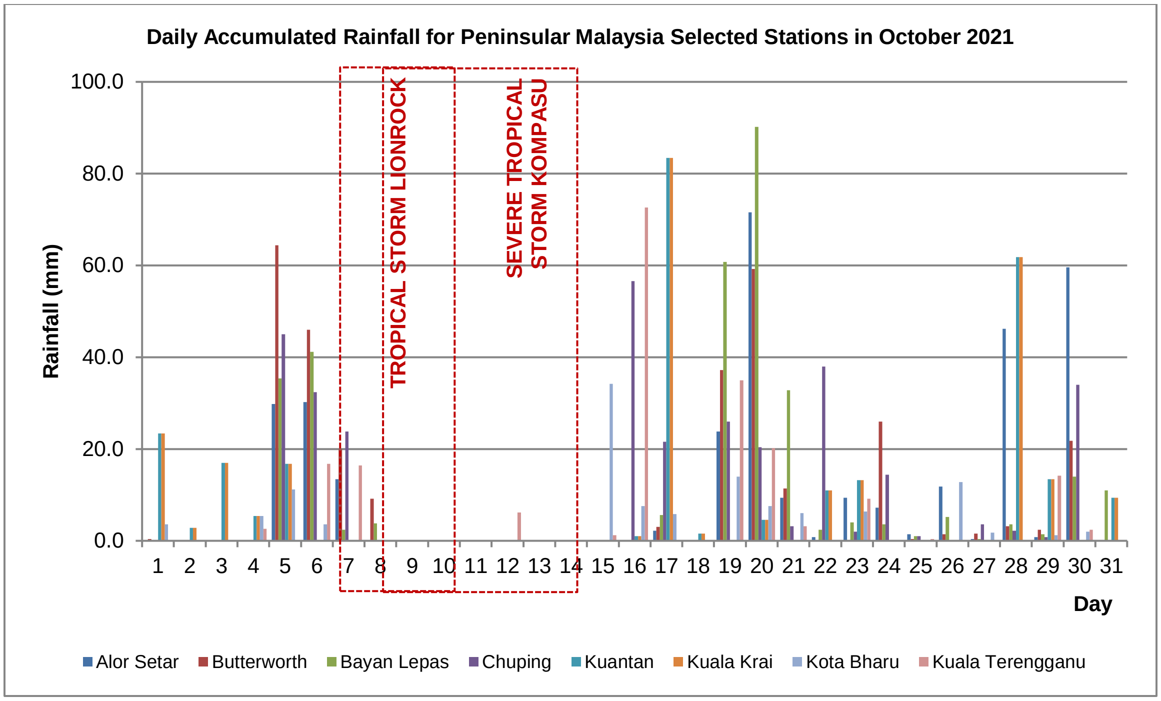


Figure 5i Daily rainfall chart of selected meteorological stations in Peninsular Malaysia for October 2021

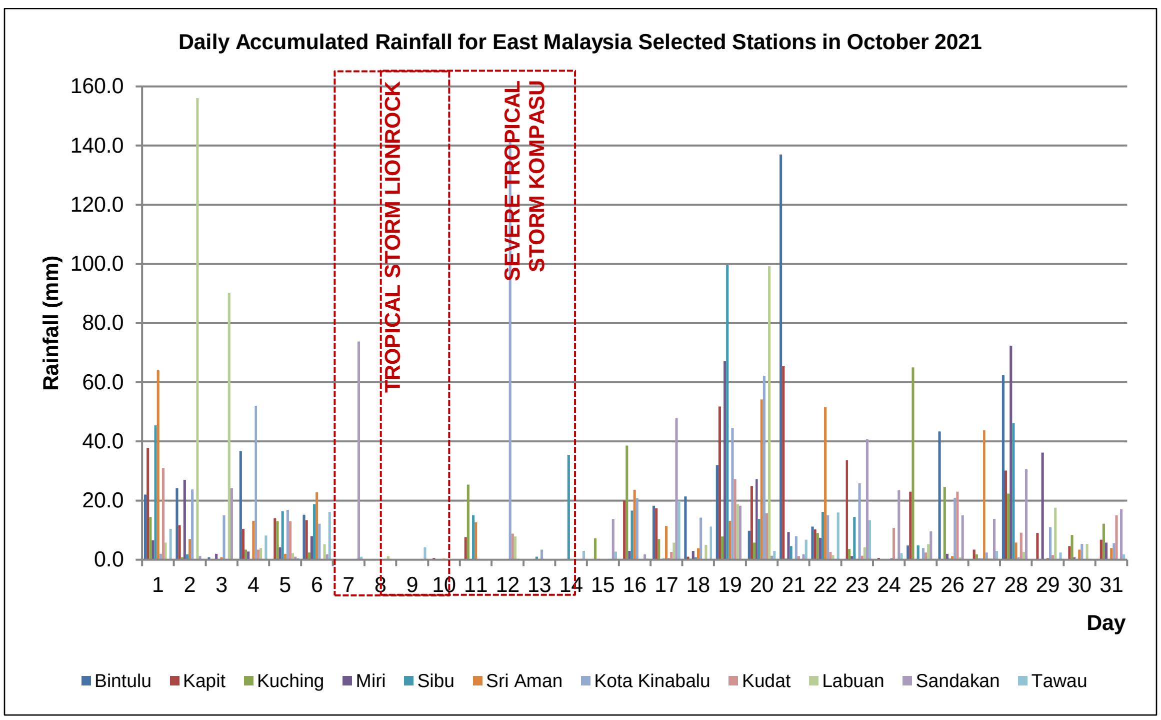


Figure 5j Daily rainfall chart of selected meteorological stations in East Malaysia for October 2021

2. Hydrological Assessment

Malaysia has experienced 622 flood events between Jan-Sept 2021. More than 80% of flood is flash flood that most affected area located along west coast Peninsular Malaysia, Sabah and Sarawak. Usually, between November to February of the following year, flash floods will decrease where monsoon floods will hit the east coast of Peninsular Malaysia such as Kelantan, Terengganu, Pahang, Johor, Sarawak and Sabah, however, in recent years, flash floods still occur in many places in west coast areas of Peninsular Malaysia such as Kedah, Penang, Perak, Selangor, Negeri Sembilan, Melaka and Johor. This may be due to the change of climate pattern that also taking place around the world especially in the humid tropics area.

a) Headwaters and Debris Mudflow Flood in Mount of Jerai, Kedah on 18 August 2021

On 18 August 2021, Headwaters and Debris Mudflow flood occurred in the surrounding area of mountain of Jerai at Kedah State. The flash flood occurs between 5:00 to 8:00 in the afternoon with recorded 271mm rainfall in 5 hours equal to 71 years return period. This extreme rainfall has caused the phenomenon of headwaters and mud floods to a depth of 0.1 to 0.3 meters in the district of Kuala Muda and 0.2 - 1.5 meters in Yan. The overflow of river water brought rubbish, wood and tree stumps that cause stuck on the bridges. 6 peoples died and more than and 133 peoples were evacuated. Figure 1 shows the waterfall condition before and after the headwaters occur at Gunung Jerai recreational area.

Before headwaters After headwaters

Figure 1: Water fall condition before & during the headwaters phenomena in Gunung Jerai

During the day of flood event, there was a very heavy and widespread rainfall in the northern part of Peninsular Malaysia covering the states, namely Perlis, Kedah, Penang and Perak. The heavy storm also happens several areas in the state of Selangor and the Federal Territory of Kuala Lumpur. As a result, there have been a series of flash floods in Kedah, Penang, Perak and Selangor. However, the floods in Yan and Kuala Muda, Kedah were the worst flash floods for the flood episode this time. Figure 2 shows radar images during flood on 18 August 2021 at Kedah state.

The Malaysian Meteorological Department (MET Malaysia) has issued a thunderstorm rainfall warning on 18 August 2021 starting at 11.45 am and issued a weather warning that heavy rain is expected to occur for the period 19 to 20 August 2021 as shown in figure 3. Very heavy and continuous rain starting at 2.00 pm in the Gunung Jerai area caused surface water to flow rapidly down to the foot of the mountain resulting in the overflow of river from Sungai Gurun, Sungai Kampung Badak, Sungai Kunyit, Sungai Tupah, Sungai Pengkalan Kakap, Sungai Tok Malau and Sungai Singkir. This incident has caused flash floods in some settlement areas, especially in the area near the foothills of Gunung Jerai and in some settlement areas in the Kuala Muda district.

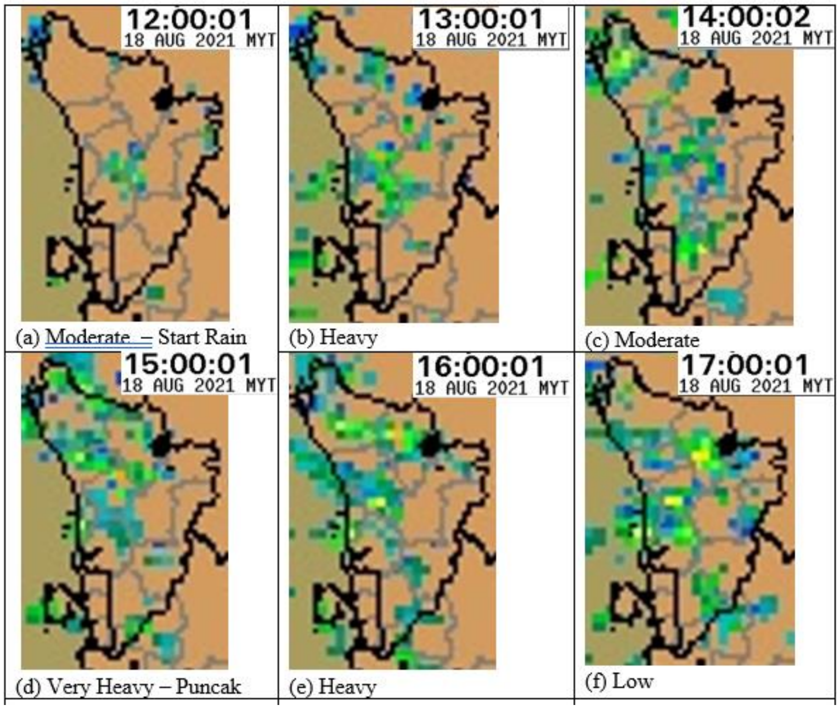


Figure 2: Weather radar images during the flood on 18 August 2021, by MET Malaysia

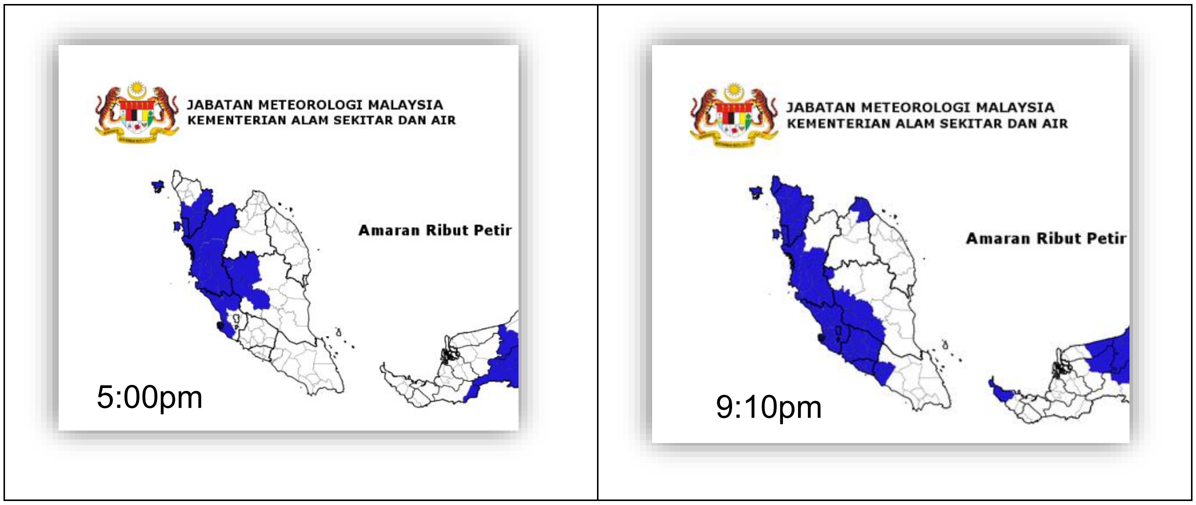


Figure 3: Thunderstorm warning on 18 August 2021, 15:30 by MET Malaysia

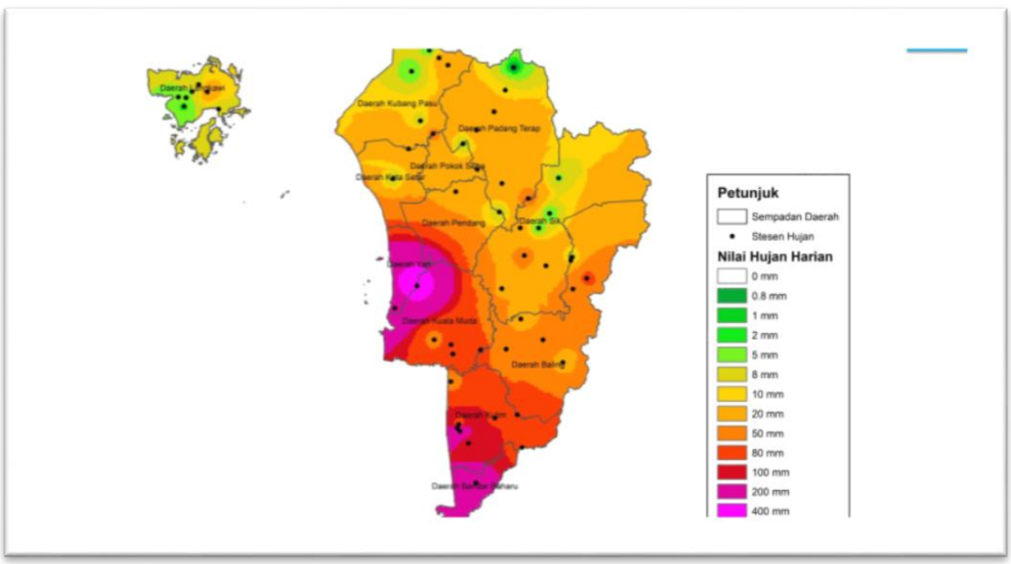


Figure 4: Rainfall Isohyetal Map on 18 August 2021, 12:00pm to 12:00am

Figure 4 shows the isohyetal map for rainfall at state of Kedah. The rainfall for 12-hour downpour widespread area in Kedah, however the heavy rainfall more than 300mm concentrated at few location particularly in district of Yan, Kuala Muda and Kulim. More than 400mm rainfall occur in Mount of Jerai that cause massive disaster of debris and mudflow flood.

The flash flood disaster happens due to high intensity of rainfall in 2 to 7 hours. The flood worsens when high flows carried timber and sediment from the mountain. The timber and sediment obstacles the river flow especially at crossing structures such as bridges until it causes overflows to low -lying areas.

The depth of flood is between 0.1 to 1.1 meters. The total rainfall recorded at the Gunung Jerai rainfall station is 281 mm for a period of 8 hours, while the rainfall reading at the Singkir Genting station is 158.5 mm for the same period. The Average Recurrence Interval (return period) for the highest rainfall at the Gunung Jerai rainfall station is 71 ARI for 5 hours duration. Meanwhile, the amount of rainfall for a period of eight (8) hours which is 281 mm is more than the total monthly rainfall for the state of Kedah.

Table 1: Maximum rainfall and the return period recorded on 18 August 2021 from 2.00pm to 07.00pm.

No	Station	District	Maximum rainfall (mm)						
			1 hr	2 hr	3 hr	4 hr	5 hr	6 hr	7 hr
1	Gunung Jerai	Yan	91.0	166.5	212.0	237.0	270.5	277.0	281.0
2	Singkir Genting	Yan	55.5	83.3	118.5	142.0	155.5	164.5	165.0
3	Sg Wang Pinang	Kulim	60	120	120	120	120	143	147
4	JPS Kulim	Kulim	65.5	83	89	89.5	90	107.5	116
5	Pekan Serdang	Bandar Bahru	37.5	64	76.5	81.5	100	113	119
No	**Sation**	**District**	**Return Period, ARI (Year)**						
			1 hr	**2 hr**	**3 hr**	**4 hr**	**5 hr**	**6 hr**	**7 hr**
1	Gunung Jerai	Yan	8	33	51	53	**71**	59	49
2	Singkir Genting	Yan	<2	2	5	8	9	**10**	8
3	Sg Wang Pinang	Kulim	2	**17**	10	7	5	10	9
4	JPS Kulim	Kulim	**3**	3	2	2	1	3	3
5	Pekan Serdang	Bandar Bahru	0	1	1	1	3	5	**6**

The flood disaster has recorded six (6) deaths, damage to property, infrastructure and even crops of farmers. The number of houses affected is estimated at 800 houses in Yan and 200 houses in Tupah, Kuala Muda.

There are more than 23 locations affected to flood. Among the areas affected by the floods in Yan district are Kampung Setar, Kampung Teroi Bukit, Alang Kenari, Titi Hayun Recreation Centre, Perigi, Yan Besar, Kawasan Perumahan Titi Bakong, Kampung Setol, Kawasan Perumahan Awam Pantai Murni, Kampung Kepala Bukit, Kampung Lubok Boi, Ruat, Titi Raga, Kampung Seberang Pekan Yan, Kampung Acheh, Taman Guru, Kampung Permatang Keramat, Kampung Teras, Singkir Keling, Singkir Laut, Singkir Genting, Singkir Darat and Singkir Paya. Areas affected by floods in Gurun are Taman Sri Utama, Belakang SMK Gurun, Kampung Baru, Kampung Sungai Kunyit, Sungai Badak, Kampung Jelatang and Taman Jerai Harmoni. The areas affected by the floods in Merbok are Titi Sungai Tupah, Taman Lembah Merbok, Kampung Pasir, Kampung Sungai Batu, Kampung Tandop Batu, Masjid Pengkalan Kakap, Kampung Bujang, Kampung Tok Malau and Kampung Singkir Laut. Figure 5 shows the hot-spot location affected by floods in Kuala Muda and Yan, Kedah.

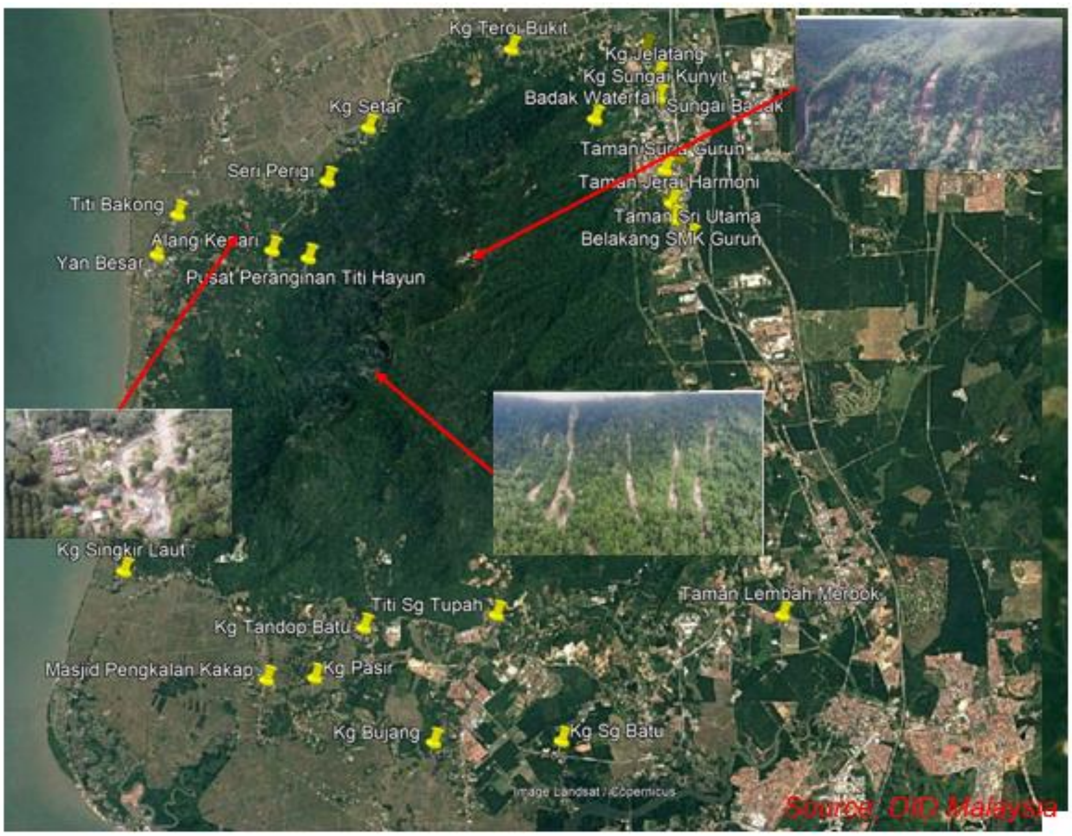


Figure 5: Hot-spot area affected by floods in Kuala Muda and Yan district

The floods in the Gunung Jerai area were exacerbated by landslides and headwaters disasters. Based on a report from the Department of Minerals and Geosciences (JMG), it has identified major changes in the earth's surface after finding 69 traces of landslides in the Gunung Jerai and Titi Hayun areas. The impact of the landslide was detected by the JMG Geological Disaster Task Force which conducted aerial monitoring and investigation at the location of the headwaters disaster from 19 to 31 August 2021. Most of the landslides were detected on the mountain slopes located near Titi Hayun and Batu Hampar. The flow of mud as well as debris to the settlement area at the foot of the mountain at the headwaters incident on 18 August 2021.

There is also detected landslides involving 47 in Titi Hayun, 10 locations in Batu Hampar, 10 locations on the Gunung Jerai ascent route and one each in Tanjung Jaga and Lembah Bujang. The ruins detected include small size with a width of between two to five meters, while large size with a width of between 10 to 50 meters which are mostly detected in Titi Hayun and Batu Hampar. The effect of the flood is that the river becomes wider, where the original average width of the river is between 10 meters to 15 meters but after the flood the width of the river increased by reaching 20 to 30 meters and also changed the geomorphology of the river in Gunung Jerai Area. Figure 6 shows the picture during and after the flood.

	
Debris log at Alang Kenari Chalet	Damages of Utility Crossing Bridge

	
Debris trees and mud blocking the road to Gunung Jerai	Road damages due to mudflow

Figure 6: Flood images at several location at Gunung Jerai area on 18 August 2021

II. Summary of progress in Priorities supporting Key Result Areas

1. Radar Integrated Nowcasting System (RaINS)

In the MET Malaysia nowcasting system (RaINS), radar echoes are extrapolated by optical flow and semi-Lagrangian advection using the SWIRLS algorithm developed by the HKO. This scheme tracks radar echoes realistically within a short period based on extrapolation of past radar echoes. At longer periods, the growth and decay of thunderstorm cells are predicted by blending with NWP data generated by the MET Malaysia using the WRF model at high-resolution (1km).

Various enhancements have been made to the RaINS nowcasting system between 2019 – 2020. Phase correction has been added to reduce location errors of NWP relative to radar observation. The number of radar stations in Malaysia has been increased from 12 to 17 to enhance radar coverage. Subsequently, the domain of RaINS nowcasting has been extended to the Celebes Sea and Sulu Sea using larger domain NWP data. Consequently, severe weather warning from squall-lines can be issued earlier.

Additionally, RaINS run-time is reduced via parallel processing allowing frequent nowcast cycles every 11 minutes near real-time. The Graphical User Interface (GUI) of RaINS has been enhanced with a geospatial interface to facilitate viewing of nowcasts for major towns in Malaysia. In addition, JavaScript mouse-over and intensity threshold selection adds user customisation options to RaINS GUI. These GUI improvements are accessible to the public. The accuracy of RaINS nowcast is periodically evaluated by visual comparison, probability of detection/false alarm ratio, and fraction skill scores to identify weaknesses of RaINS nowcast for continual improvement. The radar extrapolation engine of RaINS is upgraded from SWIRLS-2 (2012) radar extrapolation scheme to the most current version of Community SWIRLS (2.3.1). SWIRLS and COM-SWIRLS are developed by the HKO (Hong Kong Observatory) for NHMSs (National Hydrological and Meteorological Services).

2. Training Attachment on Radar Integrated Nowcasting System (RaINS) 2022

MET Malaysia has submitted a proposal to the Typhoon Committee requesting a budget for the RaINS project to be included as one of the WGM's Annual Operating Plans to conduct a training or workshop on RaINS to other interested parties in June 2022 for about two weeks.

Preferably, the training will be conducted offline and hands-on. The training will cover topics such as:

i. compositing radar reflectivity from multiple radars
ii. nowcasting techniques using radar and satellite data
iii. retrieving radar reflectivity from satellite data using Fast Artificial Neural Network (FANN)

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

MET Malaysia will continue to collaborate with Hong Kong Observatory (HKO) to further improve the accuracy of RaINS for extreme weather event.

Priority Areas Addressed:

Meteorology

a. To mitigate the damaging impacts of TCs and enhance the forecast on TCs related effects for the betterment of quality of life through scientific research, technological development and operational best practices approach.

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

Hydrology

a. To strengthen TCs related disaster risk management in various sectors, including hydrological and aviation sectors, through strategic partnerships and collaboration.

Contact Information:

Member: Malaysia

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

Telephone: (603) 7954 2146

Email: hamray@met.gov.my

3. 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

i) Study On Hydrological Data Trails Efficiency On Telemetry And Non-Telemetry Data Management System

The Department of Irrigation and Drainage Malaysia (DID) is currently operating three Hydrological Data Management Systems that are being used in the management of hydrological data, namely SPMRAB, RHN and NAWABS. Each of these systems has its own protocol and methodology in the collecting and processing of hydrological data. Since these system has its own protocol and methodology in the management of hydrological data especially in the data processing, a study needs to be done to identify the gap and deficiencies of the current systems in term of hydrological data collection, transmission and processing especially for missing and erroneous of hydrological data.

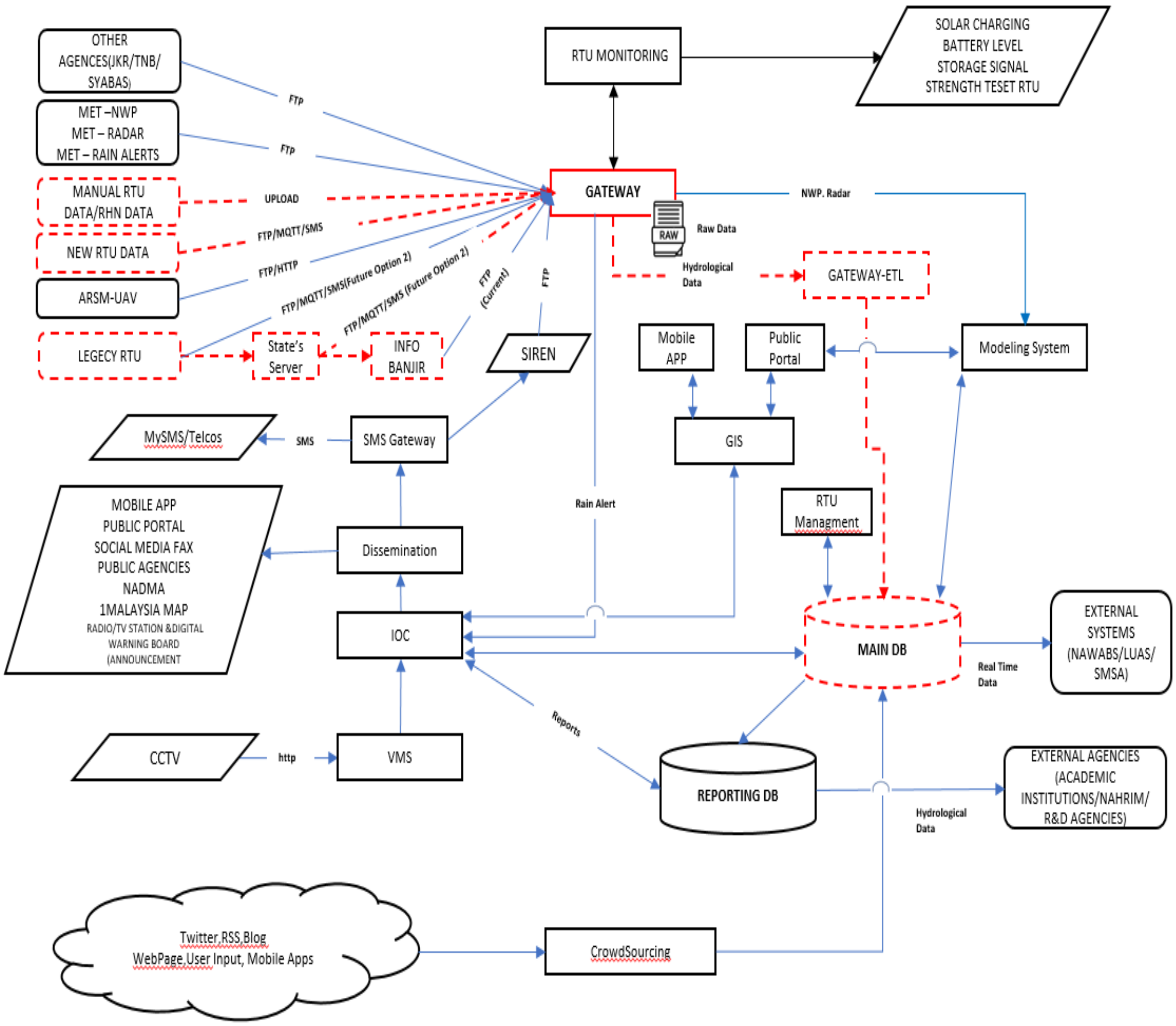
Having a long period of hydrological data and experience in managing the hydrometric station and hydrological data management system, the department encounter several problems and issues need to be solved as below:

a) Types of hydrological instrumentations not suitable to local climate;
b) Location and characteristic of hydrological station unable to follow the hydrological criteria and guideline because of the site condition;
c) Missing data due to communication line for telemetry station are not stable;
d) Various types of hydrological instrumentations, systems, software are used. For example, in hydrological telemetry stations, some states use 4 types of Remote Terminal Unit (RTU) and the RTUs has their own system and protocol, and also for hydrological manual/logger station, 3 types of loggers are being used now in all manual/logger hydrological station throughout Malaysia. Like the RTU in the

telemetry station, each of the logger using its own system or tools especially when converting the raw rainfall data into time series.

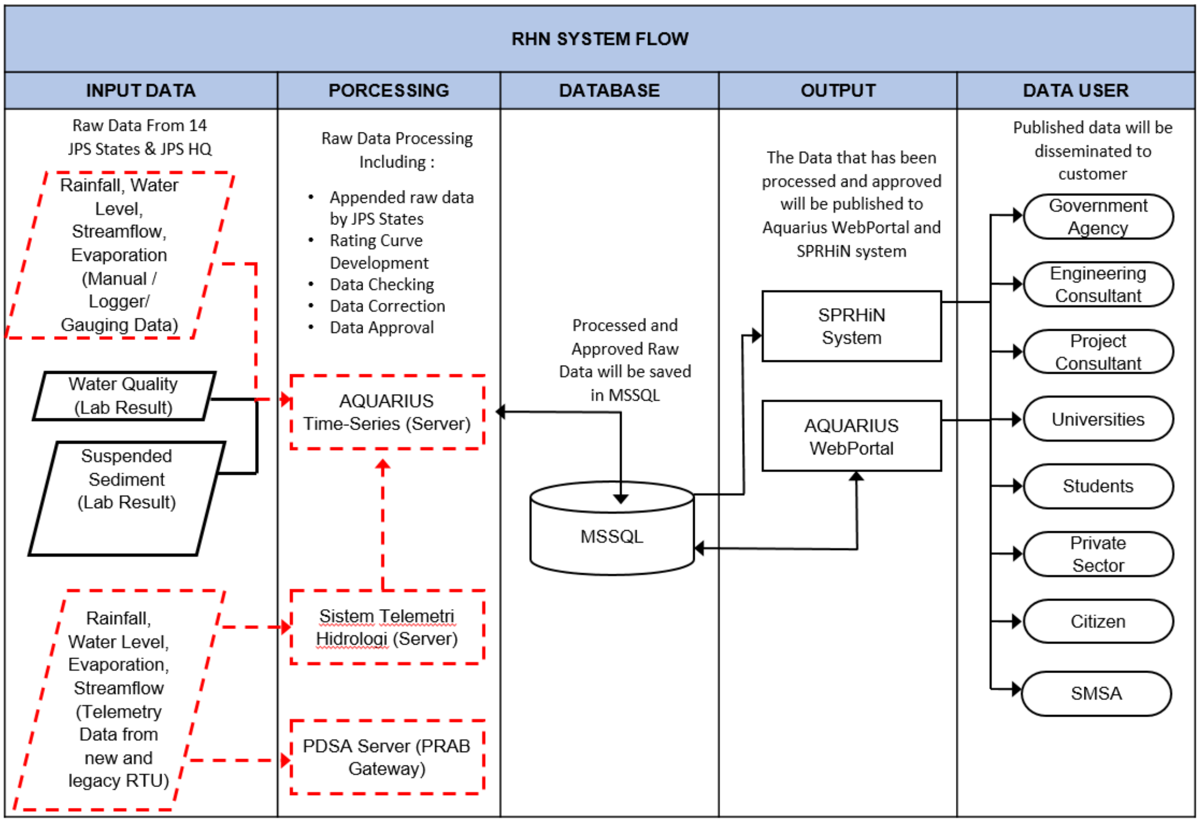
e) Poor maintenance of hydrometric station especially replacement of broken hydrometric instrumentation.

f) Lack of knowledge in information technology system and programming.



Dotted red line is a flow of hydrological data-trail analysis

Figure 7 : The Flow of Hydrological Data Trail for SPMRTAB System



Dotted red line is a flow of hydrological data-trail analysis

Figure 8 : The Flow of Hydrological Data Trail for RHN System

Through this study, it is hoped that all issue faced by the department when dealing with the hydrological management can be identified and rectified so that the quality and the availability of hydrological data and service can be improved, and furthermore the monitoring, operational of forecasting and warning of flood hazard can be done smoothly and, the accuracy of the forecast improved.

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

i. The opportunities in the project is to gain knowledge on the effectiveness of hydrological stations auditing in finding the exact point along data trails that cause errors ang missing data.

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.

Contact Information:

Member: Malaysia
Name of contact for this item: Ir. Roslina binti Yusof
Email: lina@water.gov.my

(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 Peneng 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.

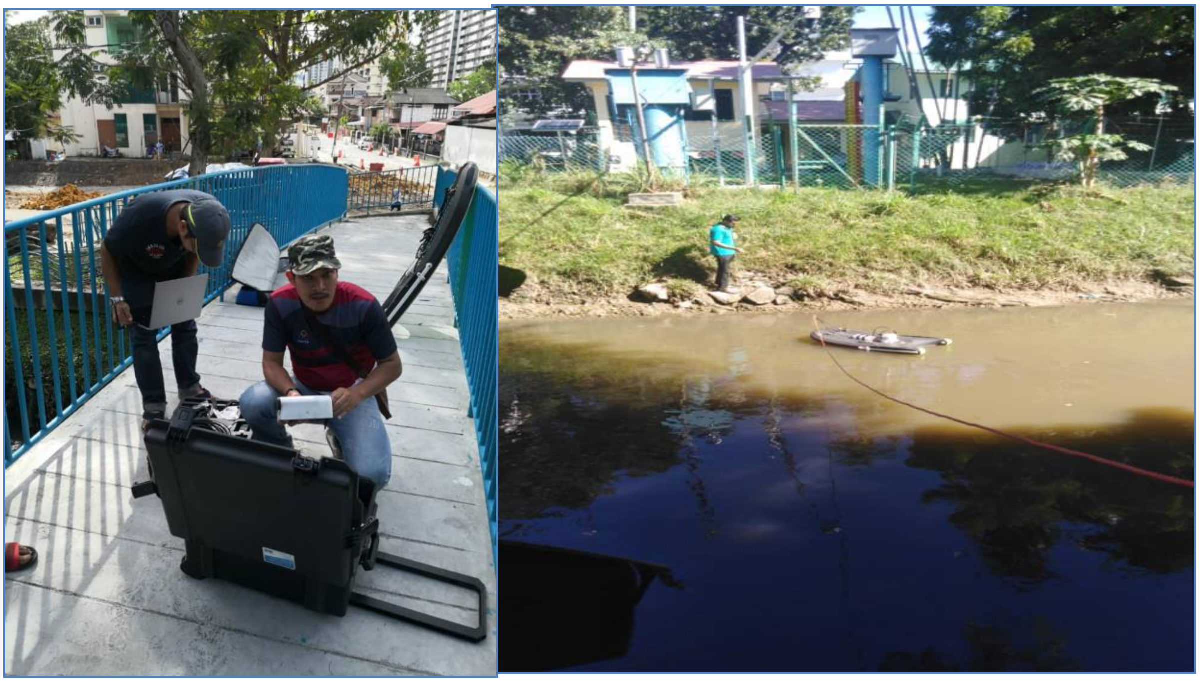


Figure b-2: Using ADCP to collect flow data

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 staff 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 covit'19 outbreak impacted to both countries, the programme is rescheduled to the this year, 2021. Again, the covit'19 outbreak limit the effort to complete the development as well as installation the software in Malaysia. Therefore, the development of OSUFFIM for Pinang river basin will continue until 2022 and is likely to be extended until 2023. Meanwhile DID will collecting more hydrological data and latest cross- section information to be used for model improvement.

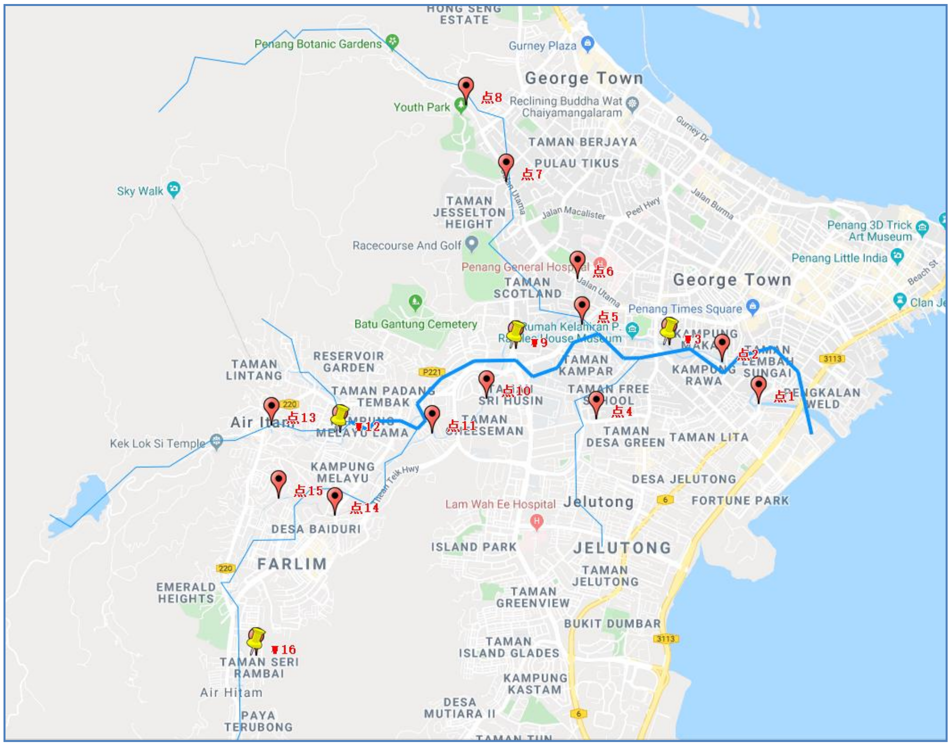


Figure b-3. 16th location points to obtain the cross-section data

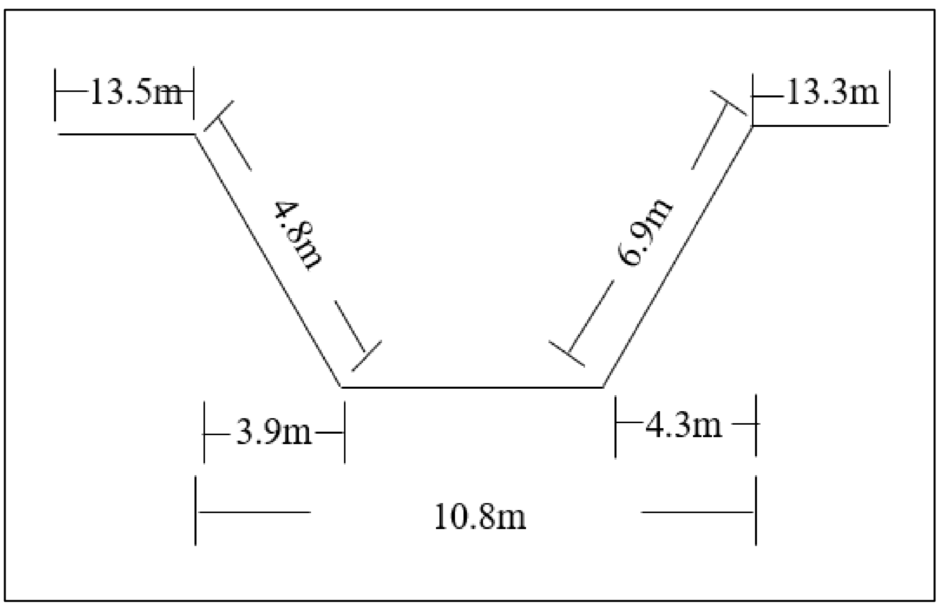


Figure b-4. The river cross section for the Batu Lancang (Observation point 11)

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.

Contact Information:
Member: Malaysia
Name of contact for this item: Mr. Abdul Hafiz bin Mohammad
Telephone: 03-42895544
Email: ahafiz@water.gov.my

(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.

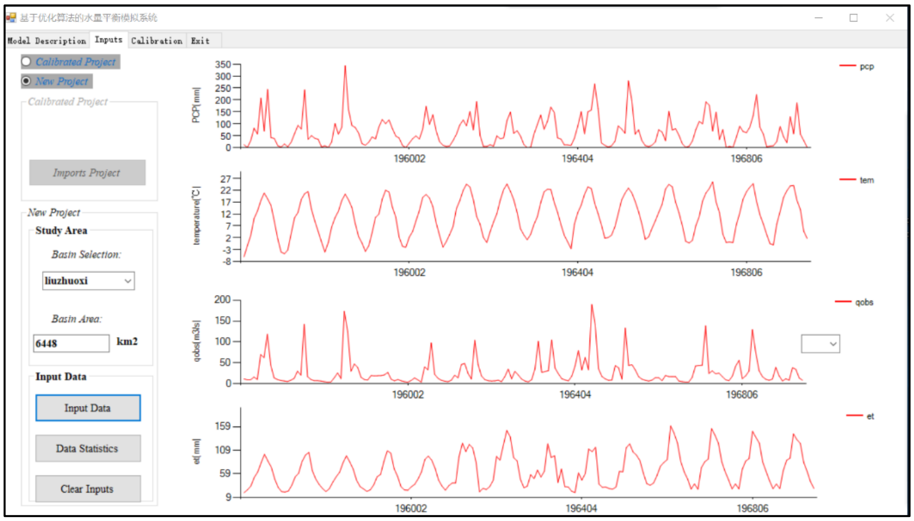


Figure c-1 : Analysis performance of input of data

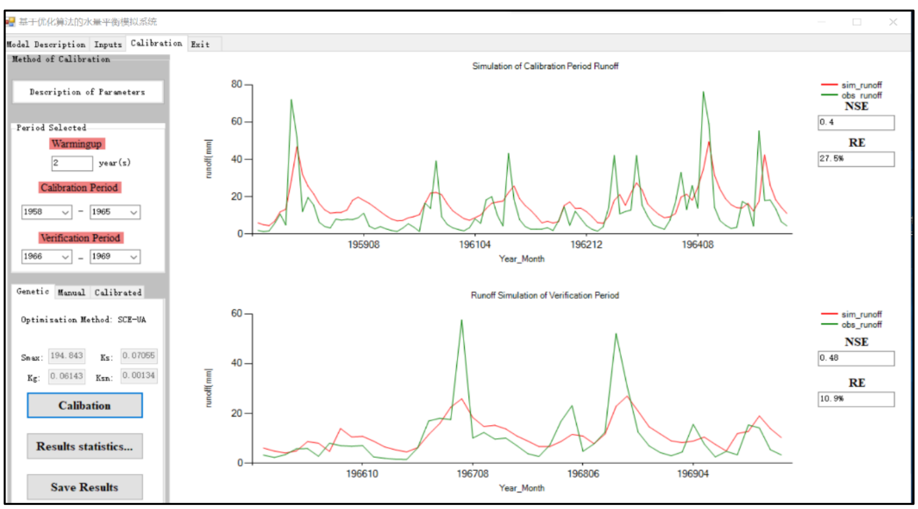


Figure c-2: Calibration Process (Auto or Manual)

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.

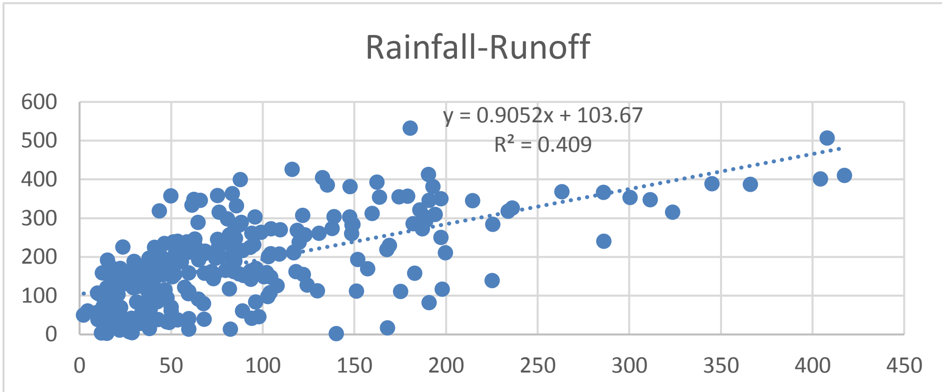


Figure c-3: Rainfall-Runoff Correlation for Muda River Basin

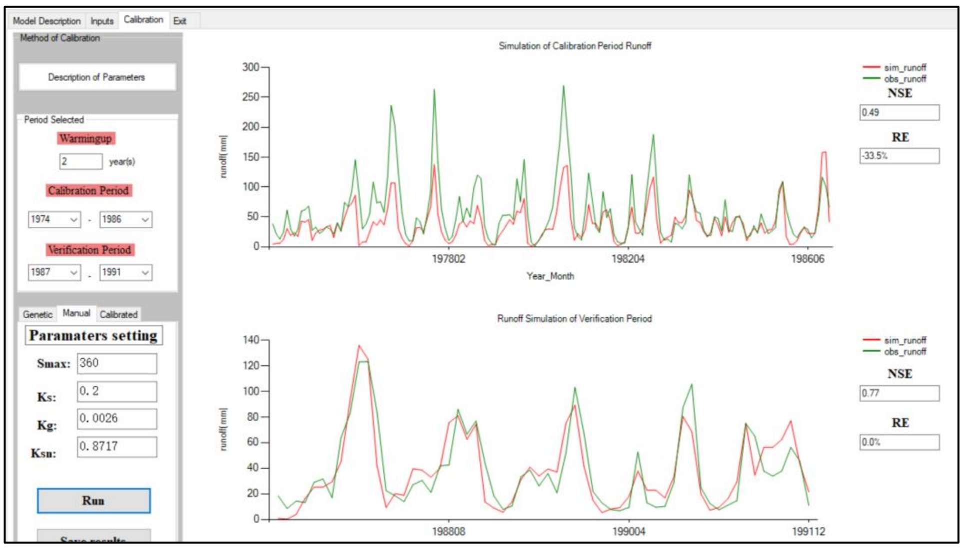


Figure c-4: Result for Calibration and Validation Period in Muda River Basin

(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 :

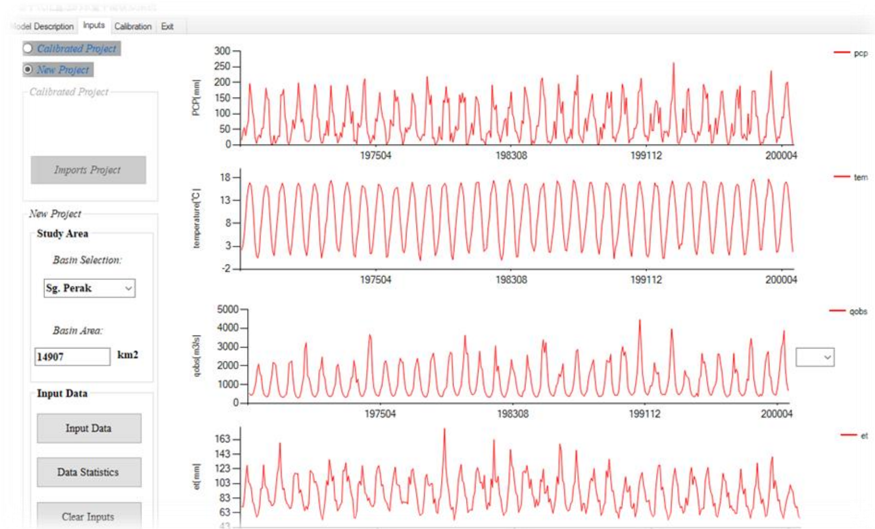


Figure c-5: Analysis performance of input of data fo Melaka river basin

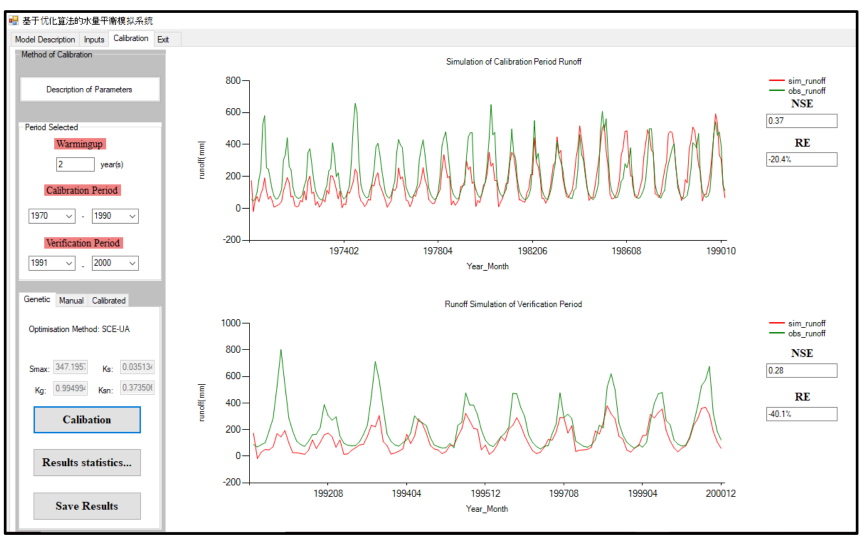


Figure c-6: Calibration Process (Auto or Manual)

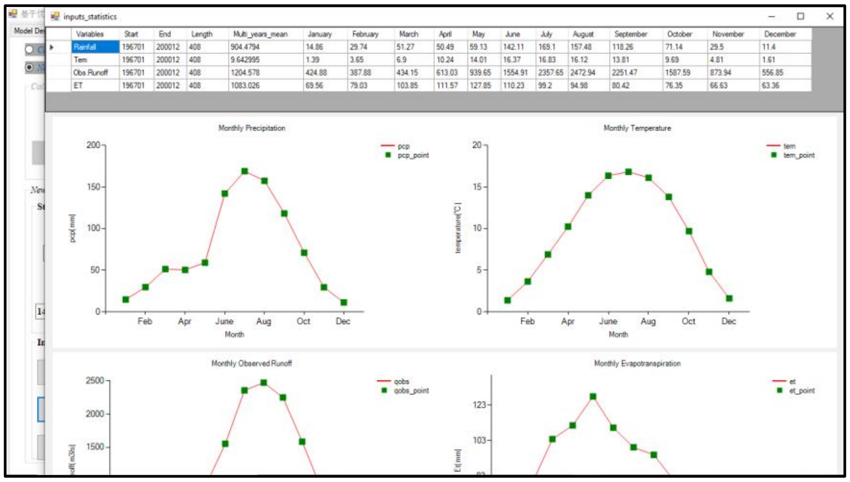


Figure c-7: Result for Calibration and Validation Period in Melaka River Basin

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.

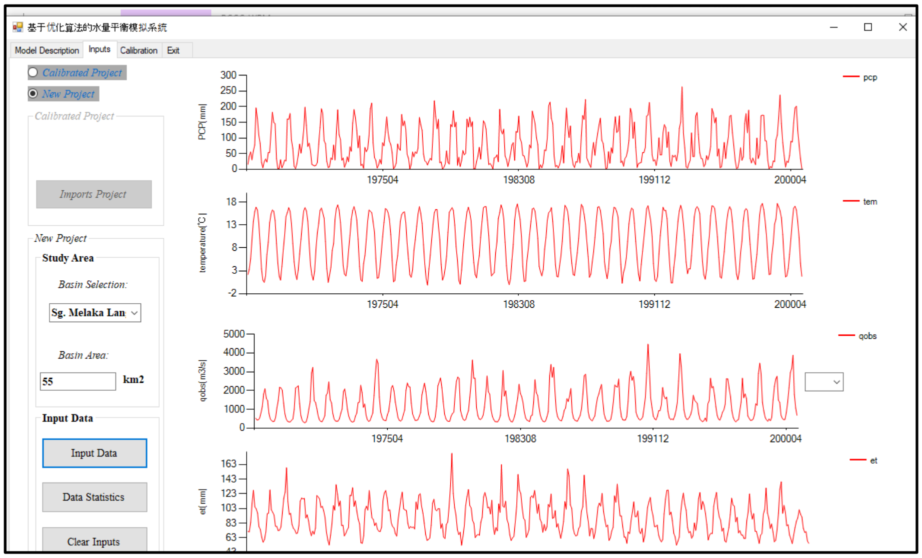


Figure c-8: Analysis performance of input of data fo Melaka river basin

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

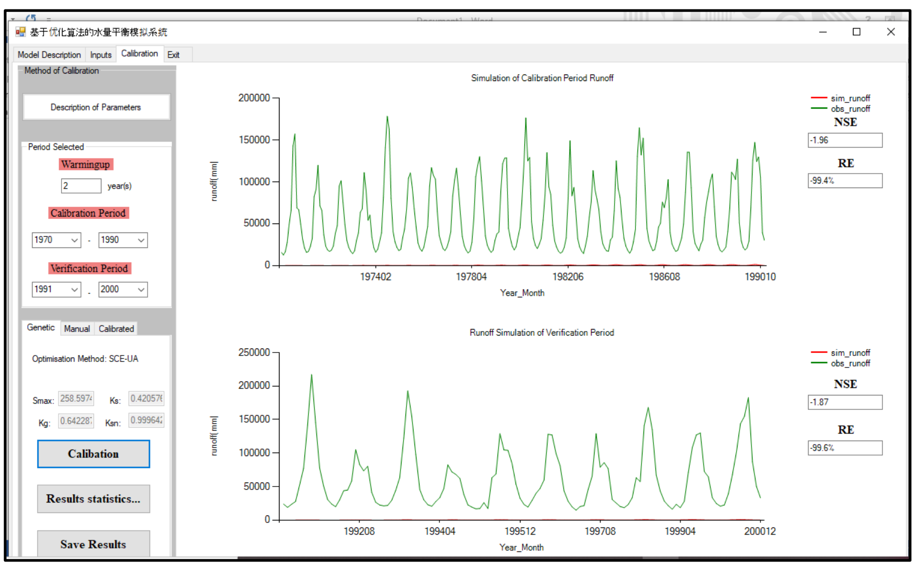
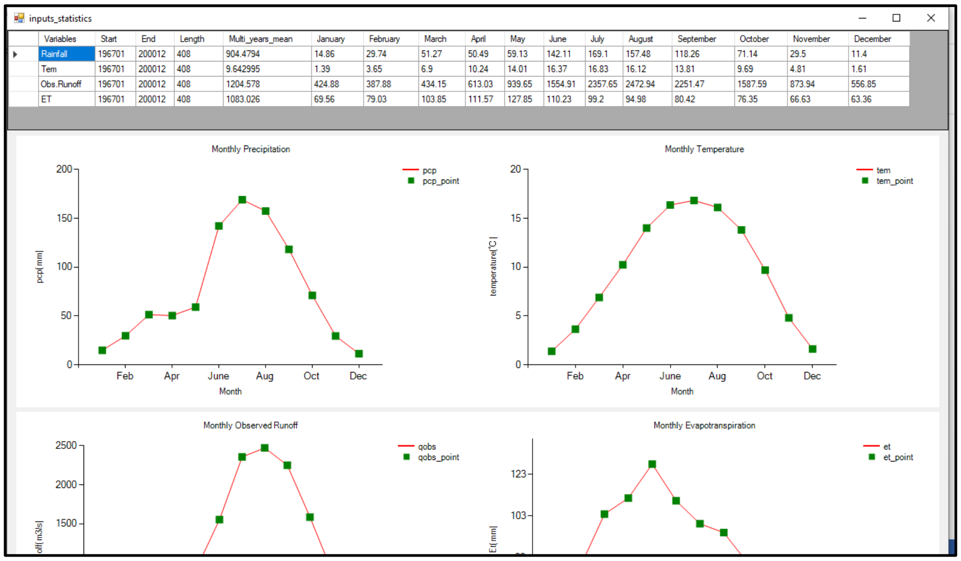


Figure c-9: Calibration Process (Auto or Manual)



inputs_statistics

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 of Photos during the workshop :

Figure c-11: Group of membersfrom 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.

A proposal for future collaboration of AOP5 :

According to the 15th Integrated Workshop (IWS) Meeting which was held from December, 1 and 2, 2020, in the context of Water Resources modelling, China Water Expert has agreed to support the AOP5 activities with Water Balance modelling in year 2022. The targeted course was to enhance the capacity building of RCCC WBM among State Water Managers in Malaysia. In addition to that, Malaysia is also looking forward Water Resources System in Real Time Monitoring (monitoring of water in and out or Real Time Water Accounting Monitoring in selected shared/unshared river basin).

On the other hand, Malaysia Water Resources is also looking forward with the water agencies from MLIT Japan Water Expert and Korean Water (K-Water) Expert for future capacity building enhancement on Water Resources Modelling and Real Time monitoring for drought forecast and warning system in year of 2023/2024/2025 IWS activities.

A Bureau of Water Resources in China, MLIT Japan and Korean Water were satisfied and excellent in drought modelling and monitoring system. Therefore, the Malaysian Water Manager aiming to have additional tools or knowledge sharing in drought forecasting and warning for water security improvement from Water Expert from BWR China, MLIT Japan and K-Water.

Contact Information:

Member: Malaysia
Name of contact for this item: Ir. Dr. Asnor Muizan bin Ishak
Email: drasnor@water.gov.my

(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 finalize 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 Covit'19 issues, all such activities have been postponed since March 2020 and it is hoped that it will recover in 2022. Thus, during this period, DID and MLIT in process to finalizing all documentation requirements that do not require physical activity. Recently, the propose location at Sulaiman Bridge facing the problem with vandalism. Therefore, other locations will be proposed where such locations are suitable for water level observation and safe from theft and vansalism. It is planned that the installation of 3L stations will be implemented in early 2022 and is expected to start recording and transmitting data in March 2022.

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 Covit'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. Hydrological data especially rainfall and water level can measure the flood condition and also flood warning.

Contact Information:

Member: Malaysia

Name of contact for this item: Ir. Sazali bin Osman & Mr. Mohd Faizul bin Mustapha

Telephone: 03-42895544

Email: sazali@water.gov.my / faizul@water.gov.my