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BULLETIN

ASEAN SPECIALISED METEOROLOGICAL CENTRE

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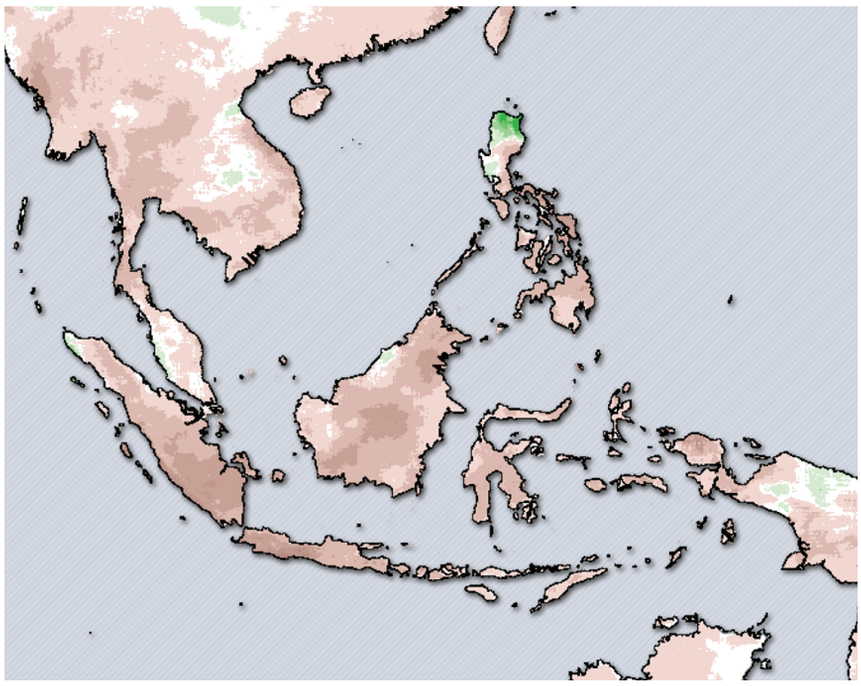

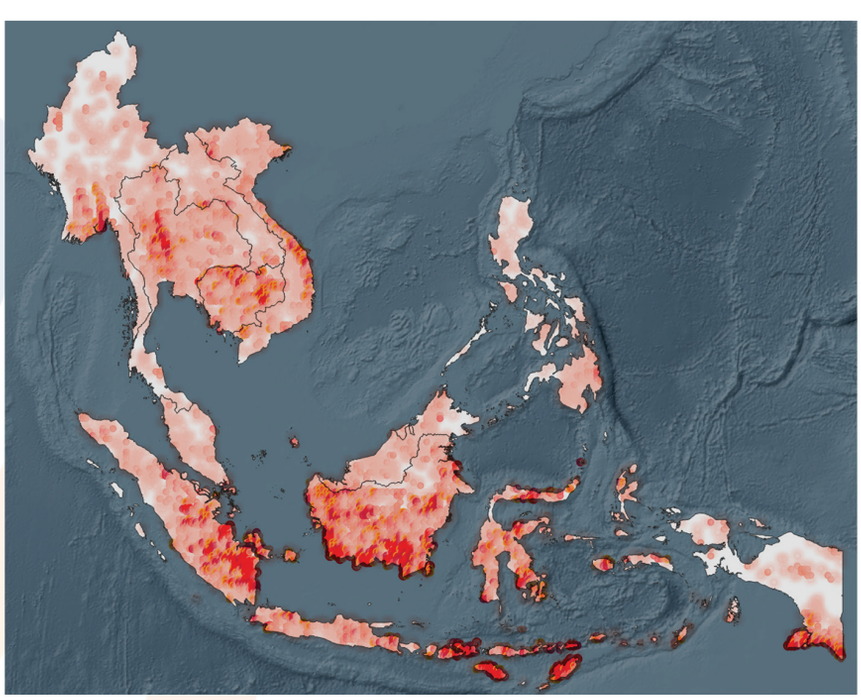

Highlights

- **In the second half of 2019,**
    - The multi-model ensemble from international climate centres had predicted weak to strong sea surface temperature warm anomalies over the Nino3.4 region. However, neutral El Niño Southern Oscillation (ENSO) conditions prevailed during the review period.
    - In contrast, a strong, positive Indian Ocean Dipole (IOD) was observed as predicted by the models. This brought about drier and, consequently, warmer conditions in the Southeast Asia region, especially the western Maritime Continent. The drier conditions contributed to the transboundary haze which peaked over many parts of the southern ASEAN region in September 2019.
    - Notwithstanding the drier conditions induced by the IOD, the region was hit by several extreme flood events caused by tropical cyclones (the Philippines and Thailand) and other circulation anomalies (Brunei Darussalam and Viet Nam).
    - As part of the Regional Capability Building Programme for the ASEAN region, ASMC organised three workshops/ forums covering important topics on seasonal predictions (ASEANCOF-13), numerical weather prediction, and haze and fire monitoring.
- **For the upcoming March to May 2020 season**,
    - Model predictions indicate the likelihood of neutral conditions for both the ENSO and IOD.
    - Nevertheless, models predict increased chances of below-normal rainfall over some parts of the region north of the Equator, and above-normal temperatures across the region.

ASMC

ASEAN SPECIALISED METEOROLOGICAL CENTRE

CLIMATE REVIEW (JUL-DEC 2019)

Neutral ENSO and strong, positive IOD were observed

El Niño Southern Oscillation

The second half of 2019 saw *neutral* El Niño Southern Oscillation (ENSO) conditions. The sea surface temperature (SST) values, over the Nino3.4 region of the Tropical Pacific, were within neutral thresholds during this period (Figure 1). Key atmospheric indicators of ENSO also exhibited mainly neutral ENSO conditions.

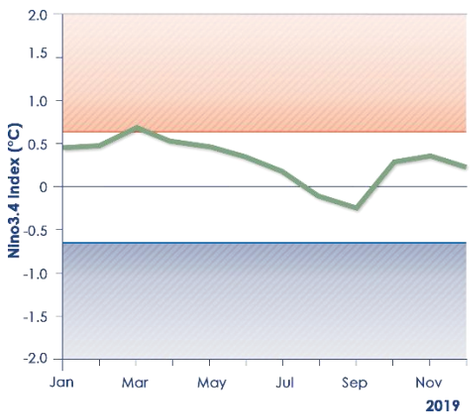

Figure 1: The Nino3.4 index (detrended) from January to December 2019 using the 1-month SST anomalies. Warm anomalies (≥ +0.65; red) correspond to El Niño conditions while cold anomalies (≤ -0.65; blue) correspond to La Niña conditions, otherwise neutral (> -0.65 and < +0.65). Reference methodology: Turkington, Timbal, & Rahmat, 2018.

In June 2019, models from the Copernicus Climate Change Service (C3S) multi-system seasonal forecast predicted a wide range of possible outcomes for the Nino3.4 index in the second half of 2019. The models' ensemble spread was, however, leaning more towards El Niño occurring (Figure 2). In retrospect, the Nino3.4 values had been over-predicted by the models. While the models' predictions gradually improved in subsequent months, considerable uncertainties remained.

Indian Ocean Dipole

In contrast, the Indian Ocean was more active during the second half of 2019. The Indian Ocean Dipole (IOD) was positive starting from May 2019 and it lasted until the end of the year (Figure 3). The positive IOD peaked in October 2019 and was considered one of the strongest IOD events since 2001 (Australian Bureau of Meteorology's (BoM's) ENSO Wrap-Up, 1 October 2019).

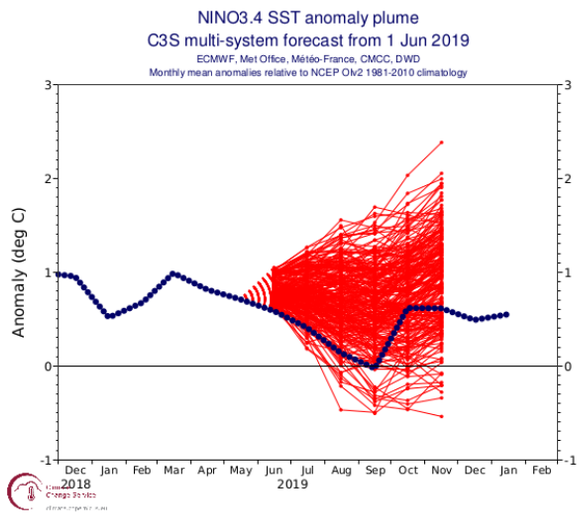

Figure 2: Forecasts of the Nino3.4 index's strength (red lines), issued in June 2019, against observed values (blue line) for the second half of the year. The forecasts were derived from various seasonal prediction models of international climate centres. Credit: Copernicus Climate Change Service (C3S).

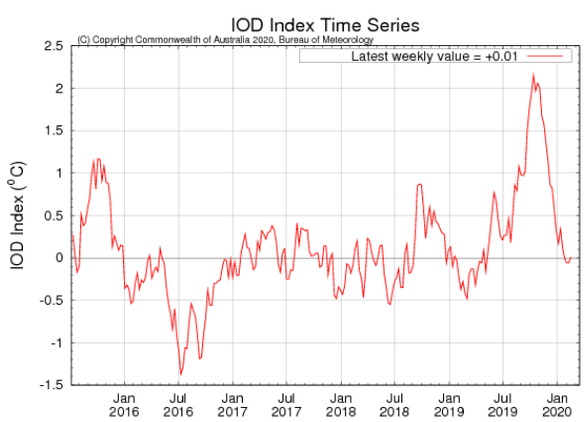

Figure 3: The Indian Ocean Dipole (IOD) index shows positive IOD values peaking strongly in October 2019. Credit: Bureau of Meteorology, Australia.

Based on the archived IOD forecasts at the Bureau of Meteorology (BoM), Australia, most models from various international climate centres predicted, from as early as December 2018, a positive IOD developing by May 2019 (Figure 4; BoM Climate Model Summary, 17 December 2018).

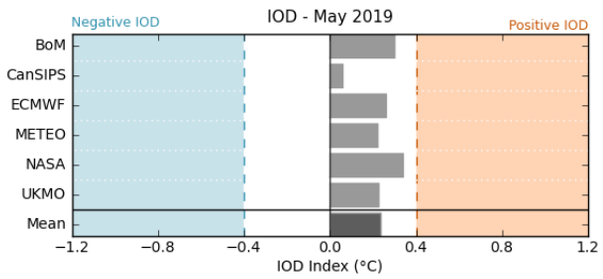

Figure 4: The IOD predictions from various international climate centres in December 2018 assembled by the BoM, Australia. Model predictions were pointing towards positive IOD developing by May 2019. Credit: Bureau of Meteorology, Australia.

The strong, positive IOD led to significantly drier conditions throughout Southeast Asia, particularly over the southern parts of the region (e.g. Sumatra, Java, and Kalimantan) during September-November 2019 (Figure 5).

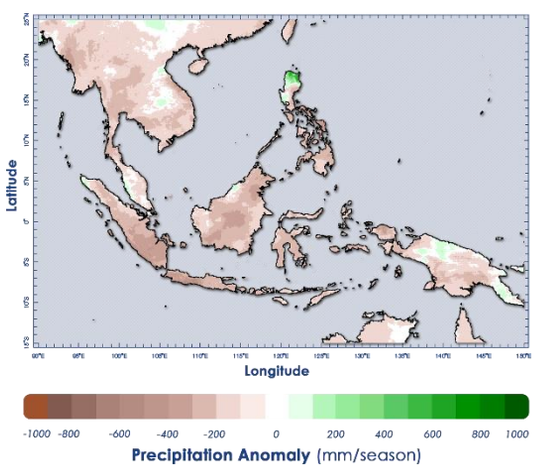

Figure 5: September-November 2019 seasonal rainfall anomaly (in mm) against 1981-2010 climatology from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) dataset. Brown (green) shades show regions of drier (wetter) conditions. Credit: IRI Data Library.

Associated with the drier conditions, the temperature over the region was also warmer during September-November 2019 (Figure 6). The warmer conditions from the positive IOD added to the ongoing global warming trend that the region had been experiencing and thereby enhanced overall temperature anomalies.

Madden-Julian Oscillation

Throughout the second half of 2019, there was limited coherent propagation of the Madden-Julian Oscillation (MJO). The strongest MJO signal occurred in November, where the MJO emerged in Phase 5 and faded into Phase 8 (Figure 7). Between these phases, the MJO is known to induce drier conditions over the Maritime Continent. However, the rainfall anomalies from 1 to 20 November 2019 (not shown) resembled the seasonal anomalies caused by IOD (Figure 5) more closely than the typical rainfall response during November for an MJO in these phases. Thus, the effect of IOD had likely dominated that of the MJO during the period.

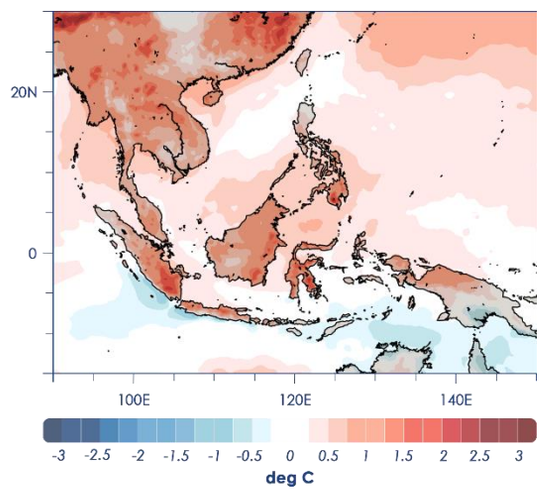

Figure 6: September-November 2019 average surface temperature anomalies (˚C) against 1981-2010 climatology show warmer conditions (red shades) for most parts over land. Data: ERA5 Reanalysis.

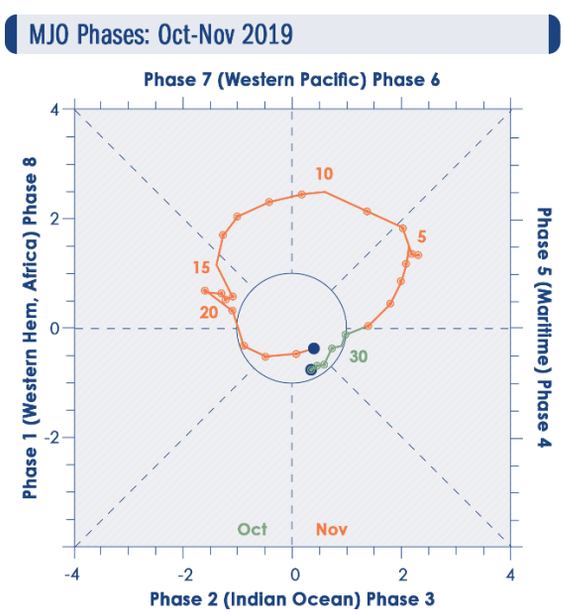

Figure 7: MJO phases towards the end of October (green) and during November 2019 (orange). The MJO was strong for much of November 2019. Data: BoM, Australia.

REGIONAL FIRE AND HAZE SITUATION (JUL-DEC 2019)

Transboundary haze affected many parts of southern ASEAN region in Sep 2019

With the positive Indian Ocean Dipole (IOD) prevailing in the second half 2019, colder-than-average sea surface temperatures were observed over the eastern Indian Ocean, and many parts of the southern ASEAN region experienced drier conditions between July and October 2019. During this period, there were several occasions where hotspot activities in the fire-prone provinces of Sumatra and Kalimantan escalated (Figure 8) and led to transboundary smoke haze affecting western Peninsular Malaysia, Sarawak, Singapore, southern Thailand, and Brunei Darussalam.

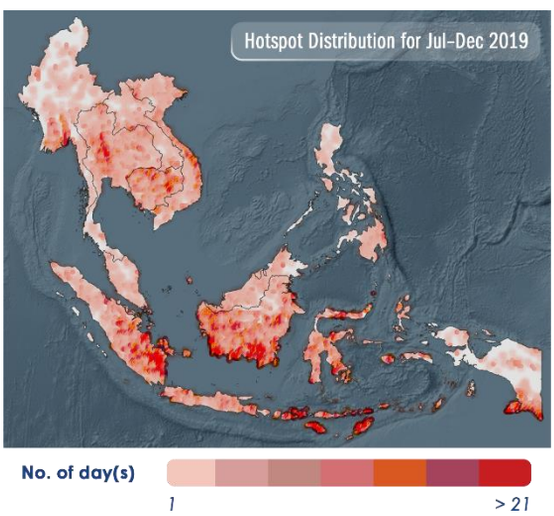

Figure 8: Distribution of NOAA-20 hotspots for July-December 2019. Persistent clusters of smoke-emitting hotspots were detected in central and southern Sumatra, and West and Central Kalimantan.

The smoke haze (Figure 9) resulted in a deterioration in the air quality and visibility in some areas. The provinces of Riau and Jambi in Sumatra, and parts of Peninsular Malaysia and Sarawak were among the most affected areas (Figure 10). Disruptions to air transport and negative social-economic impacts were reported.

The onset of the inter-monsoon season in late-September/early-October brought an increase in shower activities over the region and helped to improve the hotspot and haze situation.

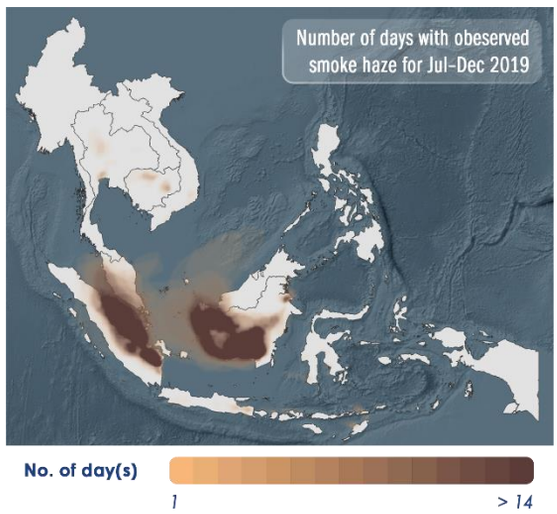

Figure 9: Number of days with observed smoke haze in the July-December 2019 period. Smoke haze from hotspots in Sumatra and Kalimantan had spread to areas as far as southern Thailand and the South China Sea.

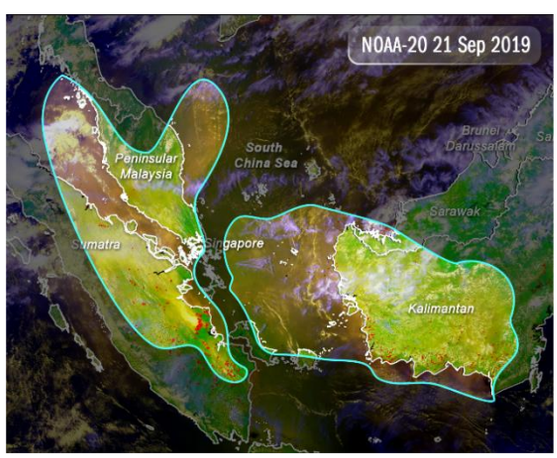

Figure 10: NOAA-20 satellite image on 21 September 2019 shows transboundary smoke haze (highlighted areas) affecting Malaysia and Singapore blown in from fires in Sumatra and Kalimantan by the prevailing winds.

For the northern ASEAN region, hotspot activities were generally subdued due to the rainy weather. By December 2019, with the setting in of the region's traditional dry season (December-April), there was a gradual increase in hotspot activities in parts of the Mekong sub-region. Localised smoke plumes were observed from some of the hotspots in Myanmar, Thailand, and Cambodia.

CLIMATE AND HAZE OUTLOOK (MAR-AUG 2020)

Overall, neutral conditions are favoured for both the ENSO and IOD

ENSO Outlook

ENSO is currently in neutral conditions. Model outlooks from international climate centres (C3S) indicate the warm, but within neutral, SST anomaly values to continue until at least April 2020. Beyond April, the models show a wide range of possible outcomes until July 2020. However, most of the models' ensemble predictions still cluster around neutral-warm values during this period (Figure 11).

In line with the Nino3.4 prediction in Figure 11, the ensemble-mean predictions of SST anomalies over the tropical Pacific Ocean, on average, show warmer but neutral conditions until May-July 2020 (Figure 12).

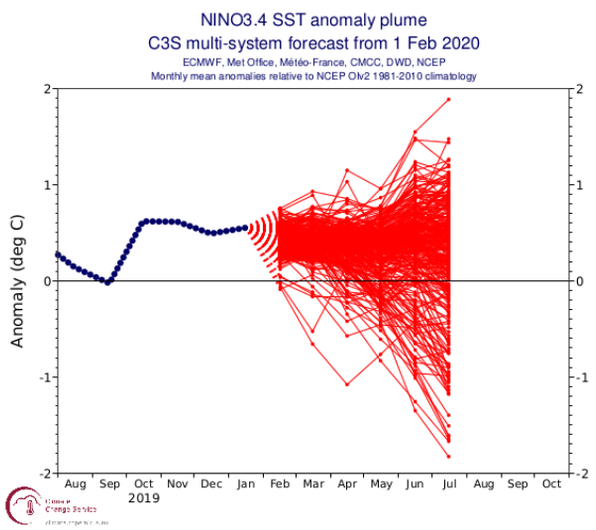

Figure 11: Nino3.4 SST anomaly predictions from C3S models show a wide range of possible outcomes until July 2020. However, most of the models' ensemble predictions still fall within the neutral range. Credit: C3S.

IOD Outlook

Likewise, the IOD is currently in neutral conditions. Model predictions favour the IOD to remain neutral until at least May 2020 (Figure 13).

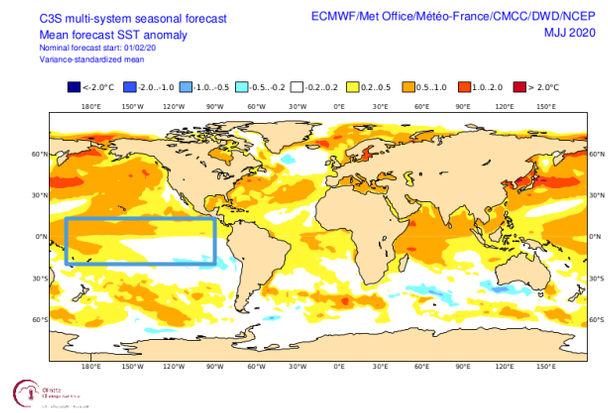

Figure 12: SST anomaly prediction for May-July 2020 from C3S model ensemble show positive but neutral SST anomaly conditions, on average, across the eastern-central tropical Pacific Ocean (blue box). Credit: C3S.

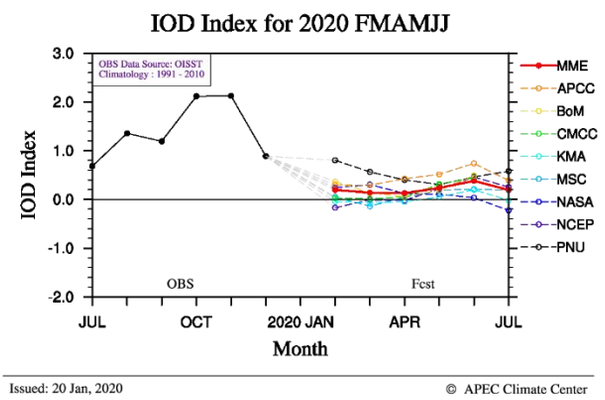

Figure 13: IOD index predictions from the APEC Climate Centre's multi-model ensemble (APCC MME) continue to be neutral although weakly positive until at least May 2020. Credit: APCC.

Rainfall and Temperature Outlook

In the upcoming March-May 2020 season, model predictions from selected C3S models (SEA RCC-Network Long-range Forecasting Node) indicate enhanced chances of below-normal rainfall (drier) conditions over Southeast Asia between 0° to 20°N with good model hindcast skill (Figure 14). To the south of the Equator, the models predict above-normal rainfall (wetter) conditions. For this part of the region, however, the models have poorer skill for this season. For temperature, most parts of the ASEAN region are predicted to continue experiencing above-normal (warmer) conditions during March-May 2020 (Figure 15).

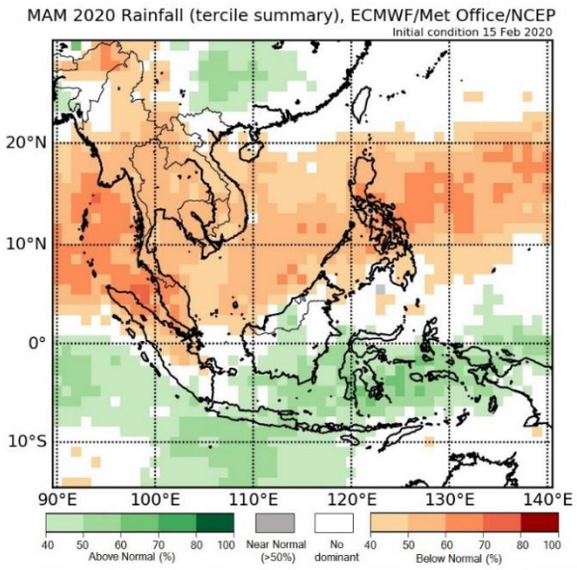

Figure 14: Rainfall tercile summary of the multi-model ensemble predictions for March-May (MAM) 2020. Brown (green) shades show regions with higher probabilities of drier (wetter) conditions (contains modified C3S information).

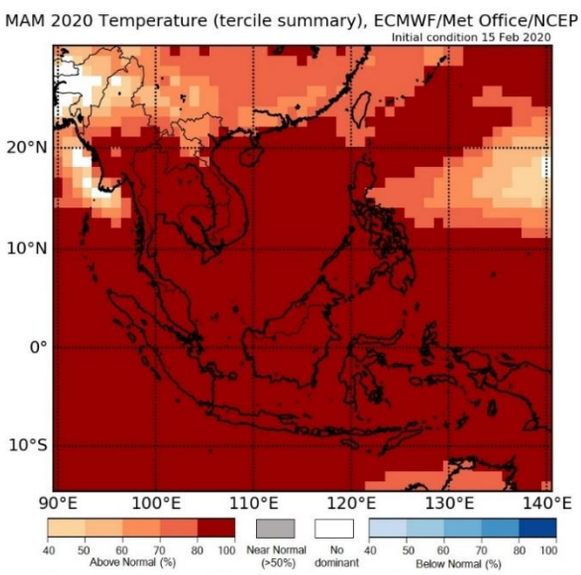

Figure 15: Temperature tercile summary of multi-model ensemble predictions for March-May (MAM) 2020. Red (blue) shades show regions with higher probabilities of warmer (colder) conditions (contains modified C3S information).

Haze Outlook

The drier conditions expected over the northern ASEAN region during March-May 2020 may contribute to further escalation of hotspot activities, and a deterioration of the haze situation in the Mekong sub-region. Nonetheless, the seasonal arrival of increased shower activities by late-April/early-May 2020 is likely to help subdue hotspot activities and bring a gradual improvement to the haze situation in the region. In the southern ASEAN region, hotspot activities are expected to remain generally subdued until around mid-2020, although isolated hotspots with localised smoke plumes may emerge during occasional periods of dry weather.

By June 2020, the start of the rainy season over the Mekong sub-region is expected to keep hotspot activities there subdued. In contrast, June is typically the start of the dry season in the southern ASEAN region. A gradual increase of hotspot activities can be expected in the fire-prone provinces of Sumatra and Kalimantan during periods of drier weather. This may lead to the occurrence of transboundary haze pollution affecting the region.

SIGNIFICANT WEATHER EVENTS IN SOUTHEAST ASIA

Heavy rain event over Brunei Darussalam on 30 Sep 2019

Contributed by Mr Arifin Yussof, Meteorological Officer, Brunei Darussalam Meteorological Department (BDMD)

Brunei Darussalam experienced heavy rainfall on the evening of 30 September 2019, which caused flash floods over many areas in the Brunei-Muara District – the most populous district in the country (Figure 16). The severe flash floods inflicted damage to houses and government properties. Fortunately, there were no casualties from this extreme weather event.

Figure 16: Flash flood in one of the areas in the Brunei-Muara district. Credit: Borneo Bulletin.

Synoptic Situation

At the time of the event, Brunei Darussalam was nearing the end of the Southwest Monsoon where typically it would experience squally weather and hazy conditions. The wind-chart analysis, done by the Brunei Darussalam Meteorological Department's (BDMD's) Duty Meteorological Forecaster, showed the presence of a vortex circulating at 850 hPa just north of Brunei (Figure 17). The corresponding surface weather chart from the Thai Meteorological Department (not shown) also showed the presence of a low-pressure system to the northwest of Brunei. Upon further analysis using the Japanese 55-year Reanalysis (JRA-55) data (Figure 18), there were southerly winds from the southwest and southeast converging over Brunei. The combination of these synoptic anomalies greatly enhanced convection and the formation of heavy-rain clouds which consequently caused the adverse weather event.

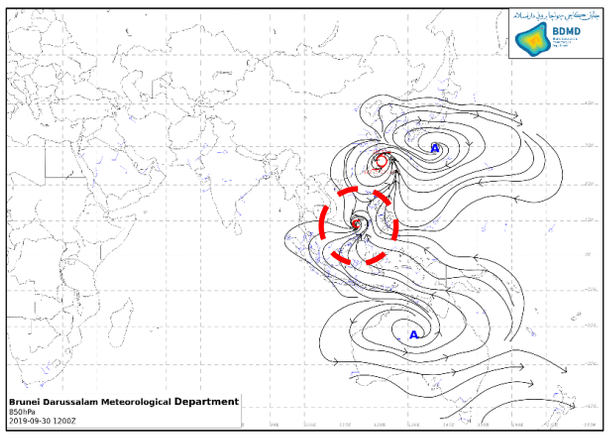

Figure 17: Wind-chart analysis on 30 September 2019 (1200 UTC) by BDMD's Duty Meteorological Forecaster.

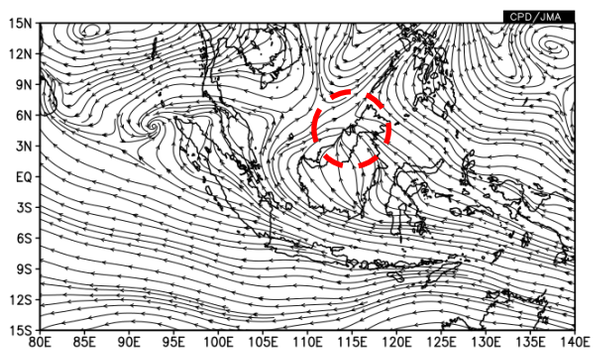

Figure 18: JRA-55 reanalysis wind streamlines at 850 hPa on 30 September 2019. Credit: Japan Meteorological Agency.

Forecasting the Extreme Weather Event

One of the essential products which BDMD's forecasters use daily is the rainfall rate forecast from NCEP's Global Forecast System (GFS). The afternoon GFS model run had early indications of active weather over Brunei that came later in the day. Another important tool is the World Meteorological Organization's Flash Flood Guidance System (FFGS) which, when combined with the rainfall rate forecast, showed the potential risk of flash floods occurring (Figure 19).

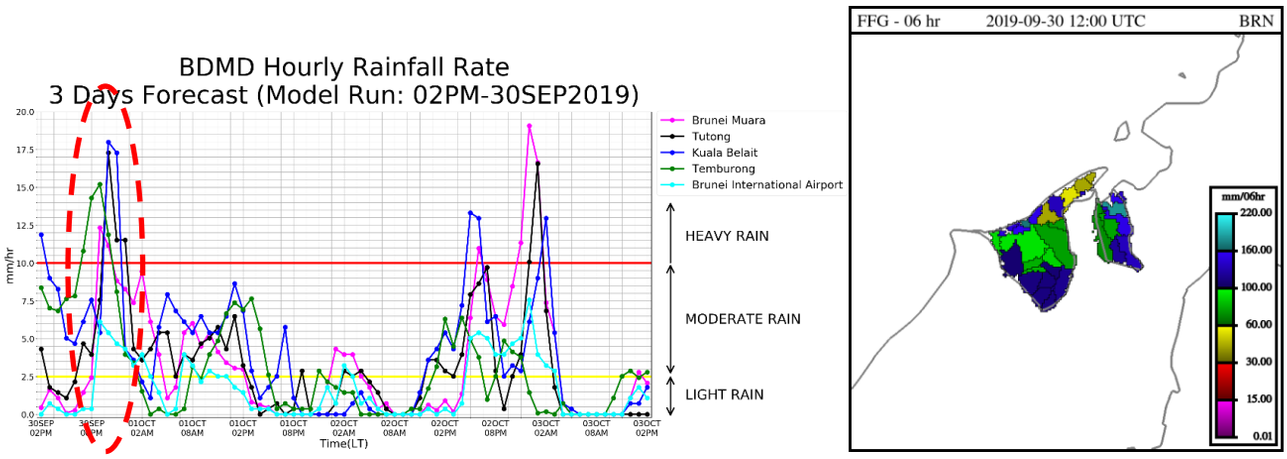

Figure 19: Global Forecast System (GFS) rainfall rate forecast initialised at 2 pm local time on 30 September 2019 (left). Flash Flood Guidance System (FFGS) product issued for Brunei Darussalam at 1200 UTC (8 pm local time) on the same day (right).

The GFS model performed admirably for this event as it had indicated hours in advance on the risk of heavy rain across Brunei.

Observations

The daily rainfall recorded at Brunei International Airport on 30 September 2019 was 275 mm, which is a new record for the highest daily rainfall recorded for the station over the past 35 years. We also observed the sudden outburst of rainfall nearing midnight, which was the primary cause of severe flash floods.

Warnings Issued

The BDMD had issued three yellow stage weather warnings on that day (Figure 20). The general public receives these warnings via the Brunei WX App, official BDMD social media accounts, and radio alerts. Government agencies, such as the National Disaster Management Center (NDMC), also receive these warnings directly via e-mail and fax. These warnings had helped to alert the public and warn them of the incoming heavy rain so that they could protect themselves and their properties.

Figure 20: An example of a yellow stage weather warning, in English and the local language, issued earlier on that day for a potentially heavy rain event.

Northwest Pacific tropical season synopsis (Jul-Dec 2019)

Contributed by Mr Junie Ruiz, Weather Specialist (Climate and Agrometeorology Division)

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

During the second half of 2019, tropical cyclones (TCs) over the Northwestern Pacific were active and a majority of these TCs entered the Philippine Area of Responsibility (PAR). Overall, twenty-six (26) TCs developed over the Northwest Pacific and seventeen (17) of these entered the PAR in the second half of 2019 (Figure 21).

Significant Tropical Cyclones

The significant TCs that crossed the coast and caused devastation happened in November and December 2019. These led to widespread flooding, flash floods, and landslides, brought damage to agriculture and infrastructure, and even inflicted loss of lives. Last year's three significant TCs, Typhoons (TYs) Kalmaegi (12-20 November), Kammuri (30 November-5 December), and Phanfone (23-28 December), made landfall over the northern and central parts of the Philippines (Figure 22). The TYs, combined with the effects of the Northeast Monsoon, brought strong winds and heavy rainfall. These three TYs caused widespread damage across Northern Luzon, Southern Luzon and the Visayas, where most floods and landslides occurred. The TYs caused 61 fatalities and cost an estimated 12 billion Philippine Peso (240 million USD) worth of damage to infrastructure and agriculture.

Disaster Risk Reduction

PAGASA coordinates closely with the National Disaster Risk Reduction & Management Council (NDRRMC) to mitigate the impact of TCs on the Philippines. When a TC develops and is forecast to enter the Philippine Area of Responsibility (PAR), both agencies work together to closely monitor and prepare for the event. A Pre-disaster Risk Assessment (PDRA) meeting is conducted among NDRRMC member agencies at least two days before the TC enters the PAR. Updates are then regularly issued as the TC comes closer to the country, especially if it is forecast to make landfall. This procedure has become an established protocol for warning agencies to mitigate the adverse impacts of TCs through early warning and early action from the national to the local government levels.

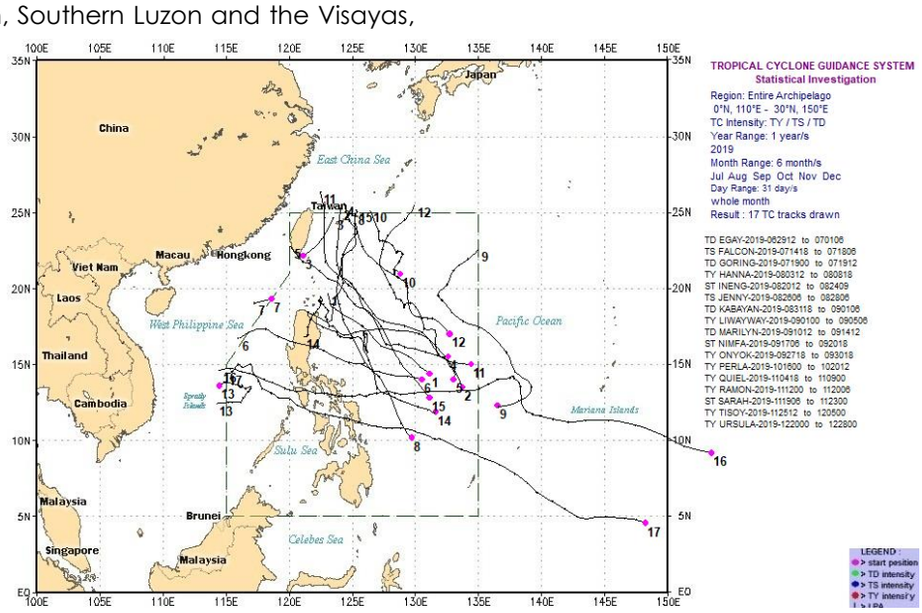

Figure 21: Tracks of tropical cyclones that entered the Philippine Area of Responsibility (July-December 2019). Credit: PAGASA.

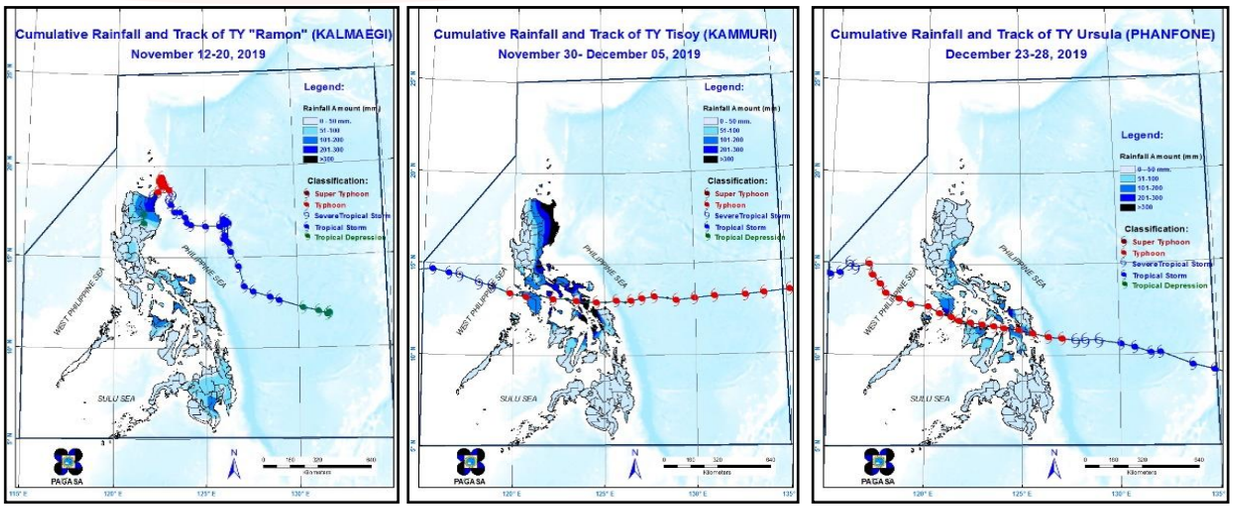

Figure 22: Tracks and rainfall of notable typhoons from the Northwest Pacific (Kalmaegi: 12-20 November, Kammuri: 30 November-5 December, and Phanfone: 23-28 December) affecting the region during July-December 2019. Credit: PAGASA.

The extreme torrential rainfall observed in Phu Quoc, Viet Nam (Aug 2019)

Contributed by Ms Nguyen Thi Diem Huong, Ms Hoang Thi Mai, and Dr Chinh Ta Huu, Forecasters

National Centre for Hydro-Meteorological Forecasting (NCHMF), Viet Nam

Phu Quoc, located in the south of Viet Nam, is part of the Kien Giang Province (Figure 23). The island is well known as an attractive tourist destination due to its diverse and unique plants and marine life. Every year, Phu Quoc invests hugely in infrastructure and agriculture.

Figure 23: Geographical map of Phu Quoc (left) and Viet Nam (right).

Rainfall Records Broken

In August 2019, various rainfall records for Phu Quoc were broken. The climatological average rainfall in that month is 485 mm (1981 to 2010). In the first ten days of August 2019 alone, the total amount of rainfall observed was 1167 mm, which is almost 2.5 times higher than the monthly average, and nearly twice as much as the second-largest dekadal (10-day) rainfall in the year 2000 (593 mm). Remarkably, the daily rainfall on 5 August 2019 was 264.5 mm. In addition, the 24-hour rainfall recorded from 12 UTC on 8 August to 12 UTC on 9 August 2019 was 357.9 mm. This is the highest daily rainfall amount for the period 1978 to present. The extremely high daily rainfall amounts observed in August 2019 caused severe floods and damaged infrastructure on the island, amounting to losses of more than 107 billion VND (4.6 million USD).

BSISO's Influence

This article analyses the four years with the most significant amounts of dekadal rainfall in August between 1978 and 2019 (Table 1). The reasons causing these phenomena are also investigated and discussed.

Table 1: The top four dekadal (10-day) total rainfall amounts in August between the years 1978 and 2019. The year 2019 saw the highest dekadal rainfall amount recorded within this period.

1-10 Aug 2019	11-20 Aug 2000	11-20 Aug 1990	1-10 Aug 1986
1167 mm	572 mm	593 mm	589 mm

All four years with torrential rainfall events had active Boreal Summer Intraseasonal Oscillation

(BSISO) phases, which are Phases 3, 4, 5, 6, and 7. Based on the APEC Climate Centre's (APCC) research, these phases usually contribute to the strengthening of convective activities over the southern part of Viet Nam (https://apcc21.org/ser/meth.do?lang=en).

Noticeably, the first ten days of August 2019 (Figure 24) indicated the active phases of BSISO1 in the South China Sea (Phases 6 and 7) were stronger compared to the other events (not shown). This observation suggests that the strong BSISO was a contributing factor to the extreme rainfall.

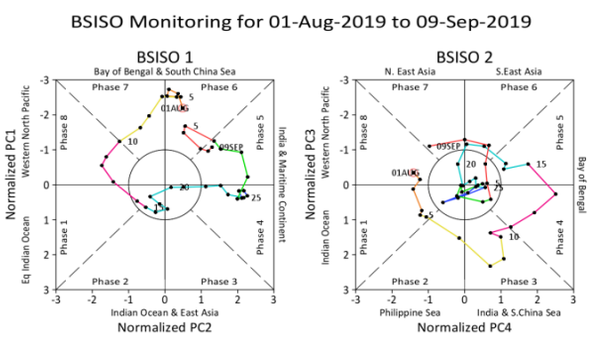

Figure 24: BSISO indices (BSISO1 and BSISO2) during the extremely heavy rainfall event in August 2019. Credit: APCC.

Circulation Anomalies

Based on the Japanese 55-year Reanalysis (JRA-55) datasets for 1000 hPa wind and sea-level pressure anomalies, cyclonic circulations or convergence were present over the East Sea during all four events. However, the significant difference in the climate conditions of the first ten days of August 2019 (Figure 25) is the notably low sea-level pressure due to Tropical Cyclone Wipha. This significant low pressure enhanced the southwest winds over the Phu Quoc region.

Figure 26 shows the average wind magnitude anomalies and their absolute wind directions at the 850 hPa level in 2019. From similar plots for the other three years (not shown), the southwest wind was stronger than normal in all four cases. The wind speed in 2019, when compared to the other years, was however the strongest with an average anomaly at 850 hPa of around 4 to 6 m/s. These strong winds could have also contributed to the extremely anomalous rainfall that year.

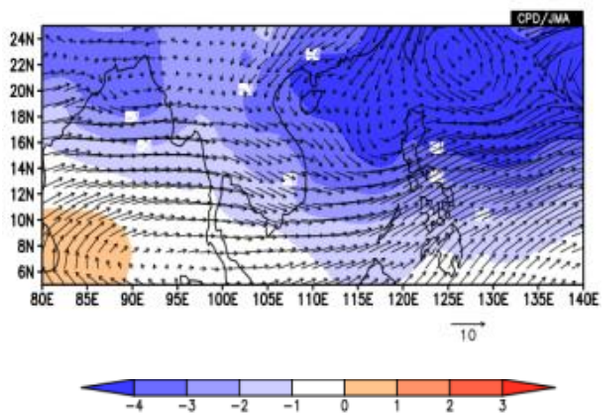

Figure 25: Wind anomalies at 1000 hPa (arrows) and lower sea-level pressure anomalies (blue) from 1-10 August 2019. Credit: Japan Meteorological Agency.

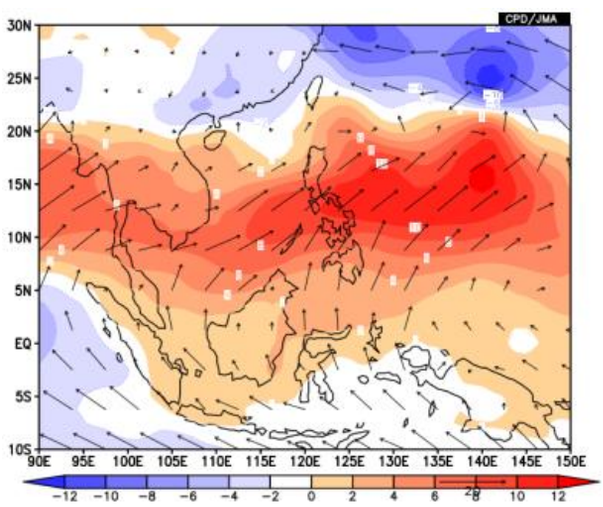

Figure 26: Stronger wind anomalies (red) and absolute wind direction and magnitude (arrows) at 850 hPa from 1-10 August 2019. Credit: Japan Meteorological Agency.

In summary, the stronger Southwest Monsoon winds brought heavier rainfall to southern Viet Nam in August 2019. During those ten days, the strengthening of winds over the Phu Quoc region was due either to the strong convergence along the Inter-Tropical Convergence Zone (ITCZ), or the presence of Tropical Cyclone Wipha. BSISO, in active Phases 3, 4, 5, 6, and 7 during the period, likely contributed as well to the extremely heavy rain amounts over the area.

Tropical cyclones affecting Thailand and mainland Southeast Asia during summer 2019

Contributed by Dr Chalump Oonariya, Meteorologist
Climate Centre, Thai Meteorological Department (TMD)

In the second half of 2019, at least three tropical cyclones intensified rainfall across upper Thailand which led to flood events. The first was Tropical Cyclone (TC) Wipha which entered northern Thailand in early August 2019. It formed as a tropical depression on 30 July in the upper South China Sea and reached tropical storm strength one day later. It then moved west through Hainan Island and made landfall in Guangdong Province, Southern China on 1 August. TC Wipha moved into the Gulf of Tokin before making landfall over upper Viet Nam on 3 August. TC Wipha then moved west-southwestward and weakened into a tropical depression on the same day. It then passed through Lao PDR before finally entering Thailand in Nan Province on 4 August.

TC Wipha over Thailand

TC Wipha moved across northern Thailand and downgraded into an active low-pressure cell while passing by Lampang Province. Despite it weakening over land, TC Wipha brought heavy and widespread rainfall in northern and northeastern Thailand. The maximum daily rainfall was reported to be 136.4 mm at Phayao Province on 4 August. The amount of rainfall was enough to cause severe flooding in Phayao Province on 3-5 August. A landslide was also reported at Nan Province on 3 August.

TC Podul and Kajiki

Later in the month, Thailand was hit by another tropical storm, Tropical Storm (TS) Podul, which first made landfall over Dong Hoi, Viet Nam on 29 August. It then passed through Lao PDR before entering Thailand in the Nakhon Phanom Province. It was later downgraded to a tropical depression and low-pressure system while it tracked over central-northeastern Thailand. Several provinces in upper Thailand reported intense rainfall which led to flash floods in many areas. Mudslides were also reported in some places, especially in the lower northeastern part of Thailand which experienced prolonged flooding.

Most of the affected areas were rice fields, farmlands, houses, bridges, and roads. The highest daily rainfall of 495.0 mm was recorded on 30 August at Phetchabun Province in northern Thailand and new records of daily rainfall in August were established for some stations. TS Podul combined with the influence of the third storm to hit Thailand during summer 2019, Tropical Depression (TD) Kajiki (3 September 2019), enhanced rainfall during the Southwest Monsoon season (Figure 27) which led to severe weather conditions.

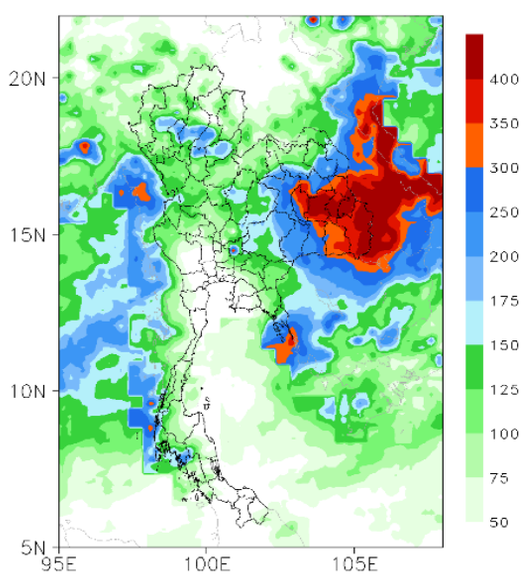

Figure 27: Total rainfall amount in mm during the passage of TC Podul and Kajiki between 28 August and 3 September 2019.

The Department of Disaster Prevention and Mitigation (DDPM) of Thailand reported that the floods affected 32 provinces across Thailand, in particular over the northeastern part. DDPM had also declared emergency status in 28 provinces affected by the disaster (Figure 28).

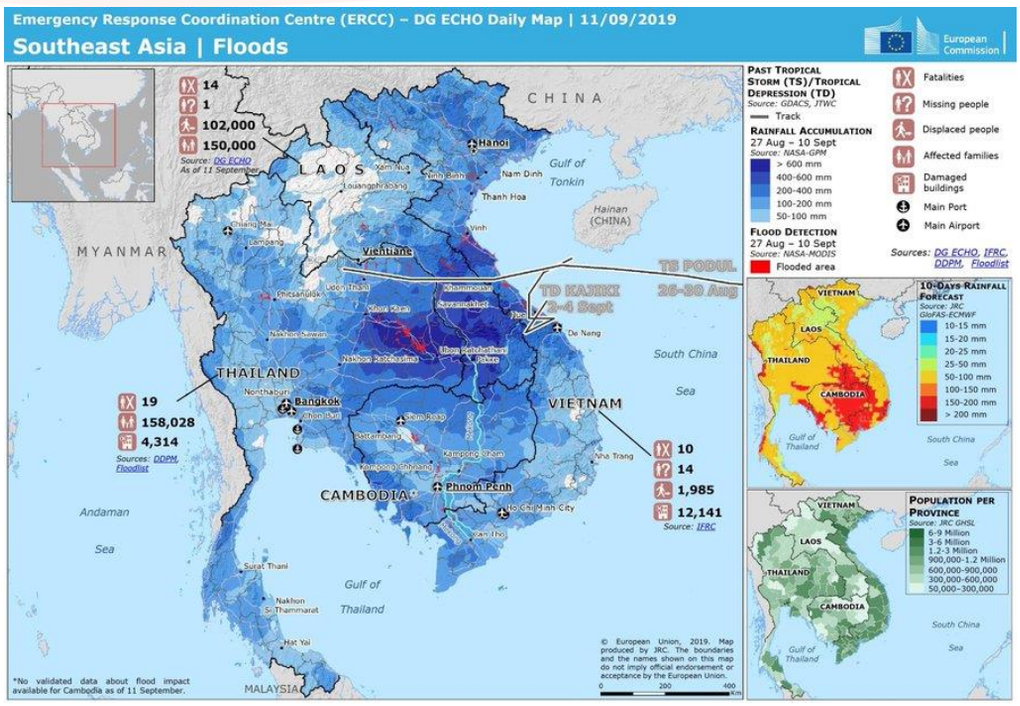

Figure 28: Floods from the tropical storms that were reported and mapped. Credit: European Civil Protection and Humanitarian Aid Operations.

ASMC EVENTS

The 13th Session of the ASEAN Climate Outlook Forum, ASEANCOF-13 (Bangkok, 18-21 Nov 2019)

The ASEAN Climate Outlook Forum (ASEANCOF) was established in 2013 and has since been held in various Southeast Asian countries with the hosts collaborating with ASMC. ASEANCOF aims to provide collaboratively-developed and consensus-based seasonal climate outlooks and related information (e.g. climate drivers and monitoring) at the regional scale. The Regional Climate Outlook Forum concept (RCOF) was initiated by the World Meteorological Organization (WMO) Climate Information and Prediction Services (CLIPS) project, in collaboration with the National Meteorological and Hydrological Services (NMHSs), regional and international climate centres, among many other partners. The Thirteenth Session of the ASEAN Climate Outlook Forum (ASEANCOF-13) was held in November 2019, hosted by the Thai Meteorological Department. The forum consisted of two days of pre-COF training, followed by two days of the Climate Outlook Forum proper.

Pre-COF Training

The pre-COF training (18-19 November) aimed to provide a foundation-level understanding of seasonal prediction concepts, such as predictability sources (e.g. ENSO), forecasting methods (e.g. statistical versus dynamical modelling, and terciles constructing), and model verification techniques. The training was led by two trainers from the UK Met Office, Dr Tamara Janes and Dr Rosanna Amato, who promoted an interactive and hands-on approach to learning about seasonal forecasting.

Workshop participants revising the concept of climatological terciles with a relatable application; working out what the near-normal height of participants was and those who were in the below-normal category.

Climate Outlook Forum Proper

The Climate Outlook Forum (COF) proper began on 20 November. The National Meteorological and Hydrological Services (NMHSs) participants who attended the pre-COF training were joined by representatives from the Global Producing Centres (GPC) that produce seasonal predictions: the Bureau of Meteorology, Australia, China Meteorological Administration, Japan Meteorological Agency, the International Research Institute for Climate and Society, and the WMO Lead Centre. Other participants included representatives from WMO, the ASEAN Economic Community Department, Regional

Integrated Multi-hazard Early Warming Systems (RIMES), the Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ GmbH), the Food and Agriculture Organization of the United Nations, and the DeRisk project. Both the GPC and NMHS representatives shared their regional or national level outlooks respectively for the upcoming December 2019-February 2020 season. The presentations paved the way for intensive discussion in the afternoon, before coming to a consensus on the seasonal climate outlook statement (http://asmc.asean.org/events-thirteenth-session-of-the-asean-climate-outlook-forum-aseancof-13/).

DeRisk Project

The morning's programme on the last day of ASEANCOF-13 was led by representatives from the WMO DeRisk project (https://public.wmo.int/en/projects/de-risk-south-east-asia). This project aims to develop climate risk management systems, best practices, and insurance products for the agricultural sector for select Southeast Asian countries. During the morning, participants were introduced to the DeRisk seasonal forecast online tool (including a hands-on demonstration), as well as listened to the presentations from the agricultural climate services sector in the various countries. Notably, even within the project, the group took different approaches for different countries to collect information on climate risks faced by the agricultural community, as well as different methods to disseminate information. However, all cases required interactions with users, as the presenters stressed that climate services are not possible without user-involvement.

An introduction presentation to the DeRisk project, which aims to develop climate risk management systems, best practices, and insurance products for the agricultural sector in Southeast Asia.

A Visit to the Thai Meteorological Department

ASEANCOF-13 ended with a visit to the TMD headquarters, where ASEANCOF participants mingled with TMD staff. Participants learnt about how weather forecasts, seasonal outlooks, and climate projections were developed and communicated, as well as future areas of research conducted by the TMD.

Tour of the Thai Meteorological Department, covering various endeavours by the teams looking at the weather, seasonal, and climate timescales.

First Module on Weather Prediction by Numerical Methods, WPNM-M1 (18-22 Nov 2019)

The ASEAN Specialised Meteorological Centre (ASMC) conducted the Weather Prediction by Numerical Methods Module 1 (WPNM-M1) in Singapore from 18-22 November 2019, as part of its 5-year Regional Capability Building Programme rolled out in 2018. The 5-day capability-building and knowledge-sharing training module was attended by 18 participants from nine ASEAN National Meteorological and Hydrological Services (NMHSs) and was delivered by lecturers from the Centre for Climate Research Singapore (CCRS) and Singapore University of Social Sciences (SUSS).

Participants from the ASEAN NMHSs with lecturers from CCRS and SUSS at the training module conducted by ASMC in Singapore.

The objectives of the training module were to provide participants with a deep understanding of the conceptualisation, formulation, and limitations of numerical weather prediction (NWP) models; to equip participants with knowledge on the governing equations used in NWP models; and to equip participants with knowledge of numerical methods to solve these equations and their associated limitations.

Prof Erland Källén, Director of CCRS, delivering a lecture on spectral methods, which was the last of the nine lectures in the series.

Dr Teo Chee Kiat, a CCRS lecturer, facilitating the hands-on practical sessions using simplified models.

A series of nine lectures were conducted during the WPNM-M1, covering a wide range of topics ranging from the various approximations used in the governing equations, to various numerical methods commonly used in operational NWP systems and key considerations for operational implementation. Hands-on practical sessions were conducted, using simplified models which were coded in-house by CCRS lecturers, to illustrate the concepts highlighted during the lectures and to help bridge theory with practical applications.

Overall, the training module was well-received by the participants. Almost all participants indicated interest to attend future training modules and expressed support for the continuation of the training series. Participants also commended the use of simplified models for pedagogical purposes. Plans were made to prepare a peer-reviewed publication consolidating the current and possible future NWP efforts in ASEAN.

ASMC Training Workshop on the Use and Interpretation of Data for Fire and Haze Monitoring for the Mekong sub-region and Attachment Programme (13-16 Jan 2020)

As part of the ASMC 5-year Regional Capability Building Programme for the ASEAN Member States, ASMC conducts regular training workshops in the area of land/forest fires and smoke haze monitoring and assessment using data from satellites. This year, the training workshop was held on 13-16 January 2020 together with a short attachment at the ASMC for the Mekong sub-region comprising Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam. Five participants from the environment, forestry, and pollution control sectors joined this year's programme.

Workshop participants with meteorologists from the ASMC Forecast Office.

The workshop included lectures for participants to gain foundational understanding of topics such as weather systems in Southeast Asia, sub-seasonal and seasonal predictions, interpretation of satellite imageries, data analysis methodologies, and dispersion modelling as a predictive tool. The lectures were supplemented with hands-on exercises in the interpretation of satellite data. The participants also had a short attachment at the ASMC Forecast Office, where they worked with ASMC meteorologists on near real-time assessment of the fire and haze situation in the Mekong sub-region.

Participants were briefed on the process of assessing the weather and haze situation in the Mekong sub-region.

"The lectures and activities conducted during the workshop were useful and interesting, especially the attachment at the ASMC operations centre which gave us an insight into the work of ASMC."

– Ms Phayvone Sengphone, Research Officer, Ministry of Natural Resources and Environment of Lao PDR.

Hands-on exercises for participants to practise their skills in analysing weather and satellite data to produce an outlook of the haze situation in the Mekong sub-region.

Participants visited the Meteorological Service Singapore's Centre for Climate Research Singapore, where they learnt how subseasonal and seasonal forecasts augment haze monitoring and assessment efforts.

Besides such training workshops focusing on monitoring and assessment of regional fires and smoke haze, three other workshops on the themes of Numerical Weather Prediction, Seasonal to Sub-seasonal Prediction, and ASEAN Climate Data, Analysis and Projections (ARCDAP) are also in the pipeline.

This bulletin is a biannual publication of ASMC and is published annually in March and September. The bulletin provides a review and outlook of weather and climate phenomena of importance to the region (e.g. ENSO, MJO, and monsoon) and their influence on the region's temperature and rainfall conditions.

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