INDONESIA

Impact Monitoring of Hydrometeorological Hazards

July - September 2020

a bulletin from

BMKG

BNPB

WFP

Contents

Key Messages & Recommendations

- Precipitations levels in Apr - Jun 2020 are classified as “normal - above the long-term average” for most provinces in Indonesia.
- In early Apr 2020, a meteorological drought occurred in a number of provinces, such as Jawa Tengah, Jawa Timur, Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur with at least 36 million people living in areas experiencing extended drought (30 - 60 days without rain).
- Extreme rainfalls in a short period occurred in Sulawesi Selatan, Sulawesi Tenggara, Nusa Tenggara Barat, Nusa Tenggara Timur, and Maluku.
- The water level in reservoirs across Indonesia has increased due to the favorable rainy season. In Jawa Timur, Bali, and Nusa Tenggara Barat, the conditions of water level in reservoirs remain below average. Around 1,075,000 paddy fields are threatened by a lack of irrigations that rely on these reservoirs.
- The Ministry of Agriculture indicates a crop failure in nearly 14,000 ha of paddy fields (out of a total of 7.5 million ha), which is caused by floods in Apr-Jun 2020. Overall, 119,000 ha of paddy fields were impacted by hydrometeorological disasters and pests during this period.
- Based on the June 2020 Vegetation Health Index indicator, around 960,000 ha of paddy fields during this month were affected by severe - very severe agricultural drought. Compared to previous observation in April 2020, the figure of the Vegetation Health Index Indicator has increased from 620,000 ha.
- Most provinces in Indonesia, especially in the northern equator, are predicted to have ‘normal - above normal’ rainfall at the peak of the dry season. Around 15% of areas are predicted to be severely dry, including some main rice-producing areas in Jawa, Bali, and Nusa Tenggara Barat.
- Above the average rainfalls in the dry season are predicted to occur in most peatland areas, which can minimize the risk of forest fires.
- Climate predictions vary for most of the provinces in Indonesia, therefore, providing detailed information about climate predictions may help to take precautionary measures to minimize hydro-meteorological impacts.

Media Brief

The Indonesian government through the Ministry of Agriculture is trying to increase rice-production and anticipate the dry season by pushing forward the planting season [1].

BMKG identified Nusa Tenggara Timur, Jawa Timur, Nusa Tenggara Barat, Jawa Tengah, Yogyakarta and Bali in drought conditions from standby (level 3) to alert (level 5) [2].

Entering the dry season, paddy fields in Kandanghaur Sub-District, Indramayu District, have to experience severe drought. At least 1,300 hectares of paddy fields in the district are likely to be impacted due to water shortage. Lack of access to irrigation may lead to water insecurity [3].

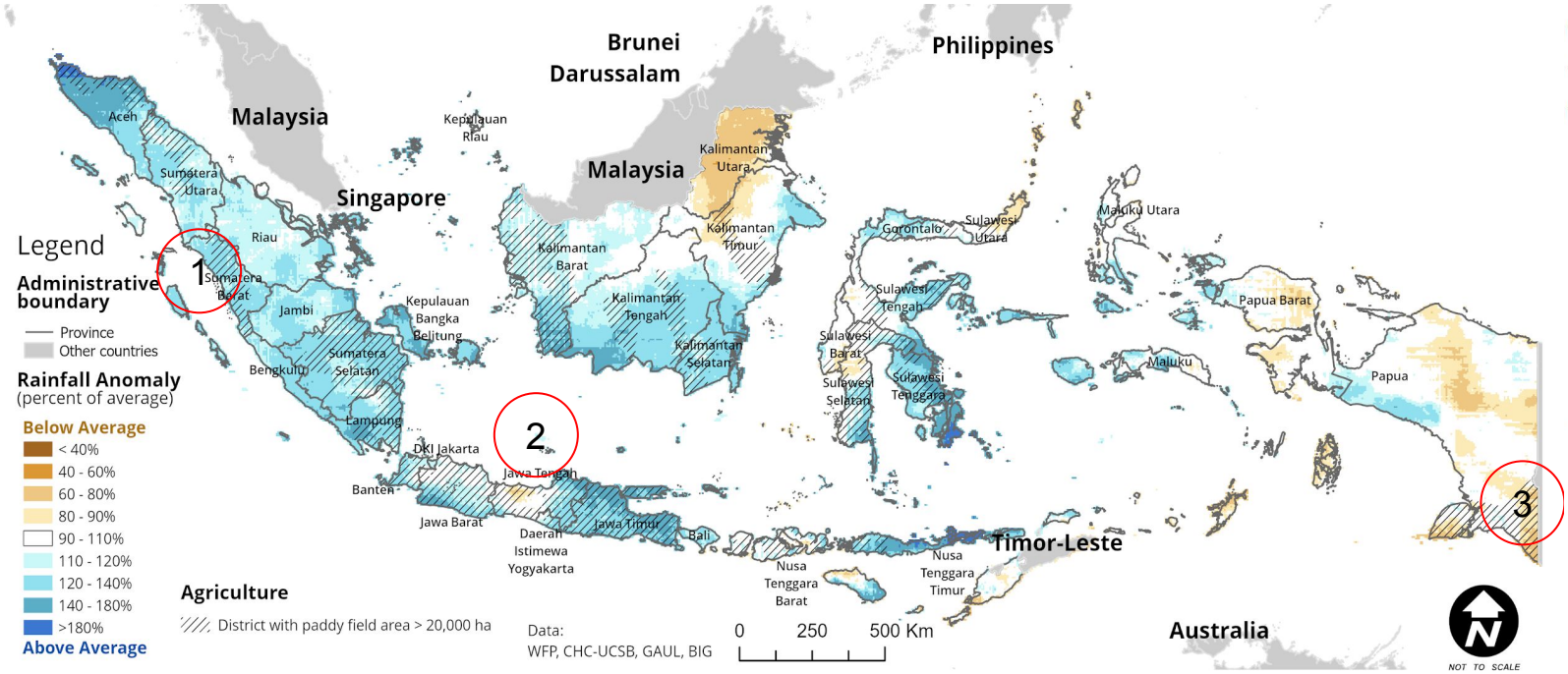
Flooding in several provinces in southern Sumatra, namely Batanghari District, Jambi Province and OKU Selatan District in South Sumatra, had triggered rice crop failure [4].

Localized pest outbreaks still occur in several provinces in Indonesia [5].

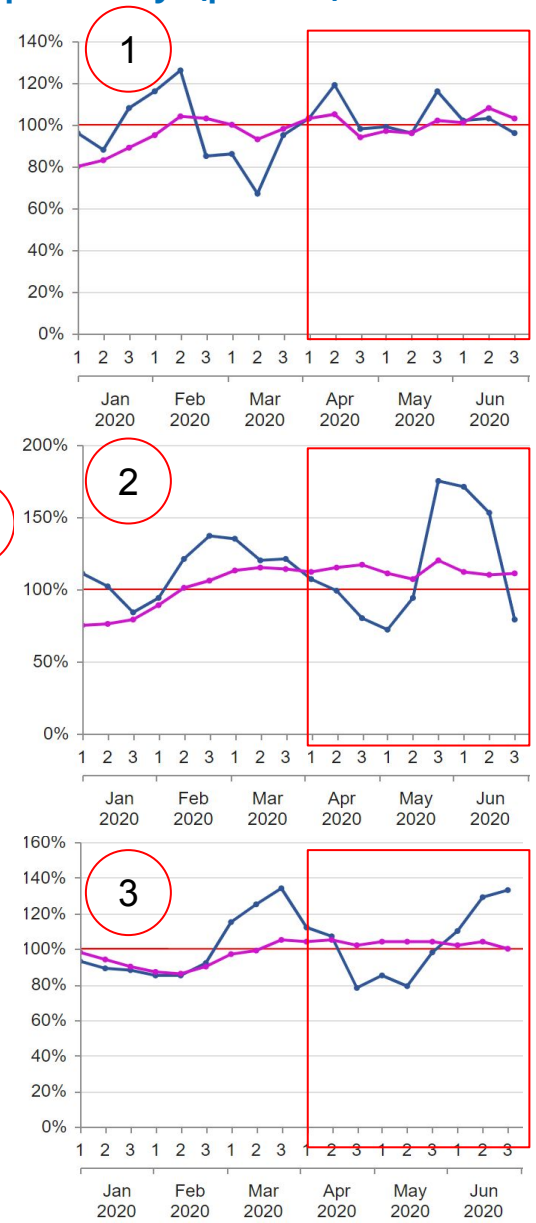
Rainfall Performance: Rainfall Anomaly Q2 2020

Rainfall Anomaly: Apr - Jun 2020

Comparison of Rainfall Accumulation with Long-Term Average



Changes in Rainfall Anomalies per 10 Days (percent)



Overall, from Apr - Jun 2020, at the beginning of the dry season, Indonesia received "a normal to higher than average" rainfall. Jawa Tengah, Kalimantan Utara, parts of Kalimantan Timur, Sulawesi Tengah, parts of Nusa Tenggara Barat, parts of Nusa Tenggara Timur, Papua Barat, and Papua experienced slightly drier conditions compared to the average.

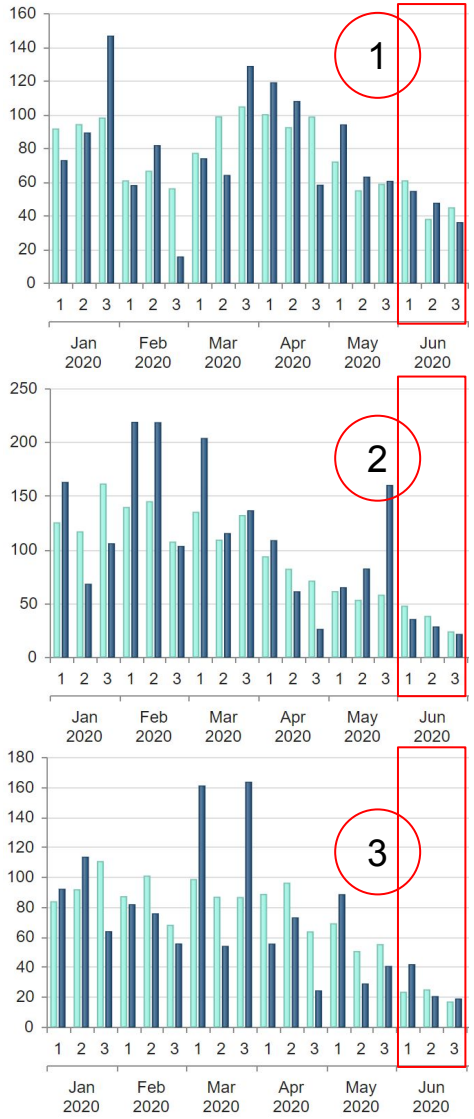
Most rice-producing provinces in Indonesia experienced 'normal to slightly above normal' rainfall, except Jawa Tengah, Sulawesi Selatan, and Papua provinces who received below normal rainfall.

The rainfalls declined to low levels in the long term average in late Apr - Jun, but the conditions started to improve in late May (see graph).

- **Dark blue: 1 month rainfall anomaly**
- **Purple: 3 months rainfall anomaly**

Rainfall Performance: Rainfall Accumulation Jun 2020

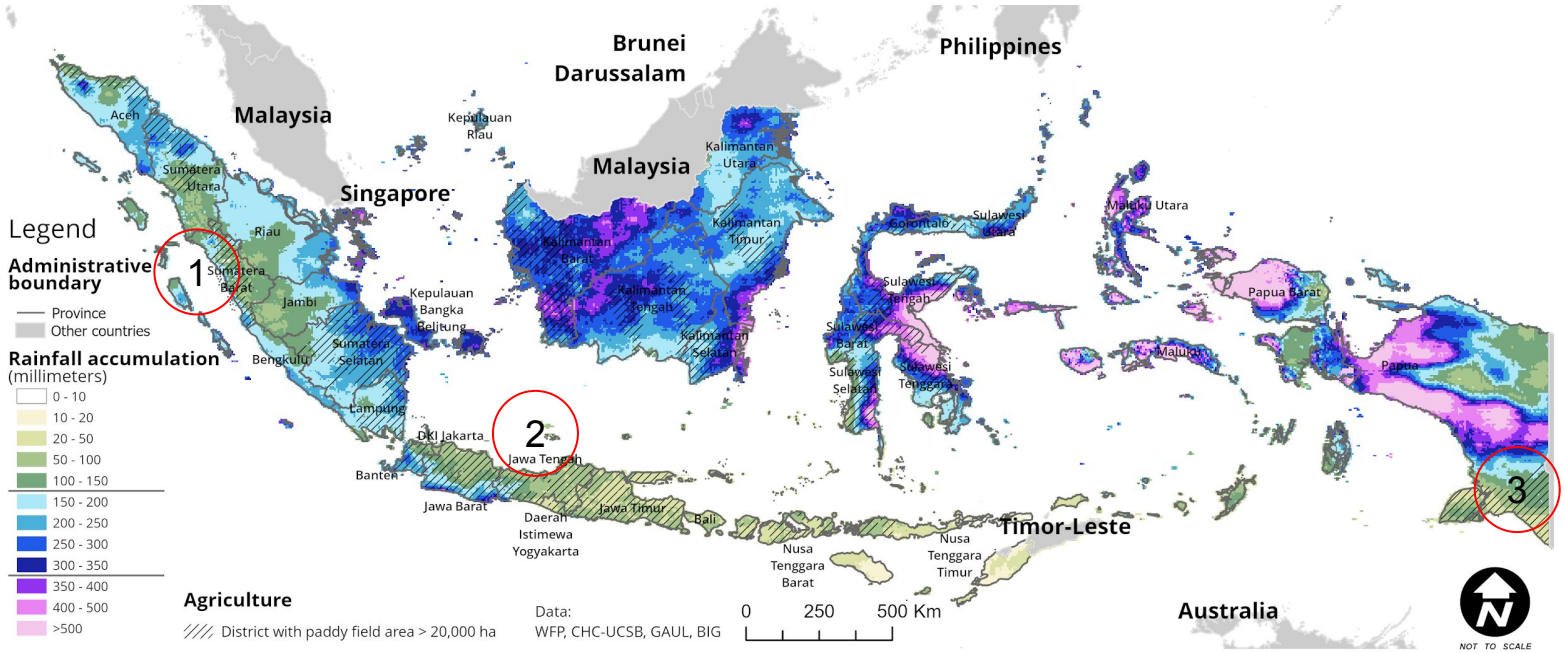
Rainfall Accumulation per 10 Days (mm)



- **Dark blue: current rainfall season**
- **Light blue: long term average (LTA) rainfall**

Rainfall Accumulation: Jun 2020

Mapping Areas Receiving Rainfall Ideal for Crop Growth



The rainfall accumulation map illustrates whether an area has received a favorable amount of rainfall to support crop growth. Paddy field crops require 150-200 mm of precipitation per month, and the above map indicates areas that did not receive sufficient rainfall in June 2020.

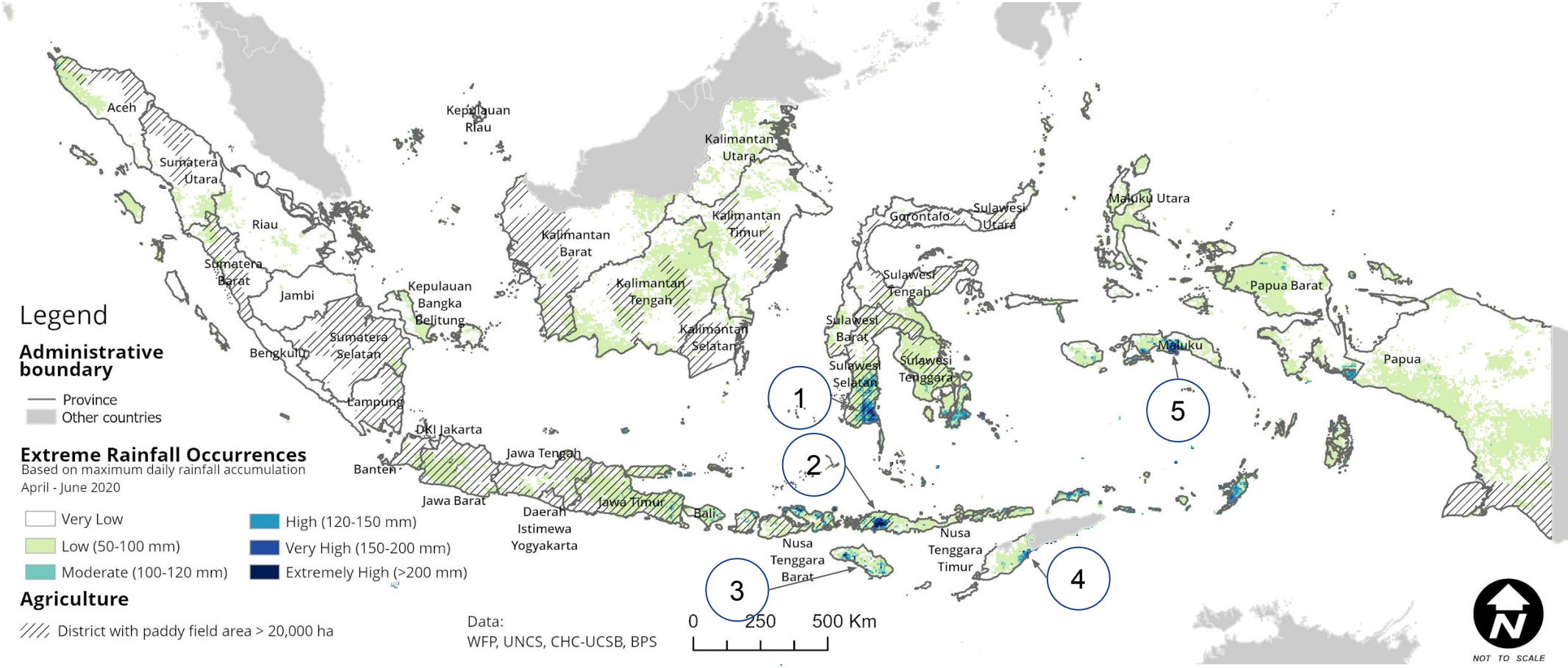
Part of Sumatera Barat, most of Java Island, Bali, Nusa Tenggara Barat, Nusa Tenggara Timur, and Merauke District - main rice-producing areas, did not receive sufficient rainfall in June 2020. Nonetheless, in comparison to the historical data for the same period for these areas, the rainfall levels seem relatively close to the average.

Prolonged low rainfall can cause drought, impacting water availability. When entering the dry season with inadequate rainfall conditions, agricultural land will utilize irrigation water. Therefore, the supply of water in reservoirs is crucial for the cropping process during dry seasons.

Extreme Rainfall: Mapping Potential Floods Events

Extreme Rainfall Event Apr - Jun 2020

Mapping the Highest Daily Rainfall During the Observation Period



High rainfall in a short period may cause floods, flash floods, and landslides. The map above shows the high rainfall event in a short period (one day) in Indonesia, from April to June 2020. This is the transition period from the rainy season to the dry season.

Extreme rain occurred in several provinces, including Sulawesi Selatan, Sulawesi Tenggara, Nusa Tenggara Barat, Nusa Tenggara Timur, and Maluku.

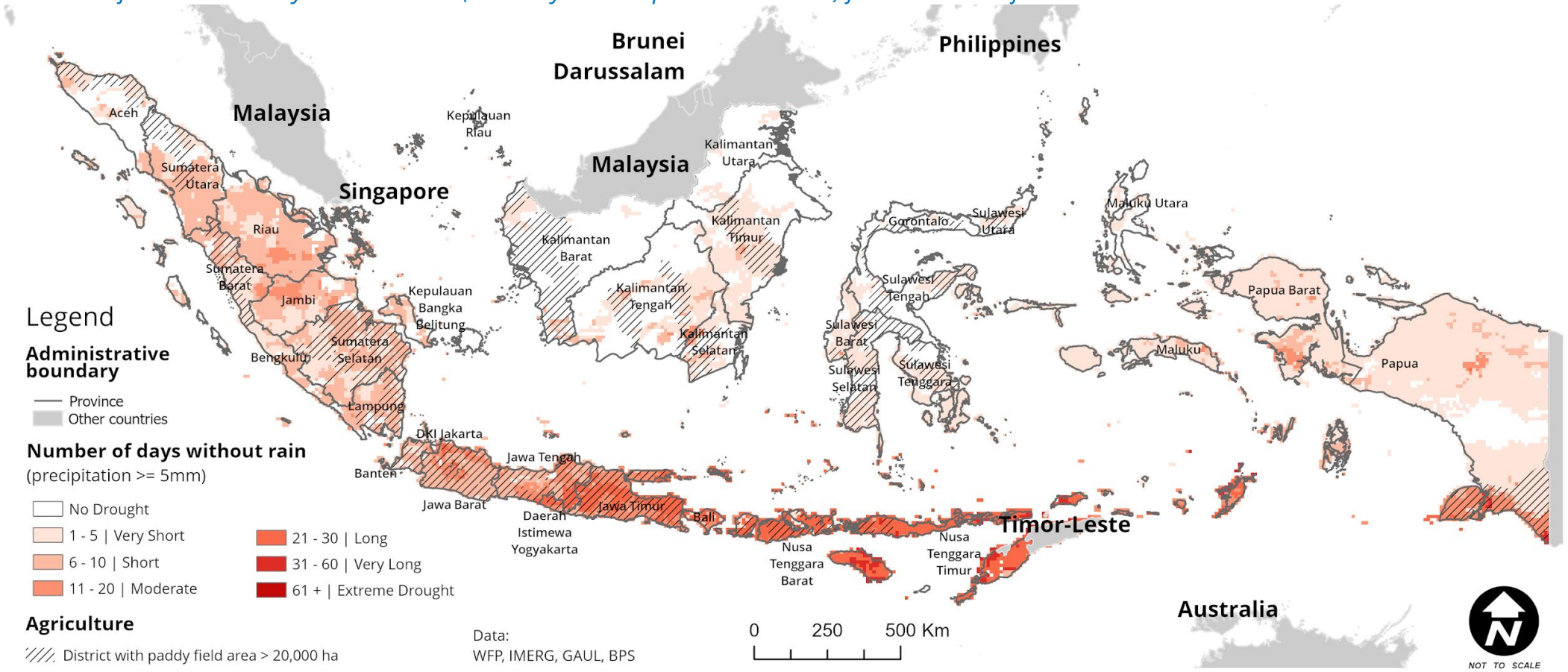
The extreme rain reportedly caused floods in Bulukumba-Bantaeng-Jeneponto (1)[link, link, link], Manggarai (2)[link], Sumba Timur (3)[link], Malaka (4)[link], and Maluku Tengah (5)[link].

Anomalies occurred in Nusa Tenggara Barat and Nusa Tenggara Timur - the provinces that reportedly have low precipitation levels. However, extreme rainfalls still caused flooding.

Consecutive Dry Days: Mapping Potential Droughts Impact

Number of Consecutive Dry Days as of 10 Jul 2020

Number of Consecutive Days Without Rain (Rain Days is Precipitation >= 5 mm) from the Date of Observation

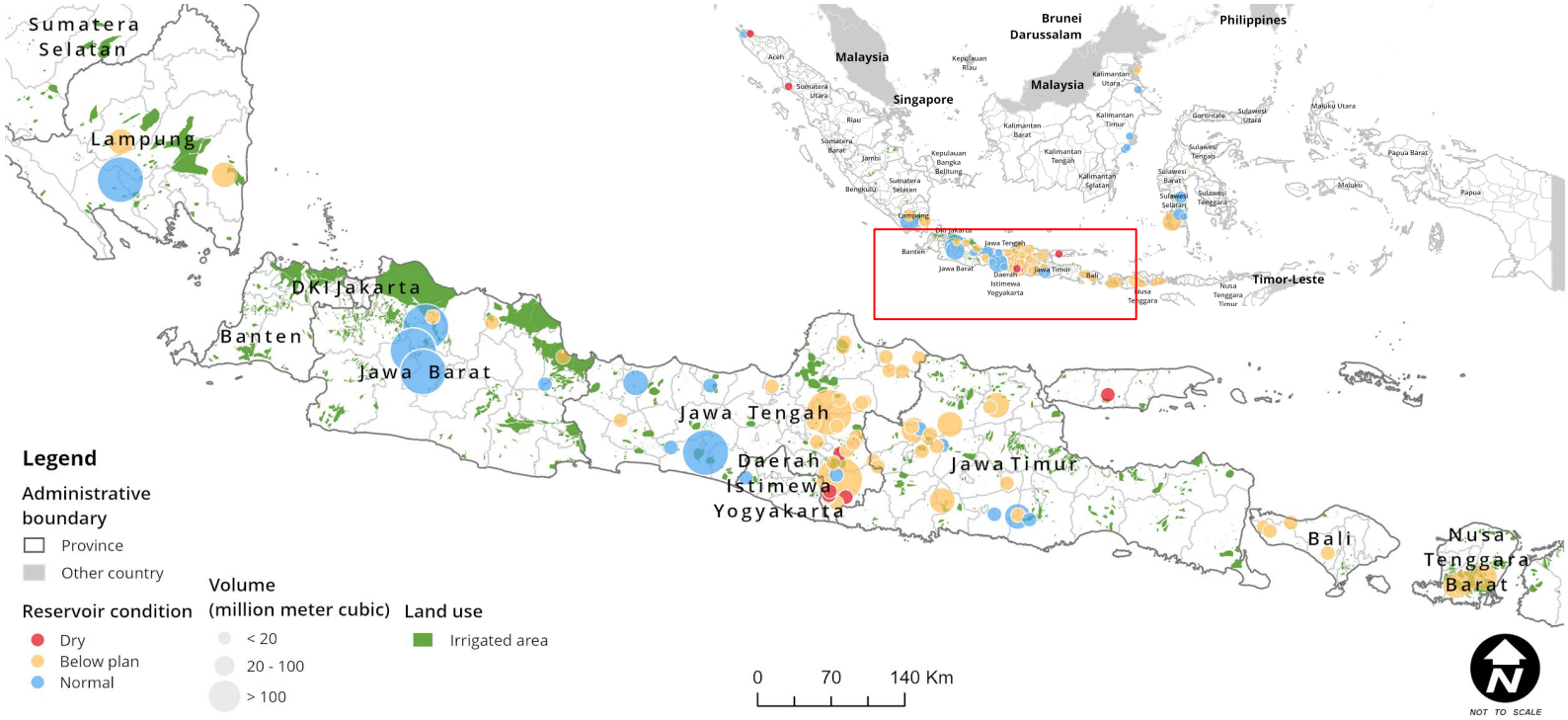


While entering the dry season, some areas across indonesia had already been experiencing a meteorological drought (days without rain >= 5 mm) and were classified as “long to very long drought conditions”. Most areas experiencing prolonged periods with no rainfall located in the southern part of Indonesia: parts of Jawa Barat, D.I. Yogyakarta, Jawa Timur, Bali, Nusa Tenggara Timur, Nusa Tenggara Barat, and Merauke Districts. Although in April - June the rainfall anomalies in these areas were classified as normal-above average levels, the rainfall accumulation during this period in the areas was still remaining low. It can be implied that the amount of long-term average precipitation is not adequate to start rice planting.

At least 32 millions people live in areas classified in “very long drought”, including some rice-producing locations.

Drought mitigation measures need to be undertaken for these areas. The availability of water for agriculture use, population and livestocks consumption is crucial. This is becoming more important as the conditions are expected to deteriorate due to low precipitations foreseen until end of September [see page 18].

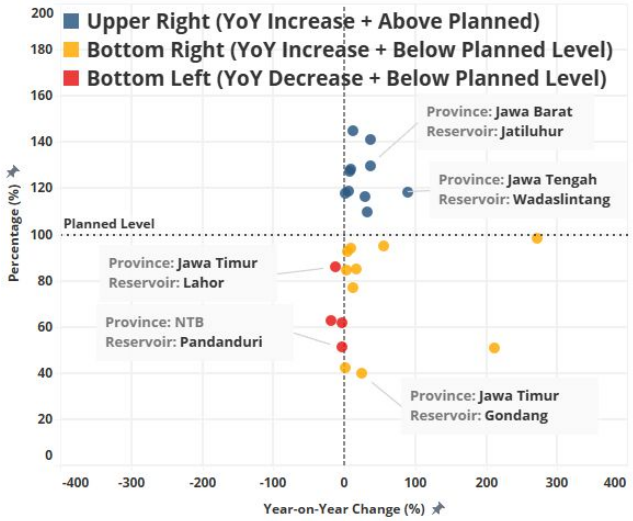
Water Reservoirs Monitoring: Overall Conditions



Water Reservoirs Status as of 30 Jun 2020

Monitoring Water Supply Readiness for 2020 Dry Season

Comparison of Reservoir Conditions as of 30 Jun 2020



Entering the dry season with unfavorable rainfall conditions, some of rice-producing locations in various part of Indonesia rely on irrigated water supplies, thus, making timely availability of water in main reservoirs is crucial.

The results of monitoring of the Ministry of Agriculture on water availability in reservoirs as of 30 June 2020, indicates 24 reservoirs being in a normal status, 60 reservoirs in below-planned status, and other 7 reservoirs in dry conditions.

In general, the central and the western parts of Java Island have a normal reservoir status due to sufficient rainfalls. In Jawa Timur, Bali, and Nusa Tenggara Barat, which experienced low precipitations [see page 5], the status of monitored reservoirs remains in below-plan levels, with some reservoirs in dry conditions.

Source: (http://sipetani.pertanian.go.id/) , Ministry of Agriculture
Note: The graph only show reservoir with volume > 20 million m^3

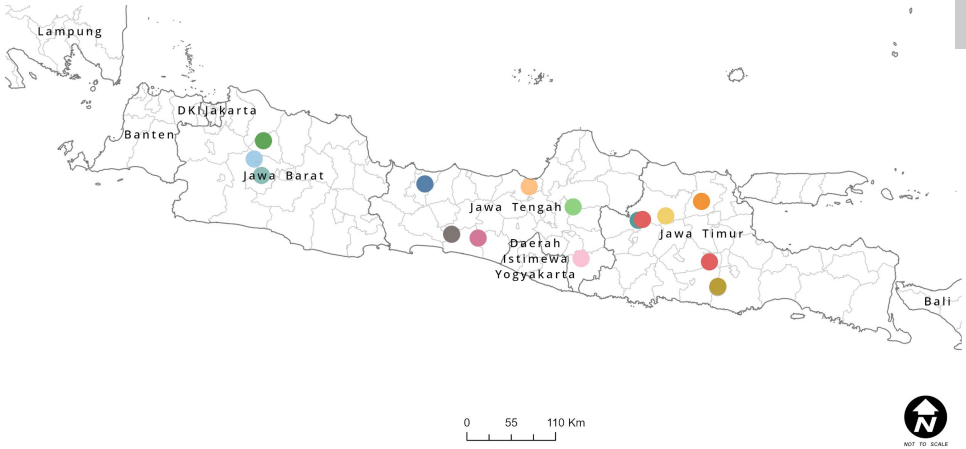
Water Reservoirs Monitoring: Jawa Island

Indonesia experienced a prolonged dry season at the end of 2019. From the graph, it can be seen that the 2019-2020 rainy season was effective in increasing water supplies in water reservoirs in Jawa Island.

On 30 June 2020, data from 14 main reservoirs* revealed 8 reservoirs having water levels above the planned capacity (baseline), while levels in 6 reservoirs were observed to be below planned capacity.

The height of the water level in reservoirs in Jawa Island from April to June this year remained better, particularly in western parts, compared to the same period in the previous year.

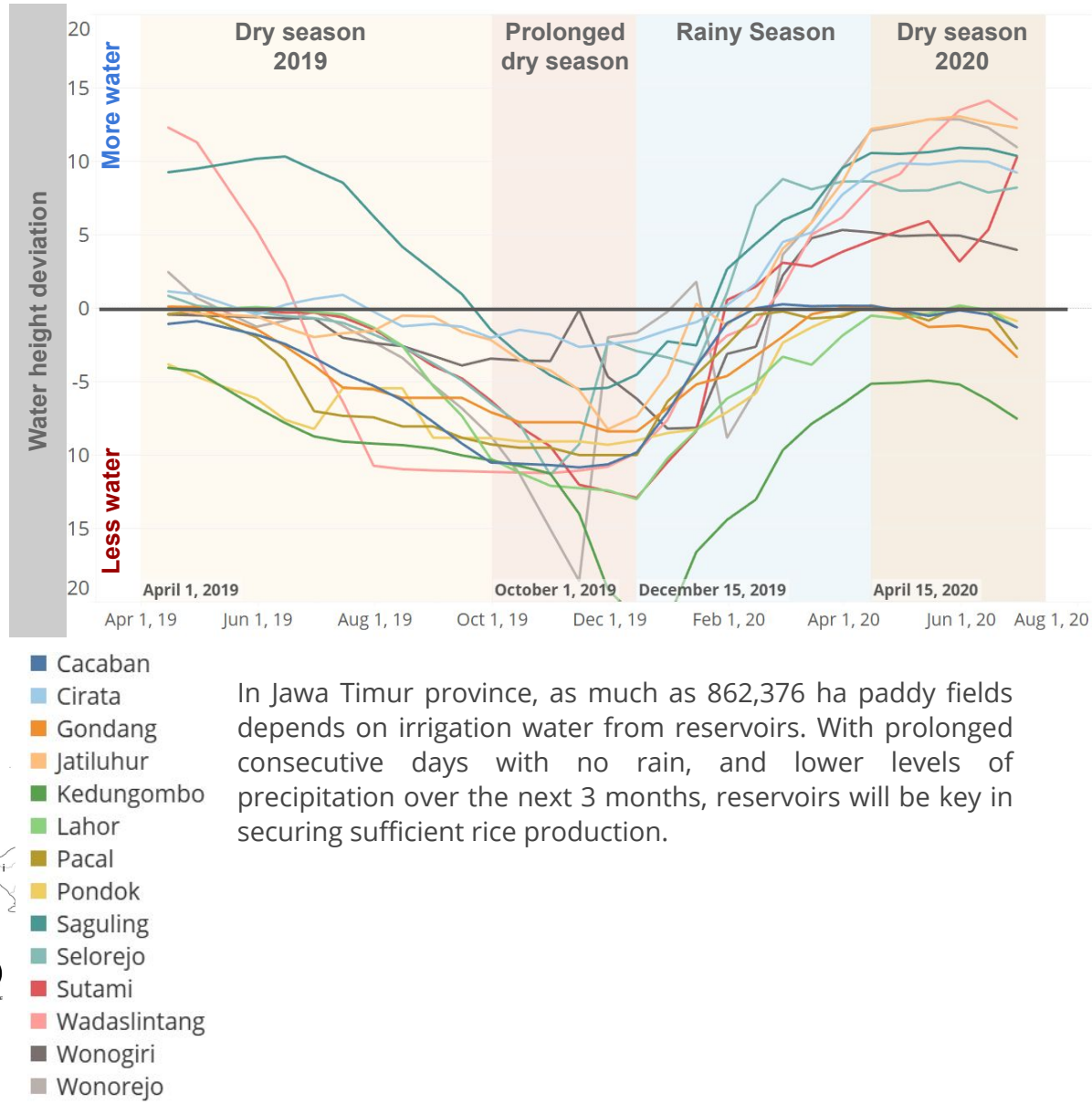
Some provinces in Indonesia experienced water level decline in the reservoirs at the beginning of June 2020, entering the dry season. Even though the decline was better compared to last year, however, the reservoirs in the eastern parts of Java remain under baseline conditions.



Source: (http://sipetani.pertanian.go.id/) , Ministry of Agriculture
Note: *The graph only show reservoir with volume > 20 million m^3

Water Level Deviation, Reservoirs in Jawa Island

Showing Reservoir with Volume >20 million m^3

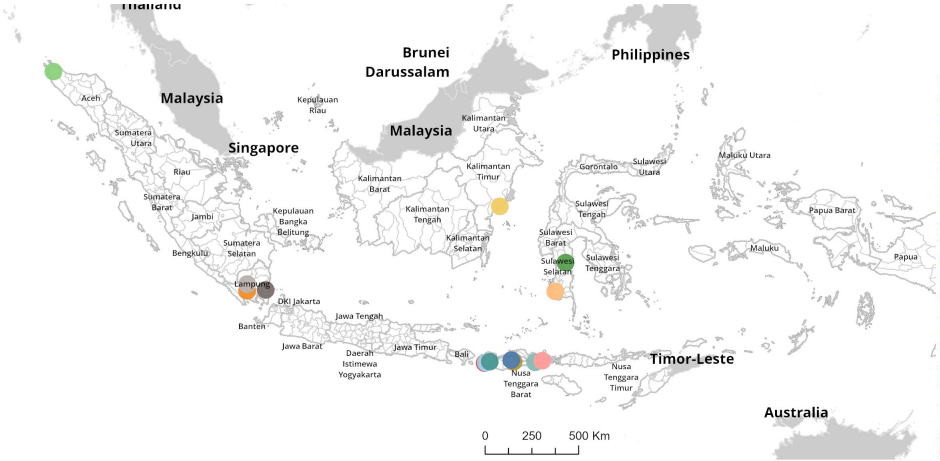


In Jawa Timur province, as much as 862,376 ha paddy fields depends on irrigation water from reservoirs. With prolonged consecutive days with no rain, and lower levels of precipitation over the next 3 months, reservoirs will be key in securing sufficient rice production.

Water Reservoirs Monitoring: Outside Java Island

Reservoirs water levels outside Java provinces vary. The Bili-bili and Kalola reservoirs in South Sulawesi are observed to be above the planned water level (baseline), due to high precipitations in the area.

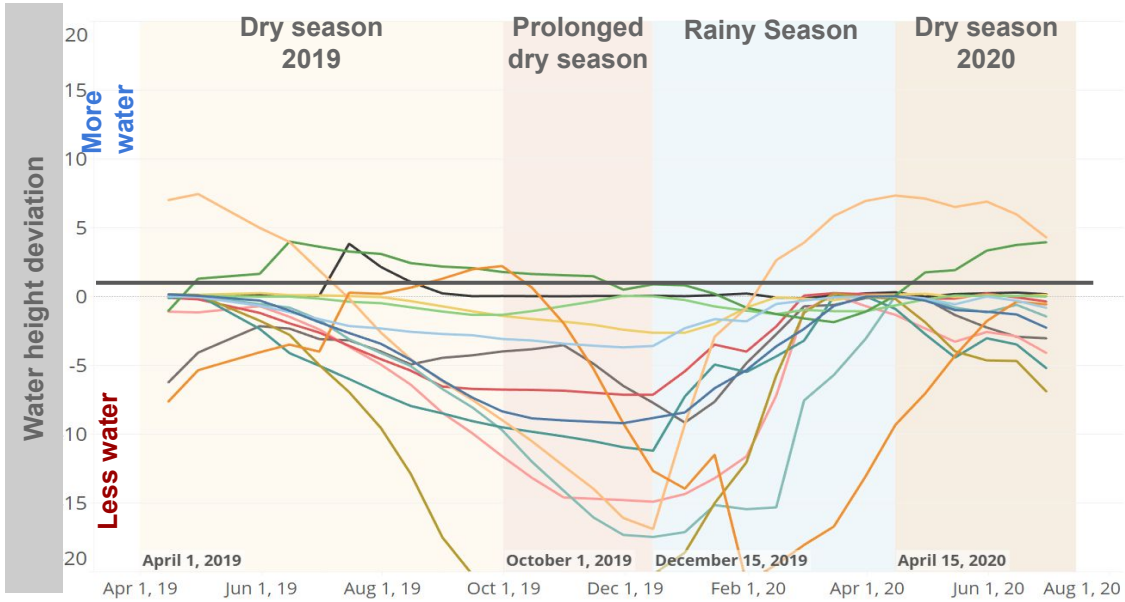
The three lowest reservoirs - Mamak, Pandanduri, and Sumi, with water levels below the baseline, are located in Nusa Tenggara Barat province. The water level in theses reservoirs continued to decline since Apr 2020, when the province entered the dry season.



Source: (http://sipetani.pertanian.go.id/) , Ministry of Agriculture
Note: *The graph only show reservoir with volume > 20 million m^3

Water Level Deviation, Reservoirs Outside Java Island

Showing Reservoir with Volume >20 Million m^3



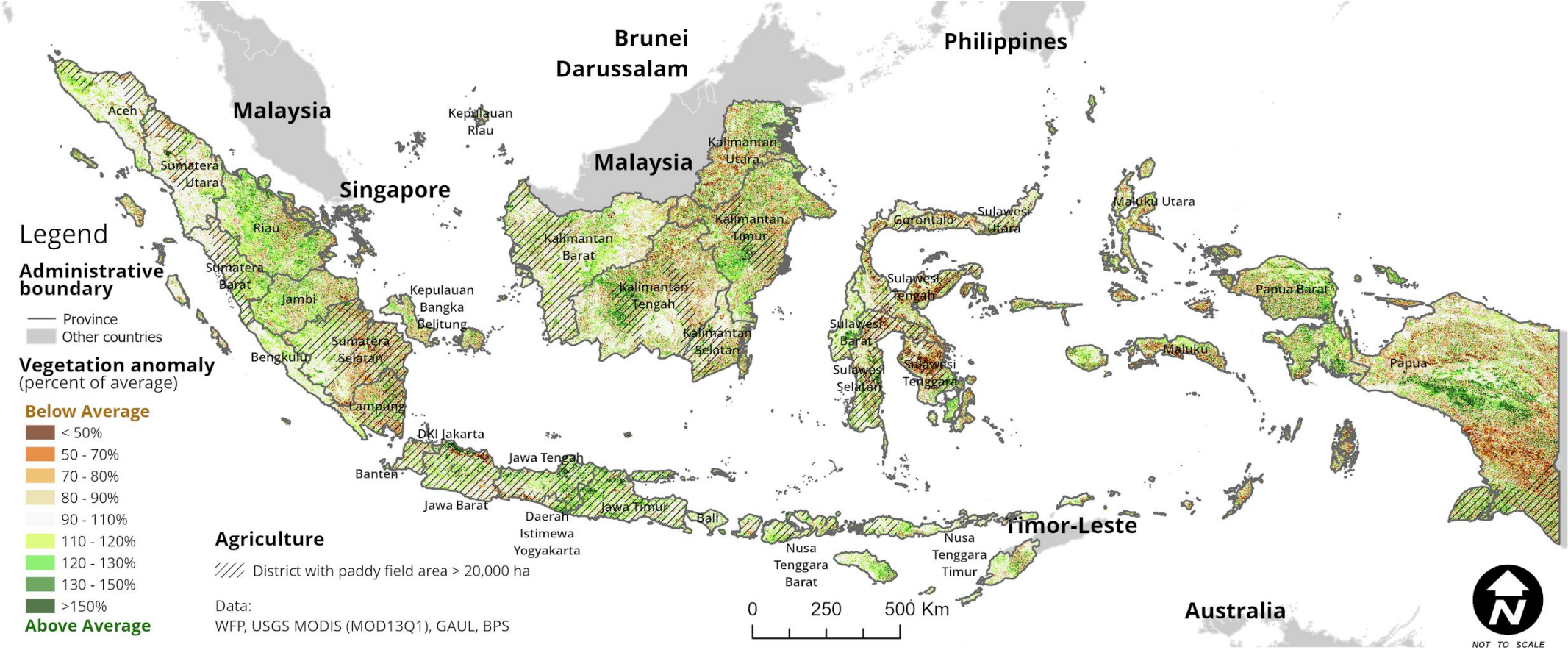
- Batu Bulan
- Batujai
- Batutegi
- Bili-bili
- Kalola
- Keuliling
- Mamak
- Manggar
- Pandanduri
- Pelaperado
- Pengga
- Sumi
- Way Jepara
- Way Rarem

Irrigated paddy fields in Nusa Tenggara Barat cover 14,450 ha of land. With the decline of water reservoir levels and with the predicted minimum rainfall in the next 3 months (Jul-Sep), careful water management is recommended to minimize the effects of drought at the peak of the dry season.

Crop Monitoring: Overall Vegetation Situation

Vegetation Indices as of 9 Jun - 25 Jun 2020

Overall Crop Condition Compared to the Long Term Average in the Same Period



Vegetation conditions from 9 to 25 June varied throughout Indonesia. In northern parts of Sumatra Island, from Aceh to Jambi, the vegetation improved compared to early Apr 2020 [link]. Similar progress was observed in the main rice-production areas such as Jawa Tengah and Jawa Timur.

However, below-average vegetation conditions were observed in other main rice-production areas which include some parts of Sumatera Utara, Sumatera Selatan, Lampung, northern parts Jawa Barat, southern part Jawa Tengah, and Sulawesi Tenggara.

In Sumatera Selatan and Sulawesi Tenggara, rainfall conditions of last month were classified as 'high – very high level'. The rainfall anomalies in these two provinces were classified as 'above average'. These conditions are likely to contribute to the decline of vegetation index stemming from floods rather than from drought.

Crop Monitoring: Climate Impact to the Crop Disruption

According to the Ministry of Agriculture (MoA), a total of 118,567 ha of paddy fields were affected by floods, drought, and pests from Apr to Jun 2020. The impact was less severe compared to the Jan-Mar 2020 observation, in which 223,177 ha paddy fields were affected.

From Apr to Jun 2020, pest attacks dominated disruptions of 83,019 ha paddy fields (in Jan-Mar was 93,660 ha). Other disruptions include floods that affected 33,074 ha paddy fields (100,185 ha in Jan-Mar) and localized droughts that affected 2,474 ha of paddy fields (29,332 ha in Jan - Mar 2020).

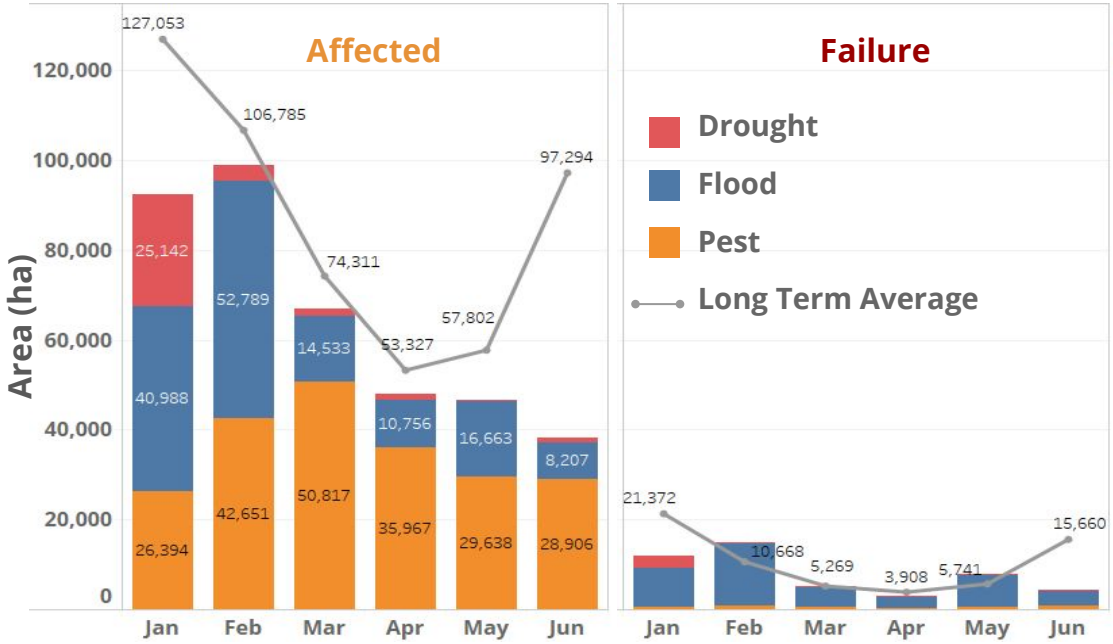
However, data on paddy fields affected by these disturbances do not necessarily mean a failure in the harvest. Therefore, appropriate mitigation measures should be considered to reduce production losses.

The paddy field areas affected by the disasters and pests are lower compared to the long-term average. Crop failure from Apr to Jun was also reported to be less than the long-term average, particularly in June 2020.

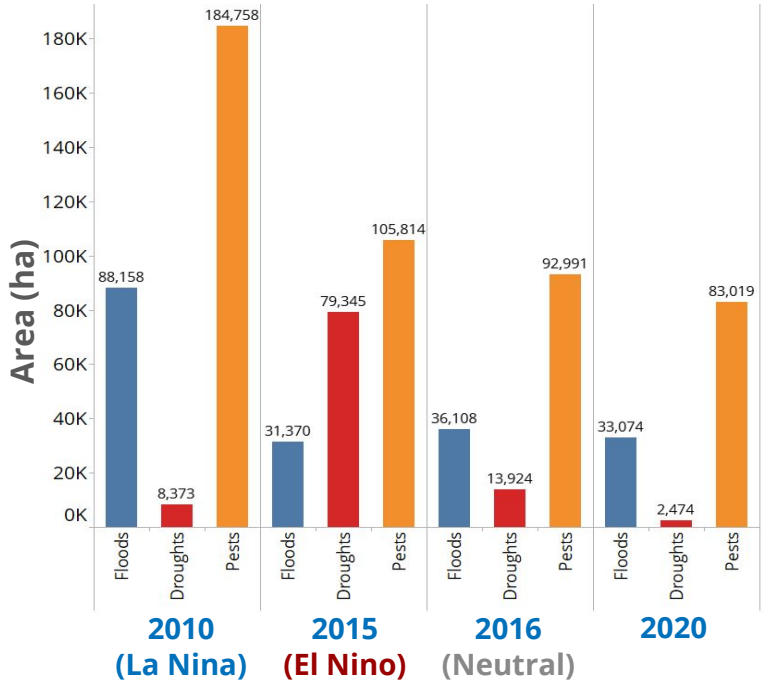
Compared to the other climate scenarios, the number of paddy fields affected by drought from Apr to Jun 2020 was relatively low.

A slightly above-average rainfall performance during this period could have contributed to improvement of crop production.

Paddy Fields impacted in 2020 compared to Long-Term Average (2010-2019)



Paddy Fields impacted in Apr - Jun (multiple years)

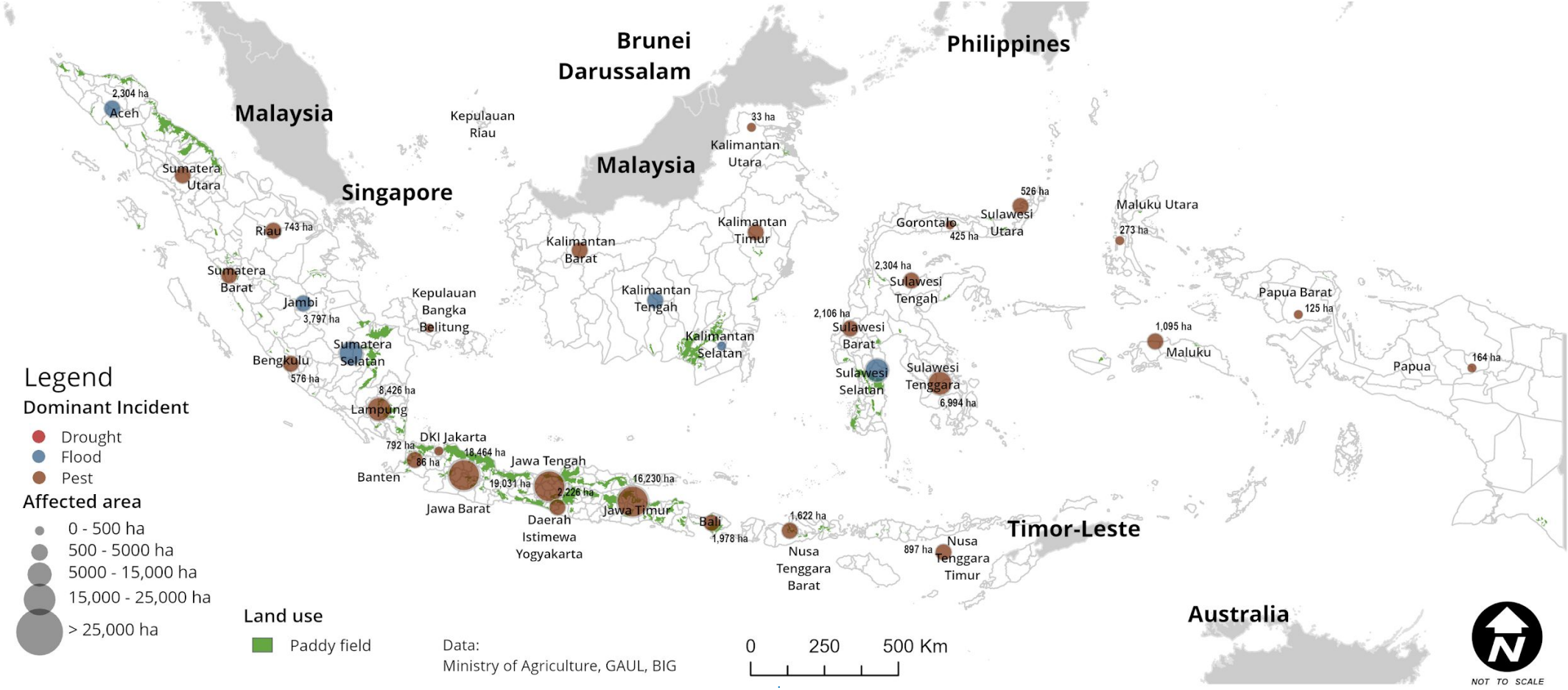


Source: (http://prasarana.pertanian.go.id/iklimoptdpimy/home), Ministry of Agriculture

Crop Monitoring: Paddy Field Affected by the Disaster and Pests

Paddy Cultivation Area Affected by Floods, Droughts, and Pests Apr - Jun 2020

Based on the Field Monitoring and Report by the Ministry of Agriculture



The main rice-producing provinces made up the majority of areas affected by disasters and pest attacks in the Apr - Jun 2020 period. Almost all paddy crop disturbances in Indonesia occured due to pest invasions.

Flood incidents dominate five provinces: Aceh, Jambi, Sumatera Selatan, Kalimantan Tengah, and Sulawesi Selatan. The five provinces received relatively high rainfall of 150 mm - 350 mm in June 2020.

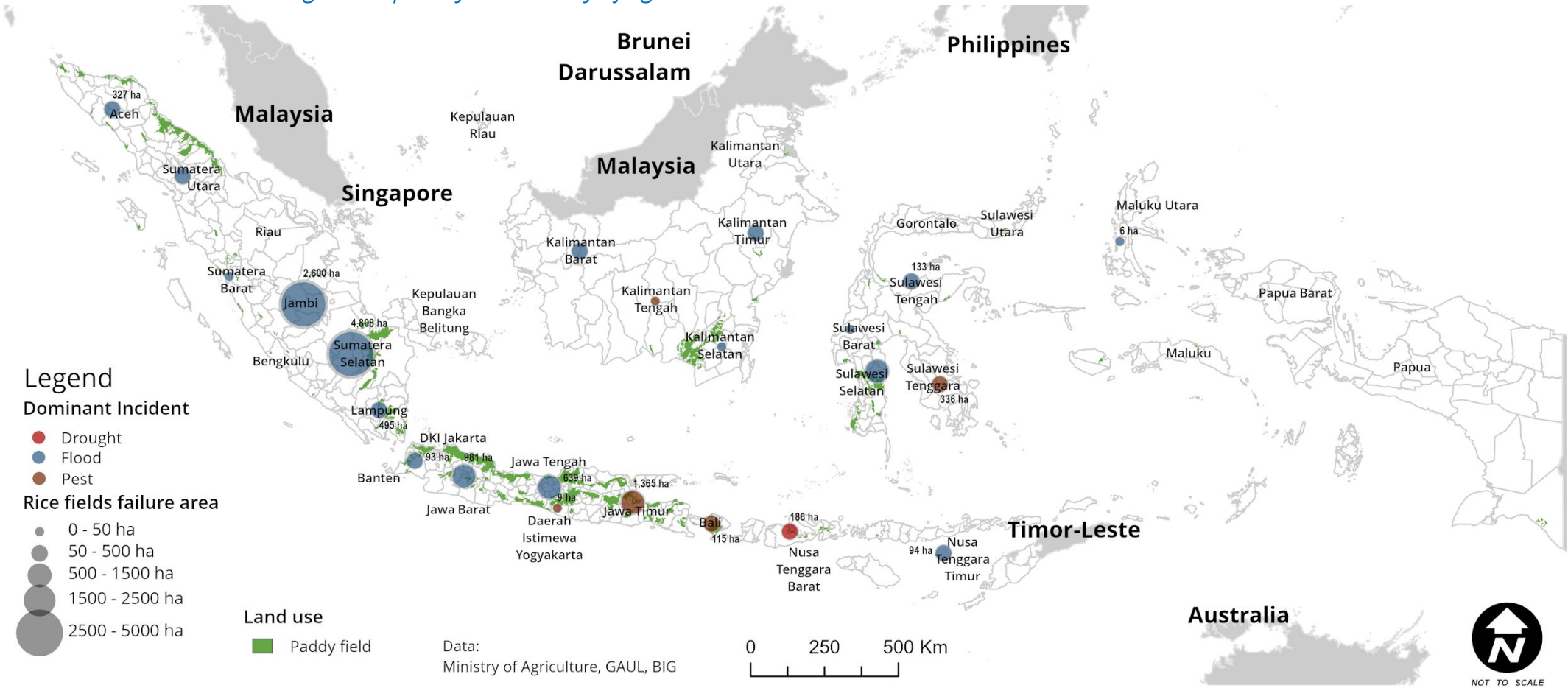
The classification of rainfall anomalies in these five provinces was also above normal.

Data on paddy fields affected by natural events and pest outbreaks does not necessarily mean a failure in the harvest, thus, appropriate mitigation measures should be considered to significantly reduce production losses.

Crop Monitoring: Paddy Field Failure by Disaster and Pests

Paddy Cultivation Area Failure due to Floods, Droughts, and Pests Apr - Jun 2020

Based on the Field Monitoring and Report by the Ministry of Agriculture

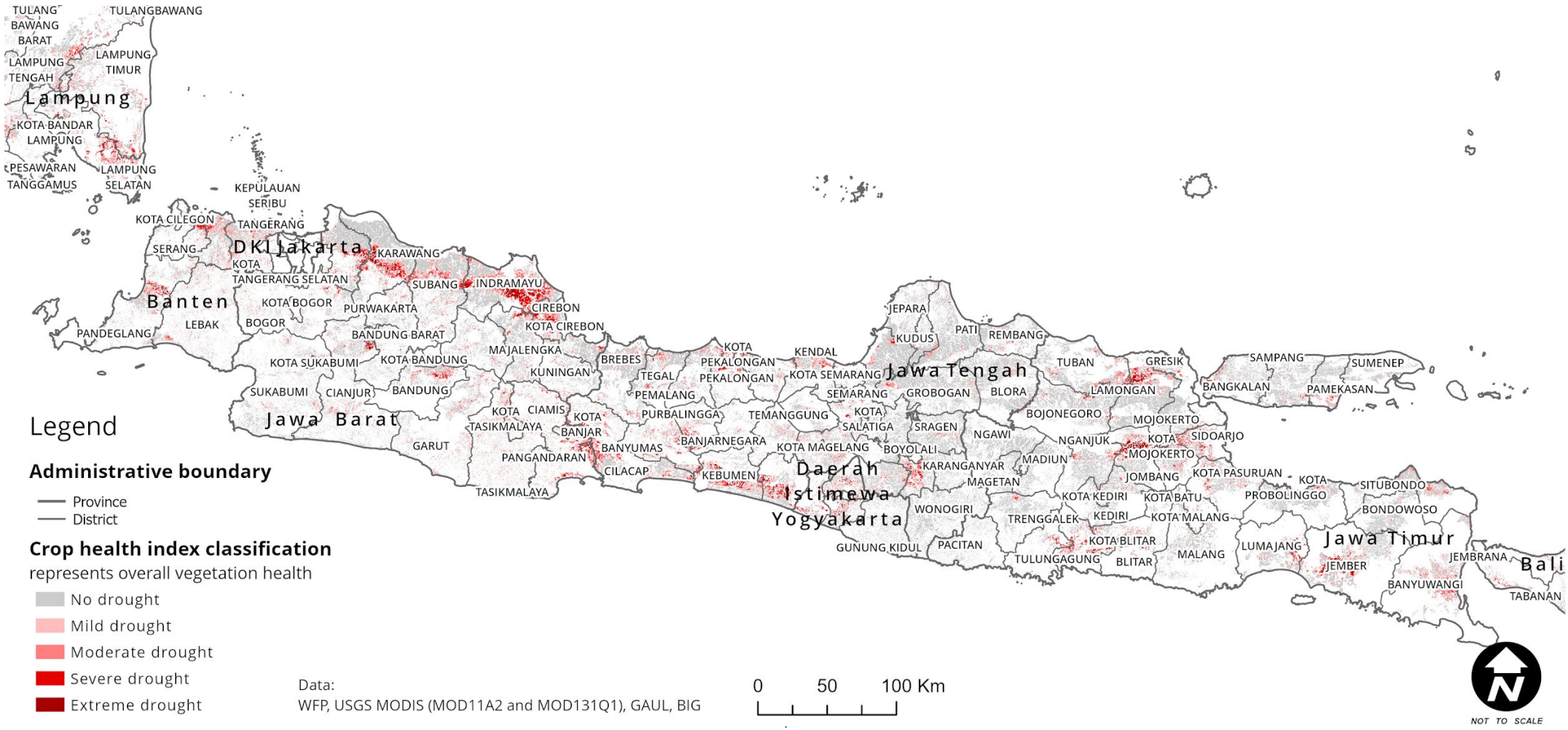


Paddy crop failure in a number of areas in Indonesia during Apr - Jun 2020 was dominated by floods. This is to be expected during the transition period from the rainy season to the dry season.

Above average rainfall in some areas is also considered to have contributed to the high incidence of flooding that caused paddy crop failure. Jambi, Sumatera Selatan, and Sulawesi Selatan are the provinces where flood events occurred that impacted paddy fields. Floods in the three provinces occurred in April 2020 and caused paddy crop failures of a 8,357 ha, more than half the value of crop failure was reported to the Ministry of Agriculture in the Apr - Jun 2020 period (total 13,882 ha).

Yogyakarta, East Java, Bali, Central Kalimantan, and Southeast Sulawesi reported pest outbreaks as the main cause of failure in paddy fields. Only West Nusa Tenggara reported drought as the main cause of failure in paddy fields during this period.

Crop Monitoring: Vegetation Health Index



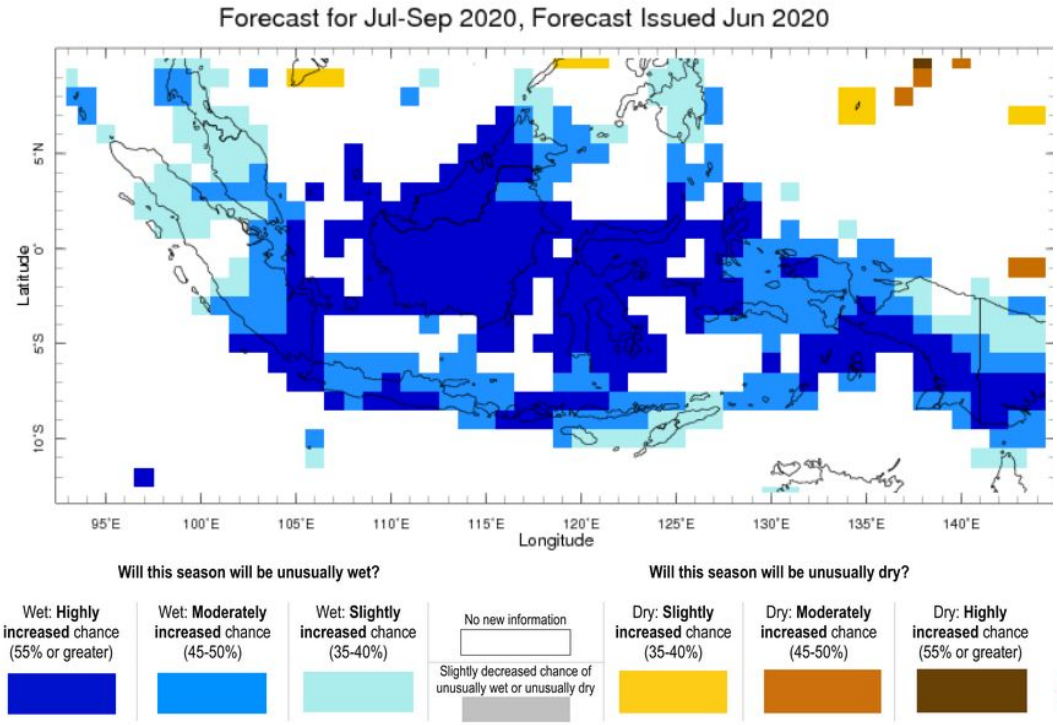
Vegetation health index (VHI) depicts stress on vegetation and can be used to assess potential crop losses compared to maximum potential. During the period of 9 Jun 2020 - 25 Jun 2020, in Java, the overall situation of cropland is observed to be in a good condition.

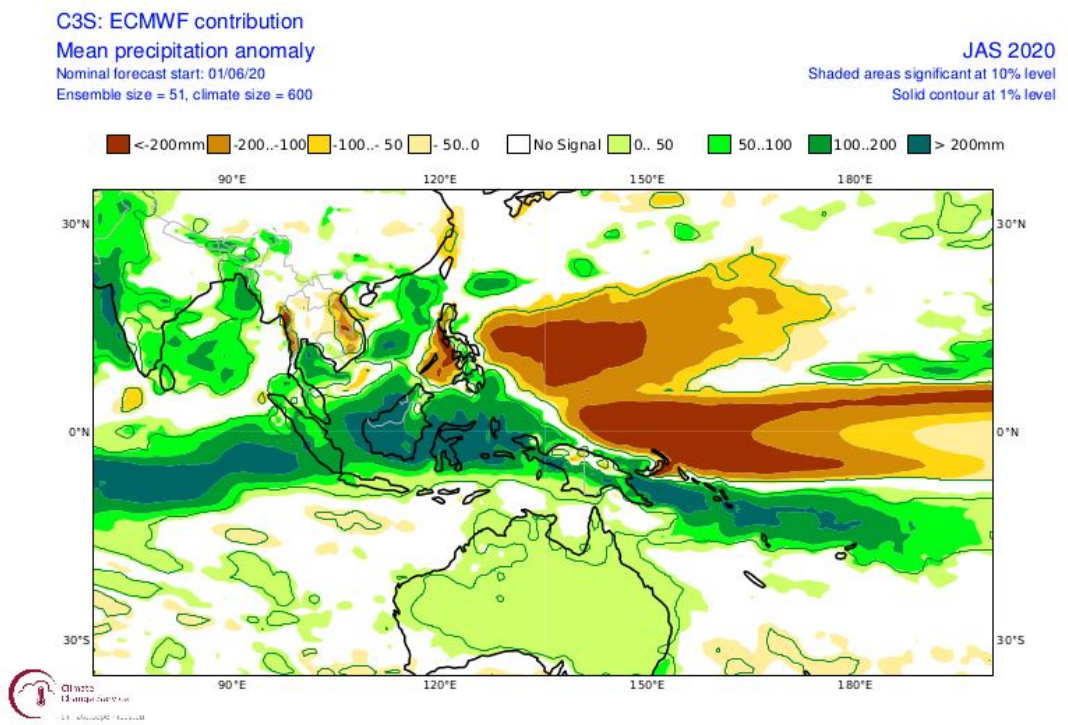
In Indramayu, Cilacap, and Sidoarjo districts more than 50% of paddy fields reported unfavorable conditions. Difficulty in access to irrigation water in drought-affected paddy fields in Indramayu, was reported to be the main reason for poor growth.

Overall, nearly 960,000ha of paddy fields are located in areas classified as severe drought - extreme drought conditions, an increase of 340,000 ha from previous observations in Mar 2020 (~620,000 ha).

It worths noting that observed severe drought and extreme drought conditions in these areas do not necessarily mean actual harvest loss in these locations. It is “loss of potentials from maximum capacity conditions” compared to the long-term average. The observation indicates the potential impact of dry conditions in the paddy field.

Climate outlook for Q3 of 2020: Indonesia in Global Forecast





IRI (left) and ECMWF (right) suggest similar forecasts of rainfall anomalies from July through September 2020.

In general, most areas in Indonesia are expected to experience a “wetter than usual” dry season. Similar conditions are predicted for the northern provinces, except for Aceh and Sumatera Barat. ECMWF analysis indicates Jawa Timur, Bali, Nusa Tenggara Barat, and Nusa Tenggara Timur will experience a slightly drier dry season.

These forecasts show only the likelihood of 3-month accumulated rainfall being unusually high or low and do not indicate chances of individual heavy rainfall events. The forecasts apply over large areas only, and should not be used to forecast local conditions or as a flood forecast.

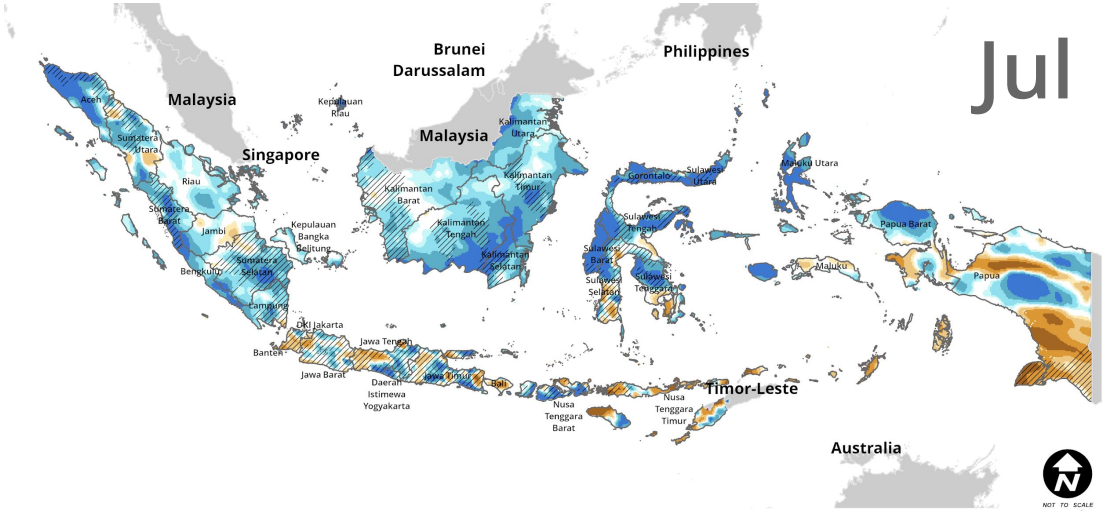
IRI Columbia University probabilistic seasonal forecast for Jul-Sep 2020 shows the likelihood that total 3-month precipitation will be unusually high or low.
http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp_fcst.html?bbox=bb%3A94.584%3A-11.255%3A141.811%3A6.308%3Abb

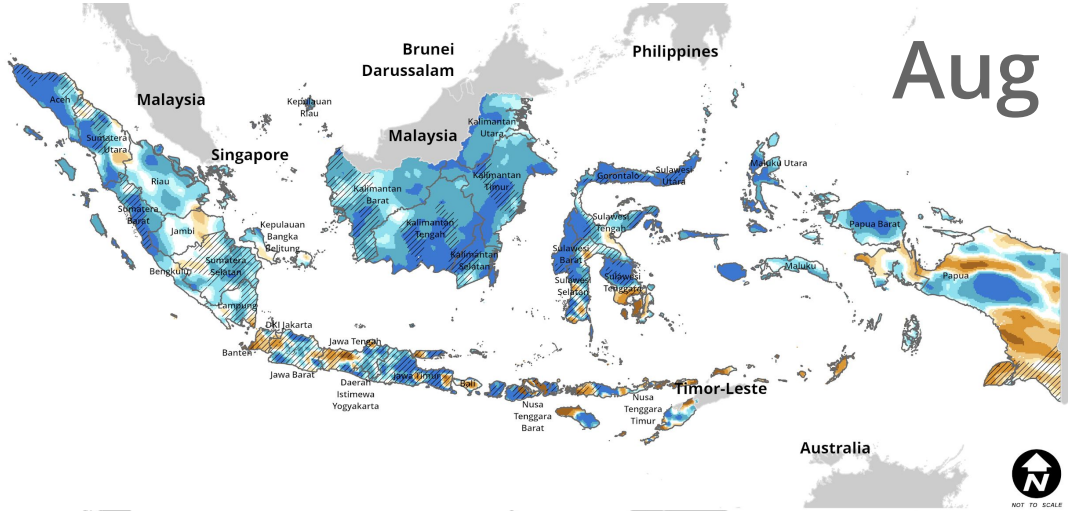
Right: ECMWF seasonal forecast for Jul- Sep 2020.
https://climate.copernicus.eu/charts/c3s_seasonal/c3s_seasonal_spatial_ecmf_rain_3m?facets=Parameters.precipitation&time=2020060100.720.2020070100&type=ensm&area=area12

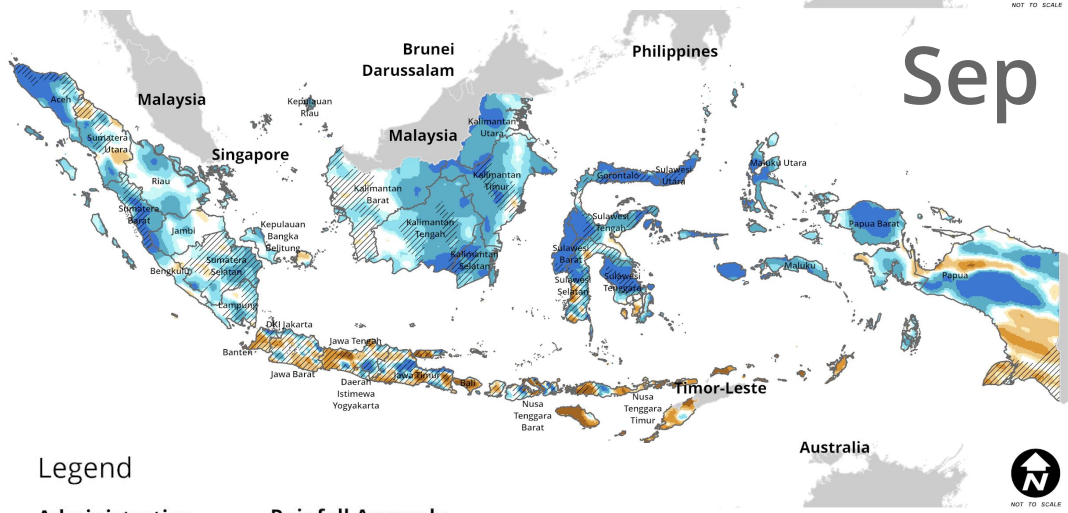
Climate Outlook for Q3 2020: BMKG Analysis Forecast

Monthly Rainfall Anomalies Forecast Jul - Sep 2020

BMKG Analysis of Monthly Rainfall Anomalies







The BMKG forecasts indicates that in Jul - Sep 2020, 85% - 87% of Indonesia will experience normal to above normal rainfalls, while other 13% - 15% of the country will be having below normal rainfall.

Above the average precipitations in the dry season is predicted to occur in most peatland areas. This can minimize the risk of forest fires. Nonetheless, above average rainfall during the dry season can also have negative effects, including for some types of farming activities, for instance, for salt farmers and fruit farmers (watermelons or mangoes). They can also reduce the potential for planting paddy in swamps (due to high water level).

Nearly 15% of the areas predicted to experience below normal rainfalls are located in the main rice-producing provinces, in Java, Bali, Nusa Tenggara Timur, Nusa Tenggara Barat, and Sulawesi Selatan.

The actual value of forecasted precipitation in an area must be checked further with the anomaly to determine whether the area will receive favorable rainfalls in order to determine meteorological drought.

Legend

Administrative boundary
- Province
- Other countries

Agriculture
- District with paddy field area > 20,000 ha

Rainfall Anomaly (percent of average)

Below Average: 80 - 90%, 60 - 80%, 40 - 60%, < 40%

Normal: 90 - 110%

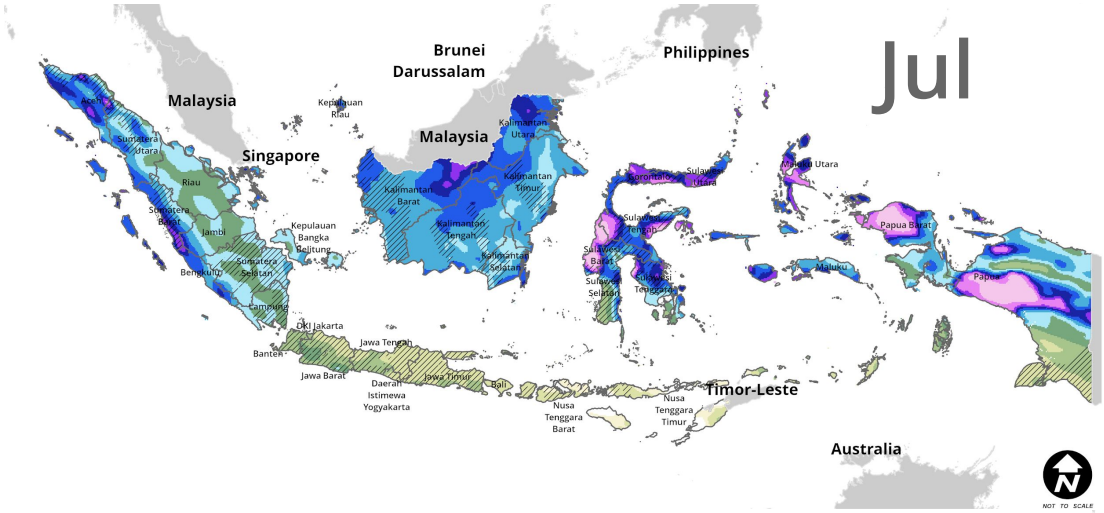
Above Average: 110 - 120%, 120 - 140%, 140 - 180%, >180%

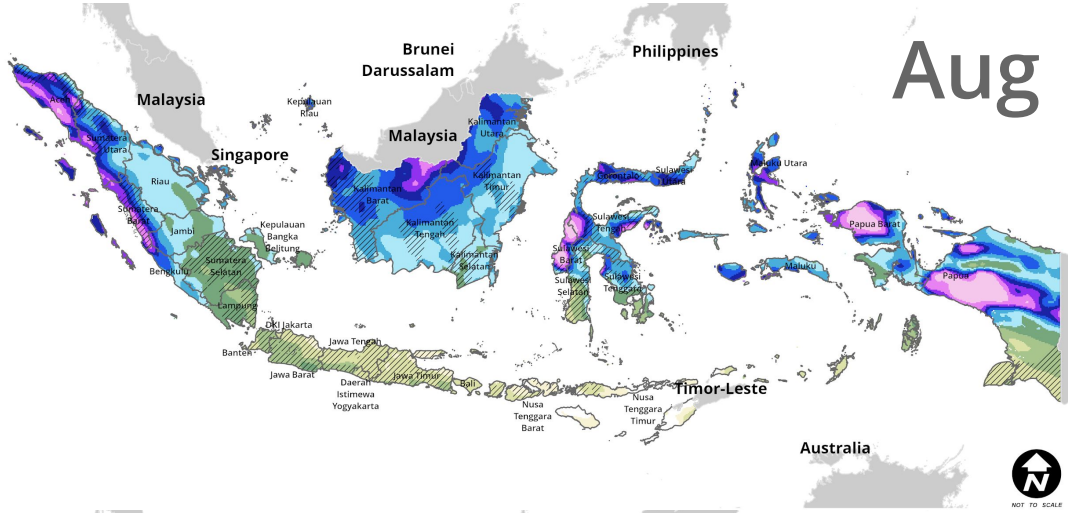
Data:
BMKG, GAUL, BIG

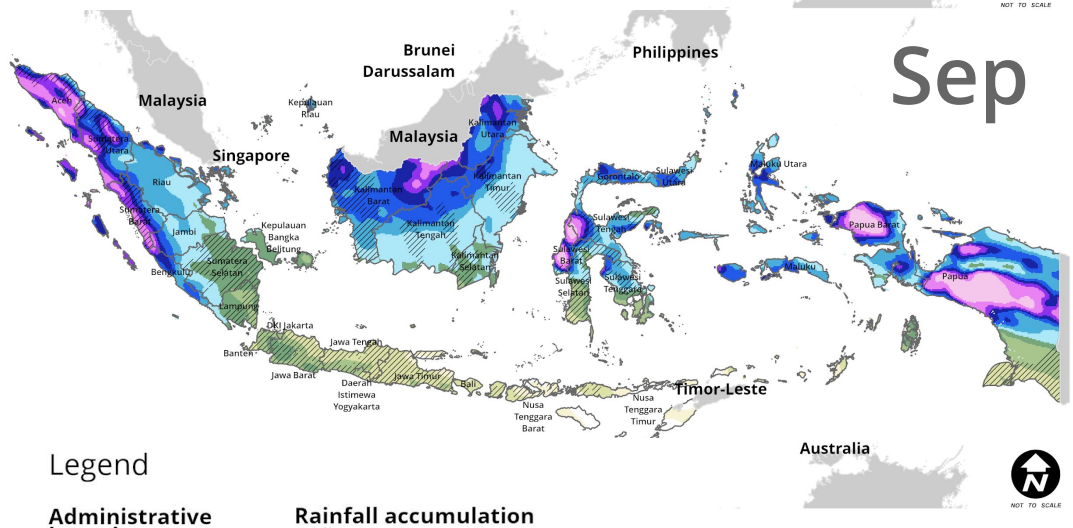
Climate Outlook for Q3 2020: BMKG Analysis Forecast

Monthly Precipitation Accumulation Forecast Jul - Sep 2020

BMKG Analysis of Monthly Precipitation Accumulation







Most rice-producing provinces in southern part of Indonesia are predicted to receive low monthly rainfall (<150 mm) over the next 3 months. The amount of precipitation is inadequate for starting rice planting (150-200 mm per month) [reference] and most locations would depend on water from storage in order for farmers to be able to start or continue the planting process.

Attention needs to be given to the rice-producing areas that are predicted to experience drier dry season and predicted to experience monthly rainfall of less than 150 mm. These areas include southern Sumatra, Java Island, Bali, Nusa Tenggara Barat, Nusa Tenggara Timur, and southern Papua.

Some of these provinces have very little rainfall for the next 3 months. The area also observed to have long days with no rain [page 7] with water storage monitoring also indicating not ideal conditions [page 9-10]. Therefore, mitigation measures must be undertaken so that to minimize the impact of the dry season.

Legend

Administrative boundary

- Province
- Other countries

Agriculture

- District with paddy field area > 20,000 ha

Rainfall accumulation (millimeters)

Low	Sufficient	High
0 - 10	150 - 200	350 - 400
10 - 20	200 - 250	400 - 500
20 - 50	250 - 300	>500
50 - 100	300 - 350	
100 - 150		

Data:
BMKG, GAUL, BIG

Methodology and Data

Method

The maps in this bulletin are largely based on satellite data which is then processed and used to create various indicators related to climate and vegetation.

Meteorological drought happens when the actual rainfall in an area is significantly less than the climatological mean for that area. Meteorological drought can be monitored using indicators such as:

- Rainfall anomaly - a measure of lack of rainfall in a period compared to the average;
- The number of consecutive dry days is calculated as the count of the most recent days since a day had more/less than 1mm of rain. GPM IMERG data is then processed to determine the number of days since the last rainfall (where a day with rainfall is noted as one where more than 1 mm of precipitation is observed). Using a standard classification, drought level is then determined.

Agriculture drought is a situation where rainfall and soil moisture are inadequate during the crop growing season to support healthy crop growth to maturity, causing crop stress and wilting. Agriculture drought can be monitored using these indicators:

- Normalized Difference Vegetation Indices (NDVI) and or Enhanced Vegetation Index (EVI) anomaly: a measure of lack of greenness vegetation in a period compared to the average;
- Vegetation health index (VHI): is based on a combination of Vegetation Condition Index (VCI) and Temperature Condition Index (TCI). VCI is constructed using the Enhanced Vegetation Index (EVI). The VHI is effective enough to be used as proxy data for monitoring vegetation health, drought, moisture, thermal condition, etc.
- The Vegetation Health is also based on MODIS vegetation indices MOD13Q1 and land surface temperature MOD11A2 using the approach from https://journals.ametsoc.org/doi/pdf/10.1175/1520-0477%281997%29078%3C0621%3AGDWFS%3E2.0.CO%3B2

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Data

Rainfall

- Daily rainfall from 2000 - now, 0.1deg ~ 10 km spatial resolution. Source: NASA GPM IMERG https://gpm1.gesdisc.eosdis.nasa.gov/data/GPM_L3/PM_3IMERGDL.06/
- Dekad and monthly rainfall from 1981 - now, 0.05deg ~ 5.6km spatial resolution. Source: CHIRPS CHC UC Santa Barbara - https://www.chc.ucsb.edu/data/chirps
- Forecast for Daily 5-day, 10-day, 15-day. 0.05deg ~ 5.6km spatial resolution. Source: CHIRPS-GEFS https://www.chc.ucsb.edu/data/chirps-gefs
- Seasonal (3 month) Forecast. Source: IRI Columbia University http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp_fcst.html?bbox=bb%3A97.981%3A8.247%3A108.366%3A24.680%3Abb
- Seasonal (3 month) Forecast. Source: Copernicus Climate Change Service https://climate.copernicus.eu/charts/c3s_seasonal/c3s_seasonal_spatial_ecmf_rain_3m?facets=Parameters.precipitation&time=2019070100,744,2019080100&type=ensm&area=area12
- Rainfall charts for every 10 days. Source: https://dataviz.vam.wfp.org/seasonal_explorer/rainfall_vegetation/visualizations

Vegetation

- Enhanced Vegetation Index (EVI), MOD13Q1. 16 days temporal resolution, 250m spatial resolution. Source: MODIS Terra, USGS https://lpdaac.usgs.gov/products/mod13q1v006/

Temperature

- Land Surface Temperature, MOD11A2. 8 days temporal resolution from 2000 - now, 1km spatial resolution. Source: MODIS Terra, USGS https://lpdaac.usgs.gov/products/mod11a2v006/

Crop monitoring data

- Paddy field affected and failure by climate and pests. Source: Data and information center, Ministry of Agriculture. http://prasarana.pertanian.go.id/iklimoptdpimy/