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The Impact of Drought related to El Niño Papua New Guinea

Version

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RBB - Bangkok Regional Bureau for Asia and the Pacific

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- Key message and recommendation

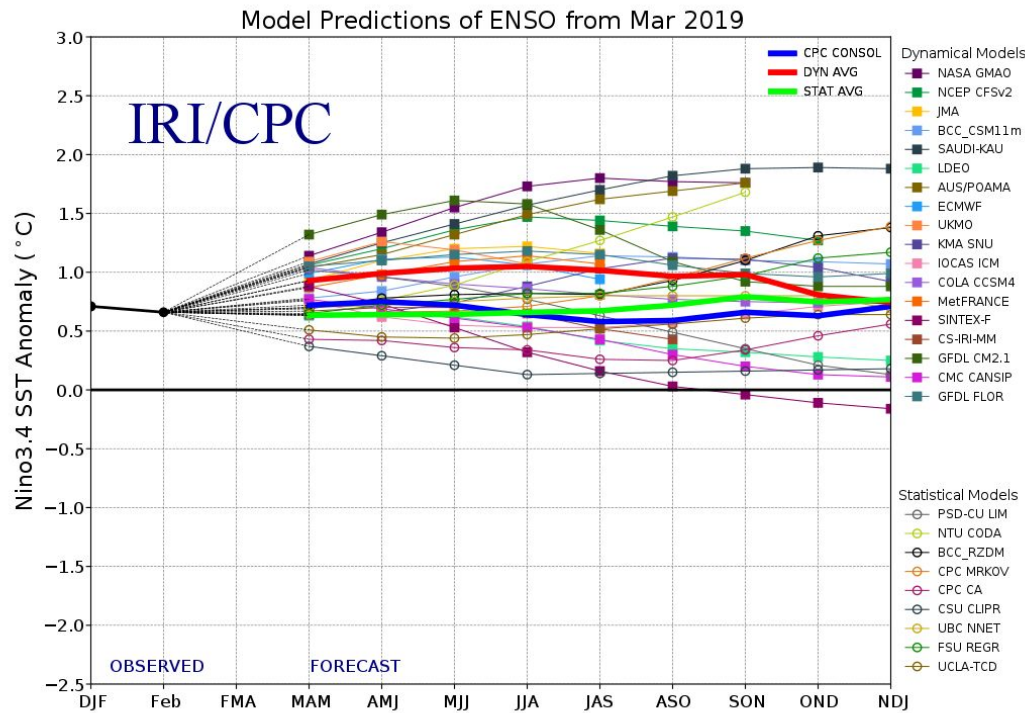
El Niño-Southern Oscillation (ENSO) Forecast, issued Mar 2019

IRI/CPC Mid-Month Model-Based ENSO Forecast Probabilities

Season	La Niña	Neutral	El Niño
MAM 2019	0%	6%	94%
AMJ 2019	0%	10%	90%
MJ 2019	0%	17%	83%
JJA 2019	1%	22%	77%
JAS 2019	2%	25%	73%
ASO 2019	4%	27%	69%
SON 2019	5%	27%	68%
OND 2019	10%	29%	61%
NDJ 2019	11%	29%	60%

The following graph and table show forecasts made by dynamical and statistical models for Sea Surface Temperature (SST) in the Nino 3.4 region for nine overlapping 3-month periods.

Source: IRI Columbia University - https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table



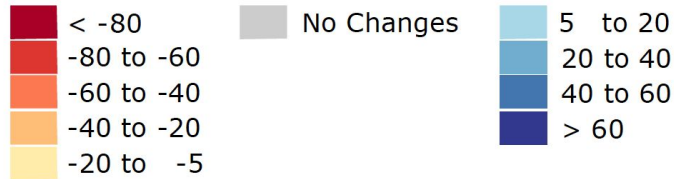
The SST forecast shows moderate (1.0°C > temperature in the Nino3.4 region) El Niño conditions developing for the initial May-Aug season, dropping slowly to weak strength ($<1.0^{\circ}\text{C}$ in the Nino3.4 region) by Aug-Dec.

Most of the models predictions (dynamical and statistical model) issued during mid-March 2019 indicate weak or even moderate strength El Niño conditions for the Mar-May season, continuing into summer and early fall 2019, weakening but not disappearing by late fall. In the most recent week, the SST anomaly in the Nino3.4 region was 1.0°C , at the “top” of the weak El Niño range, and 0.66°C for the month of February, indicative of weak El Niño.

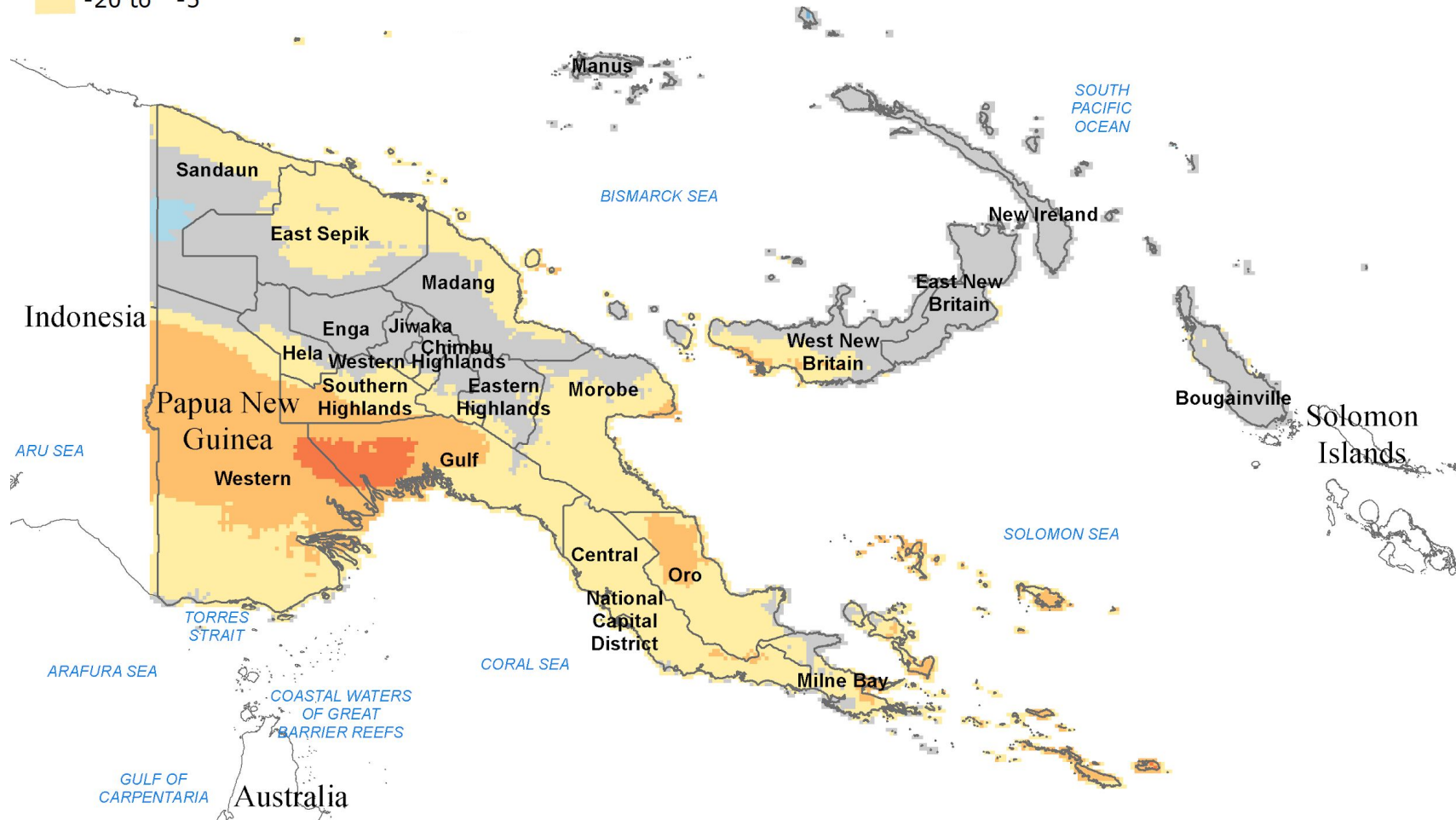
This condition may lead to **slightly** lower intensity of rainfall during dry season in Papua New Guinea and potentially risk the crop production.

El Niño and Papua New Guinea context

Change in Monthly Rainfall (mm/°C)



35 years (1981-2017) monthly rainfall data that used in the analysis are downloaded from Climate Hazard Group - UC Santa Barbara, and SST in NINO-3.4 region from ERSST v4 of National Oceanic and Atmospheric Administration (NOAA).



Relationship between the ENSO signal and rainfall in Papua New Guinea

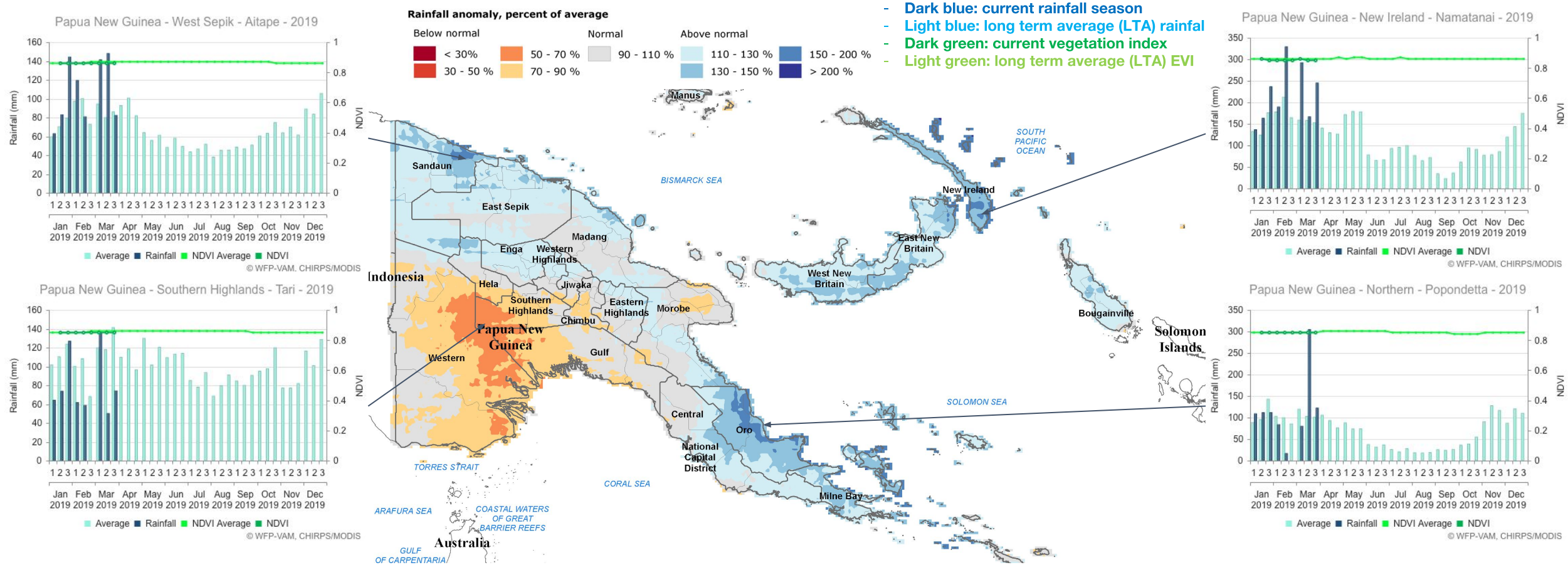
PNG is affected by El Niño which is associated with a rise in sea surface temperature (SST), negatively impacting rainfall in much of the country. The map demonstrates the change in rainfall associated with a one degree rise in SST in NINO-3.4 region. Dark red areas represent an 80mm decrease in monthly rainfall.

Data: CHIRPS, CHG UCSB

Please be aware that there are large areas of PNG which are not affected by ENSO (grey highlighted in the map)

Affected area by ENSO are mainly around Gulf and Western area. Yet changes in monthly rainfall is not extreme, only about 20-40 mm

Rainfall condition, March 2019

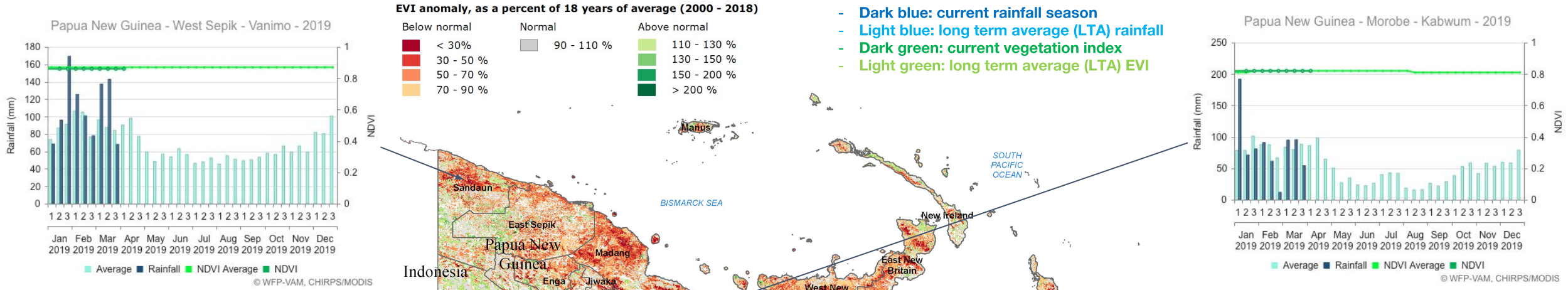


On average, Papua New Guinea received normal rainfall on 1st quarter of 2019

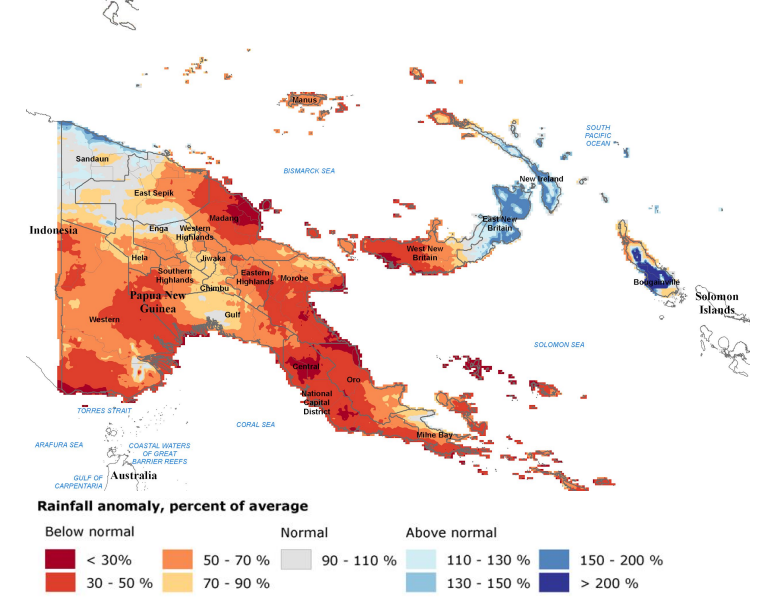
During the period of Jan - Mar 2019, most areas of PNG experienced above-normal rainfall, with a number of localized normal and below-normal rainfall. Unusually high intensity of rainfall occurred in northern and southeast part of mainland and various scattered area in New Ireland and New Britain.

In contrast, western part of PNG experienced below-normal rainfall. Some areas of Nomad, Balimo and Tari in particular experienced very low rainfall (only receiving 30-50% from usual). **Data: CHIRPS, CHG UCSB**

Vegetation condition, March 2019

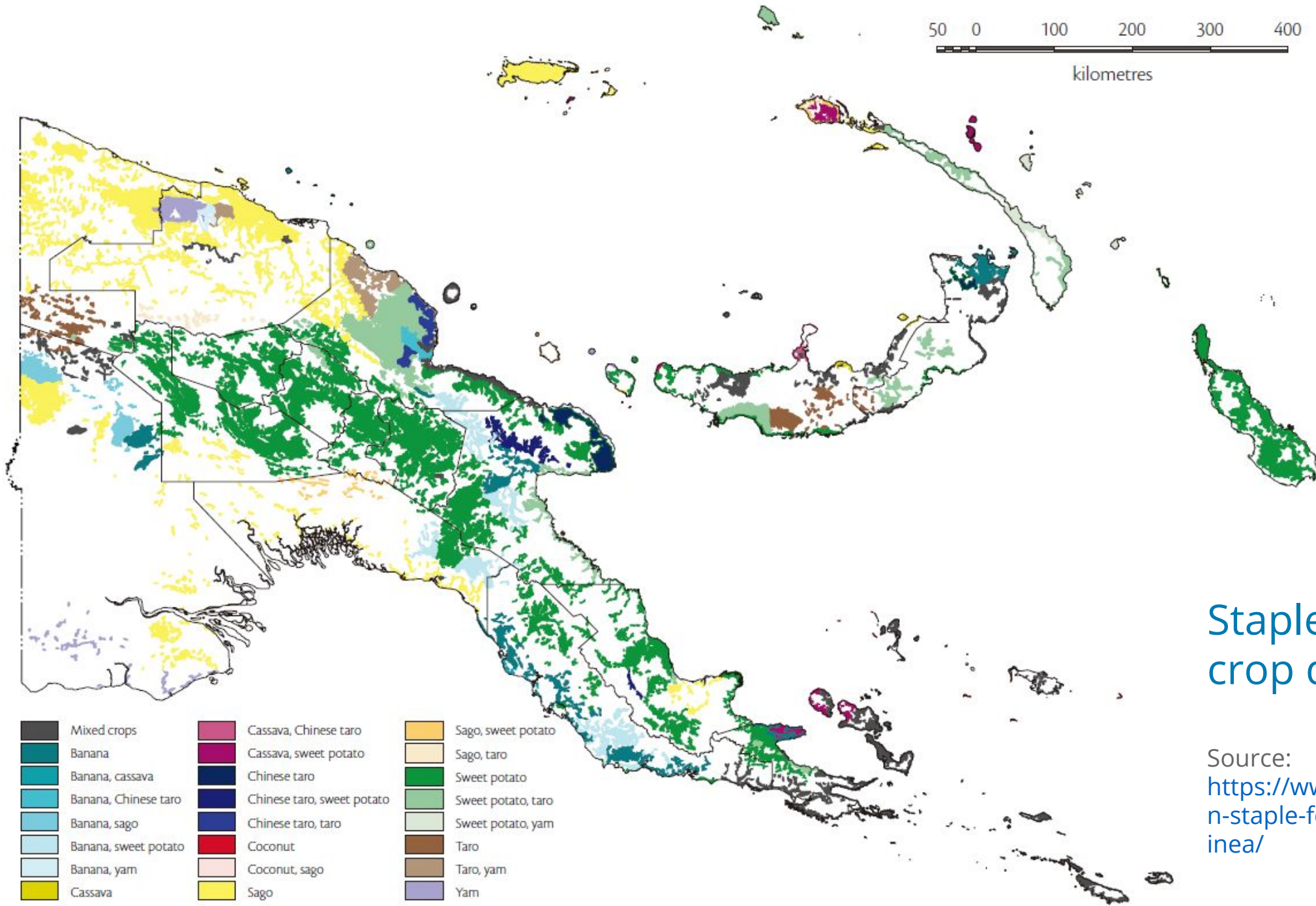


Rainfall condition, Feb 2019



Current vegetation patterns are complex

The rainfall patterns are not clearly reflected in the vegetation response one month later. Below average vegetation is maintained across most of the country as well as province in northern side. Elsewhere, very slight response was noticed in areas subjected to early season dryness. **Data: USGS MODIS MOD13A3**



Staple food and crop distribution

Source:
<https://www.tokpisin.info/commo-n-staple-food-crops-papua-new-guinea/>

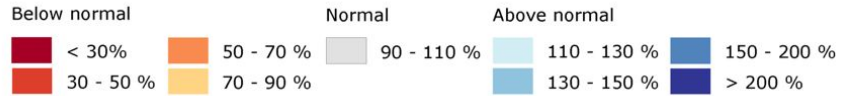
Meteorological drought

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:

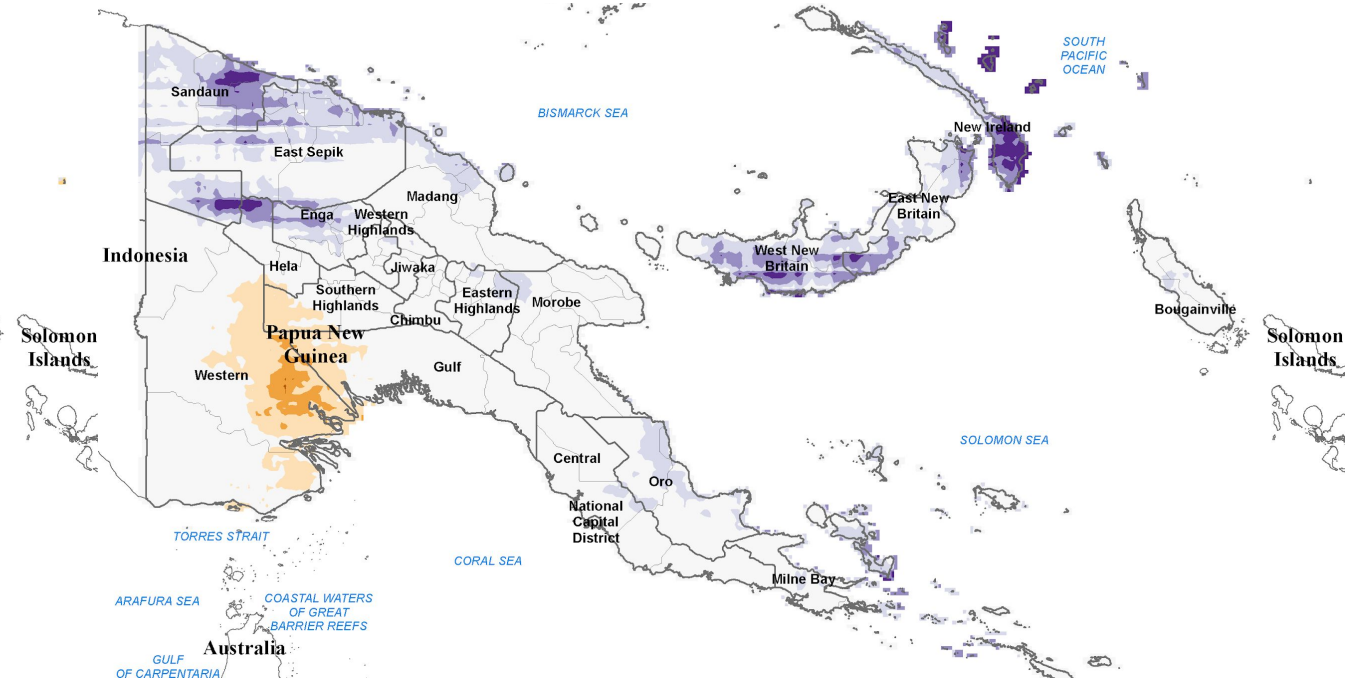
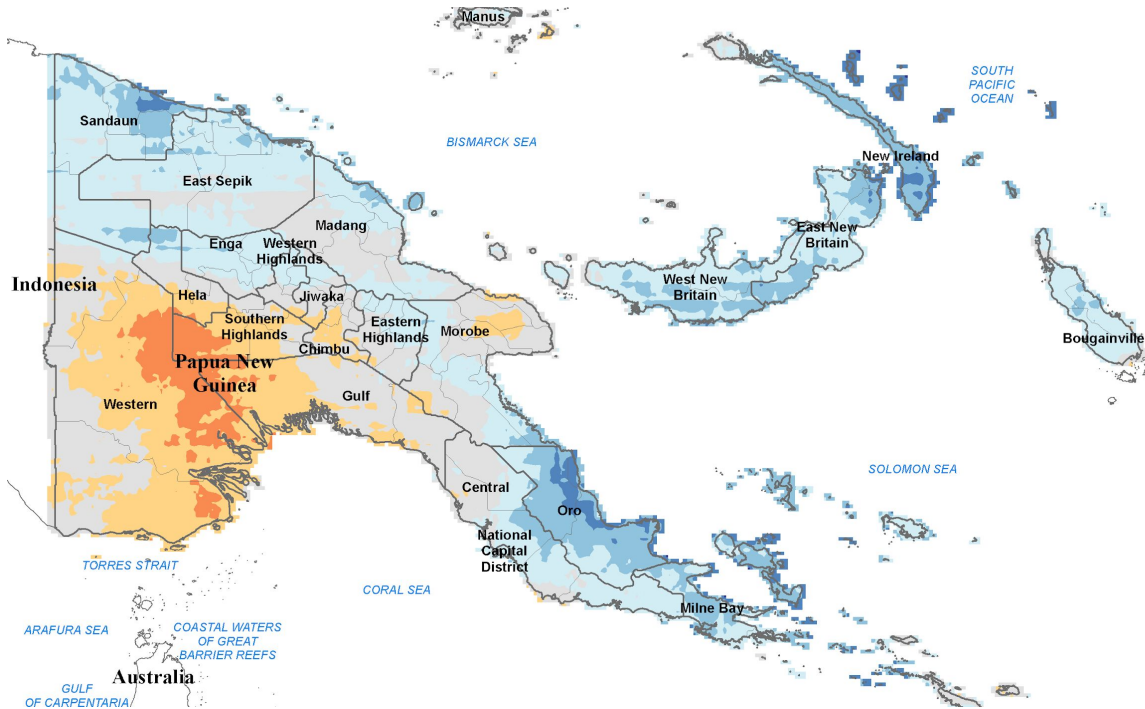
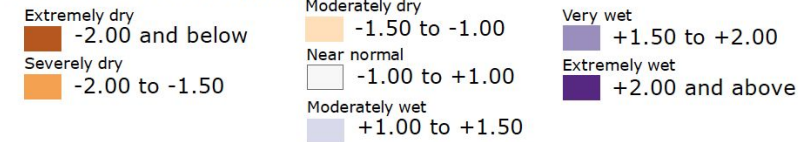
- **Rainfall anomaly:** a measure of lack of rainfall in a period compared to the average;
- **Standardized Precipitation Index (SPI):** a normalized index representing the probability of occurrence of an observed rainfall amount when compared with the rainfall climatology over a long-term period. Negative SPI values represent rainfall deficit, whereas positive SPI values indicate rainfall surplus;
- The number of maximum **consecutive days without rain (CDD)** is also calculated as the count of the most recent days since a day had more than 1 mm of rain (or depend on the rain days criteria of the country).

1-Month rainfall anomaly and SPI (March 2019)

Rainfall anomaly, percent of average



Standardized Precipitation Index

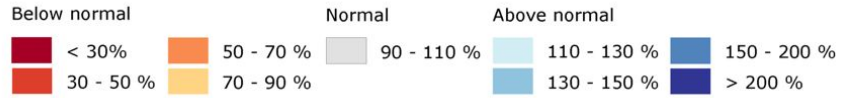


On short timescales, the rainfall anomaly and standardized precipitation index (SPI) is closely related to soil moisture.

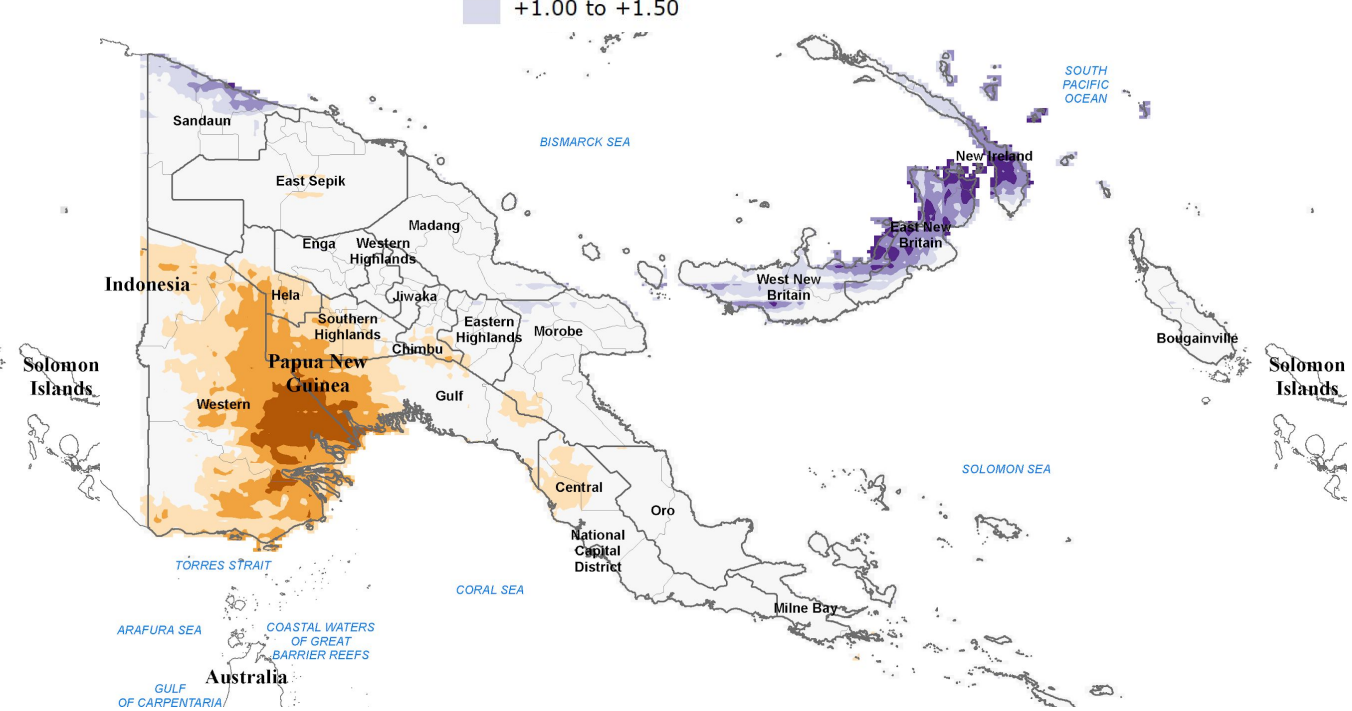
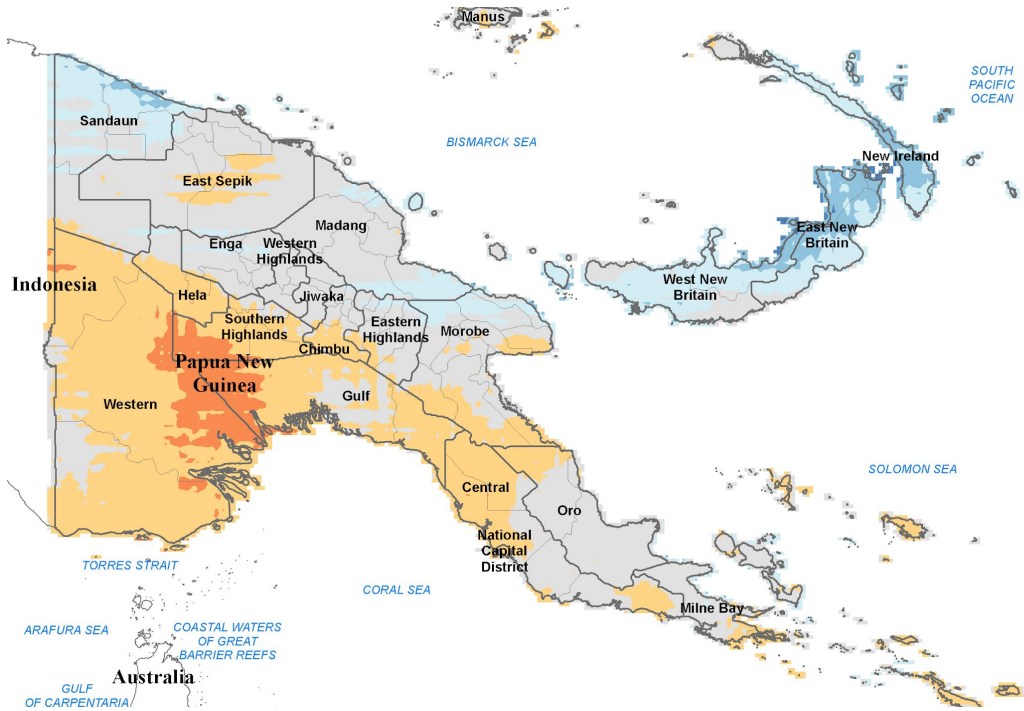
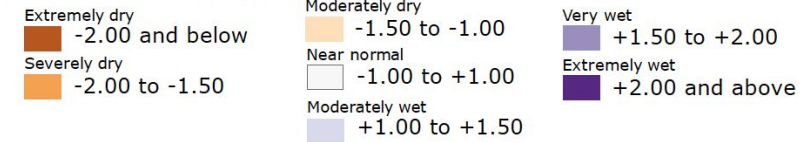
SPI analysis identifies in shorter time scale most area of the country experienced normal to moderately wet condition. Extremely wet condition occurred in New Ireland and New Britain, while small areas in western area and Gulf experienced moderate to severe dry condition. **Data: CHIRPS, CHG UCSB**

3-Month rainfall anomaly and SPI (January to March 2019)

Rainfall anomaly, percent of average



Standardized Precipitation Index

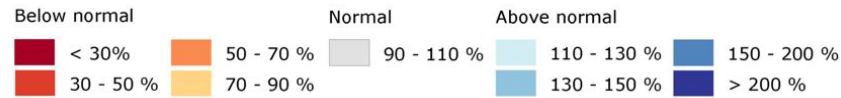


While at longer timescales, the rainfall anomaly and SPI can be related to groundwater and reservoir storage.

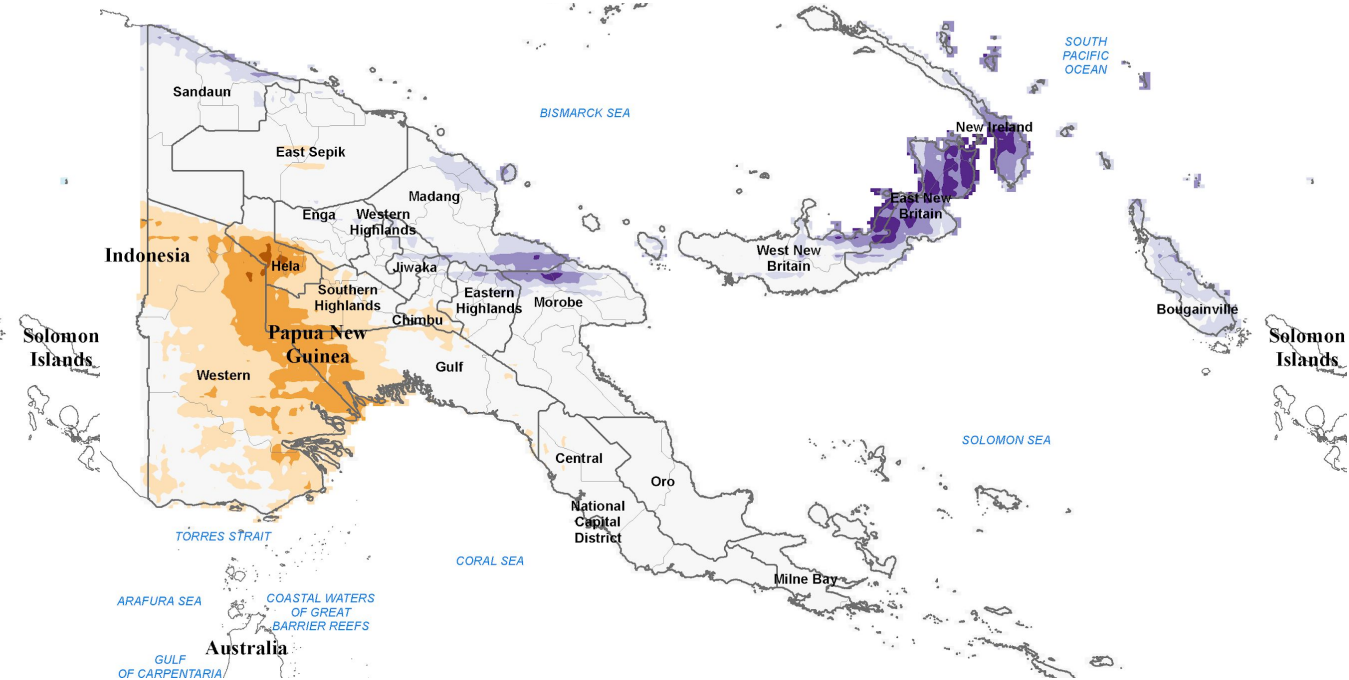
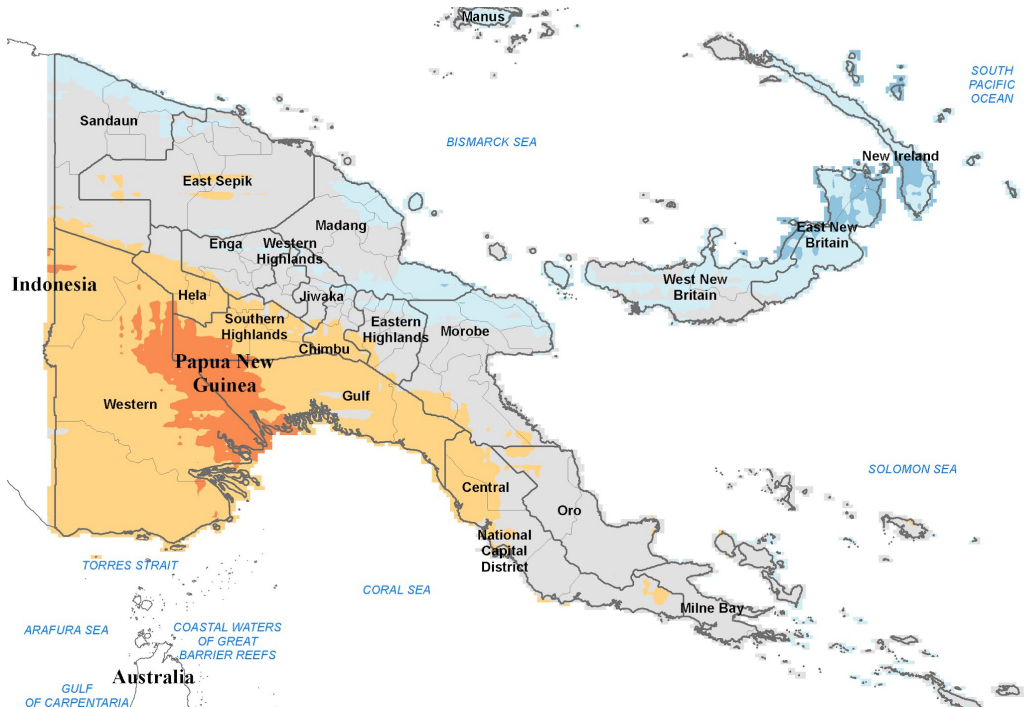
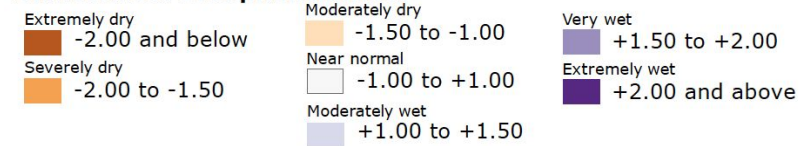
SPI analysis identifies in longer time scale more extreme wet condition occurred in New Ireland and New Britain and in contrast more extreme dry condition in Western area and Gulf. **Data: CHIRPS, CHG UCSB**

6-Month rainfall anomaly and SPI (October 2018 to March 2019)

Rainfall anomaly, percent of average



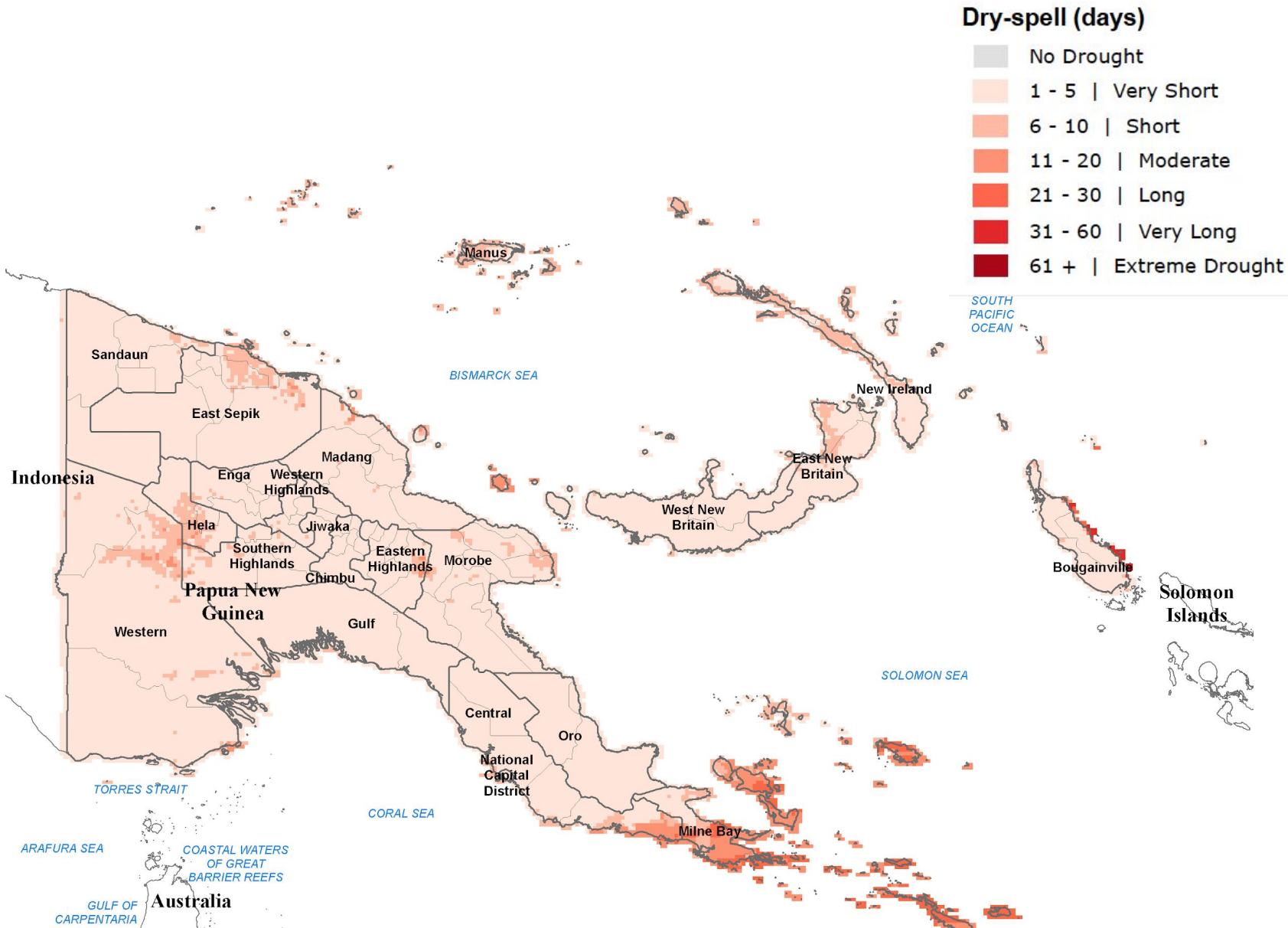
Standardized Precipitation Index



While at longer timescales, the rainfall anomaly and SPI can be related to groundwater and reservoir storage.

SPI analysis identifies similar pattern even in longer time scale (6 month). Dryness is spreading north in Western area, but in less extreme level. Wet condition is persistent in New Ireland and New Britain. **Data: CHIRPS, CHG UCSB**

Maximum Consecutive Dry Days (CDD), March 2019



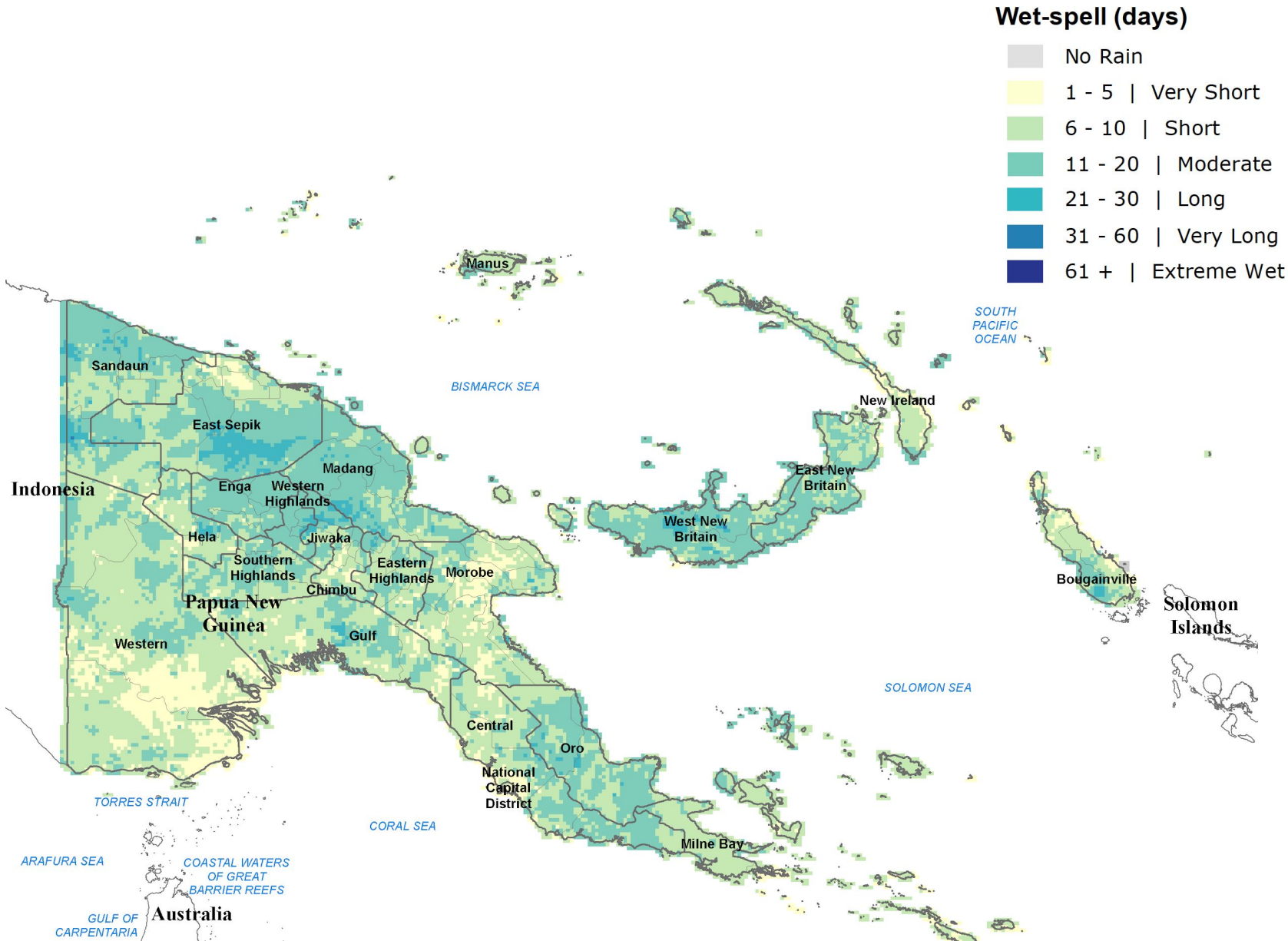
Localized meteorological drought in the south-eastern part of country

Very short to short dry spells (days without daily rainfall reaching 1 mm) were felt in the most areas of the country. Localized very long drought, or more than 21 consecutive dry days, was recorded in southeast areas, as shown in the map.

Data: CHIRPS, CHG UCSB

SPI and CDD: Better captures potential drought conditions or change compared to normal

Maximum Consecutive Wet Days (CWD), March 2019



Localized meteorological wetness in the northern part of country

Prolonged wet days were felt in most areas of the country. Long wet spells (>21 days) are experienced in northern and southeast part of the country. Very short wet spells are localized mainly in Western area.

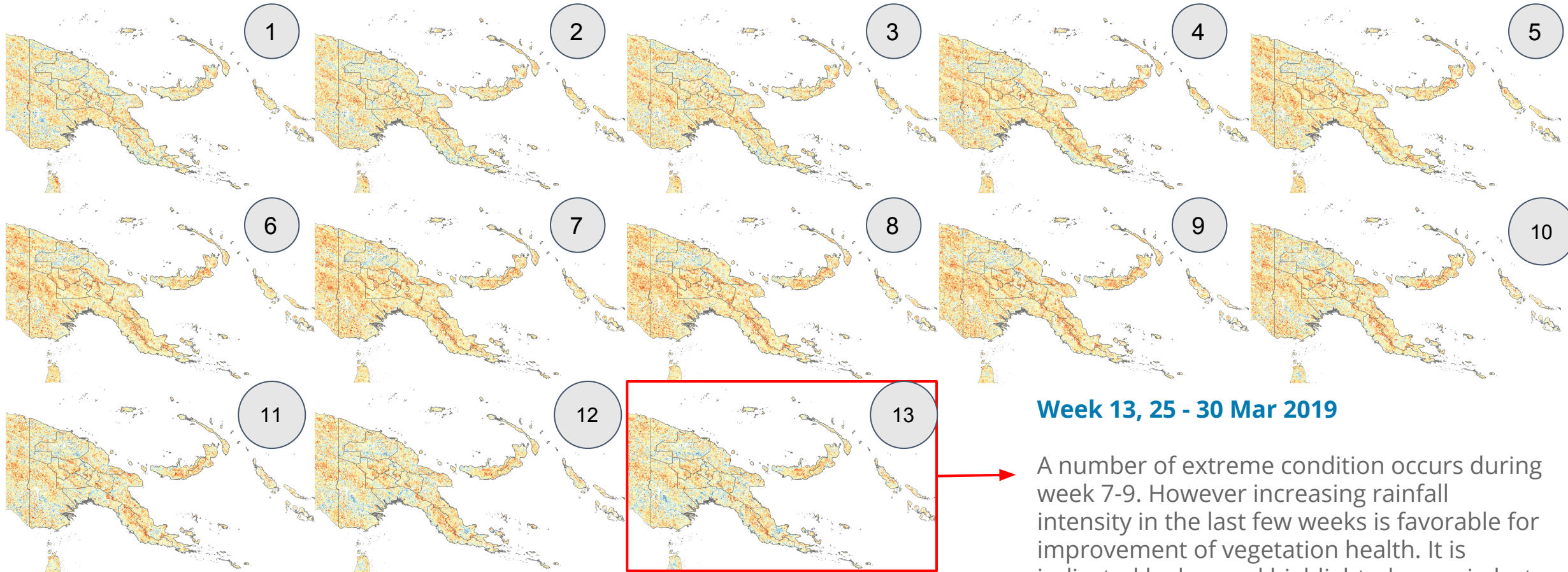
Data: CHIRPS, CHG UCSB

Agriculture drought

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; and
- VH is a product estimating vegetation health (condition) base on moisture conditions (VCI), thermal conditions (TCI) and their combination (VHI). VH is used often to estimate crop condition and anticipated yield. If the indices are below 40 indicating different level of vegetation stress, losses of crop and pasture production might be expected; if the indices above 60 (favorable condition) plentiful production might be expected. VH is very useful for an advanced prediction of crop losses.
- Soil Moisture at surface level. For farmers, soil moisture indicates the amount of water available for seed development as well as for plants' roots. Streamflow is an indicator of hydrological drought, with low flows indicating potential freshwater shortages.

Vegetation Health condition, week 1 - 13 of 2019



Week 13, 25 - 30 Mar 2019

A number of extreme condition occurs during week 7-9. However increasing rainfall intensity in the last few weeks is favorable for improvement of vegetation health. It is indicated by less red highlighted areas in last map.

Impact of drought in agriculture

They fluctuate from 0 to 100, reflecting changes in vegetation conditions from extremely bad (**Red**) to optimal (**Blue**). **Note:** For the area without vegetation (desert, high mountains, etc.), the displayed indices characterize surface conditions. **Data: VIIRS VH Product**

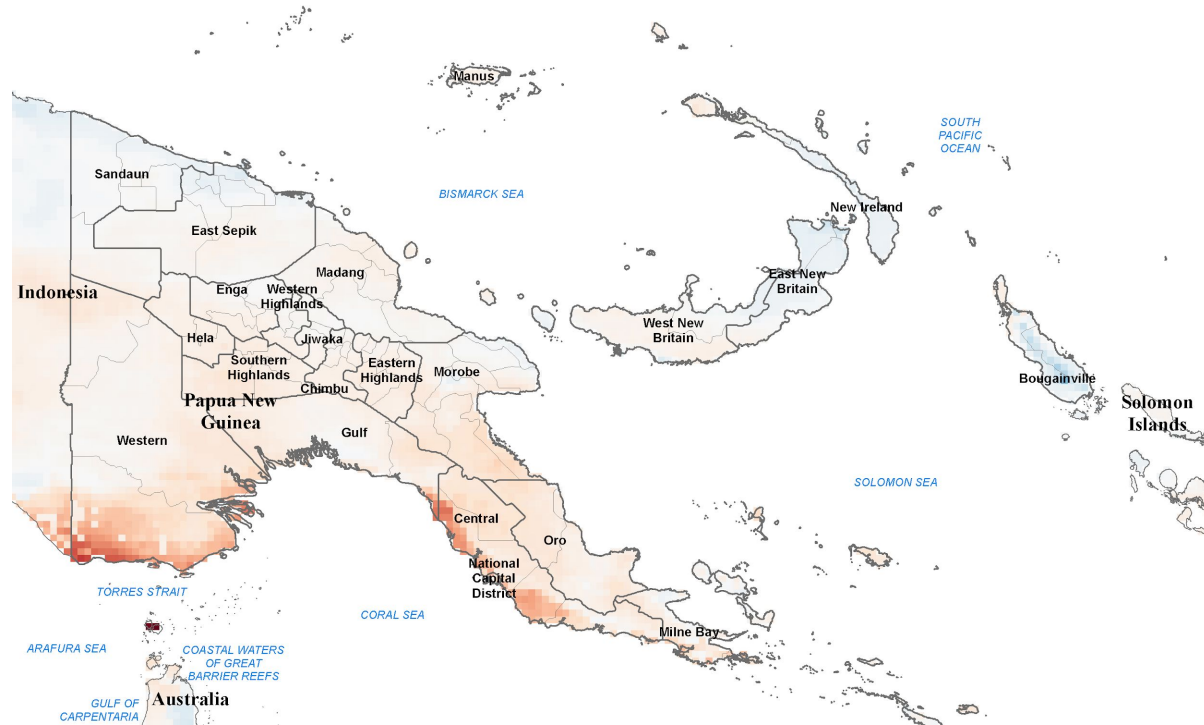
Vegetation Health



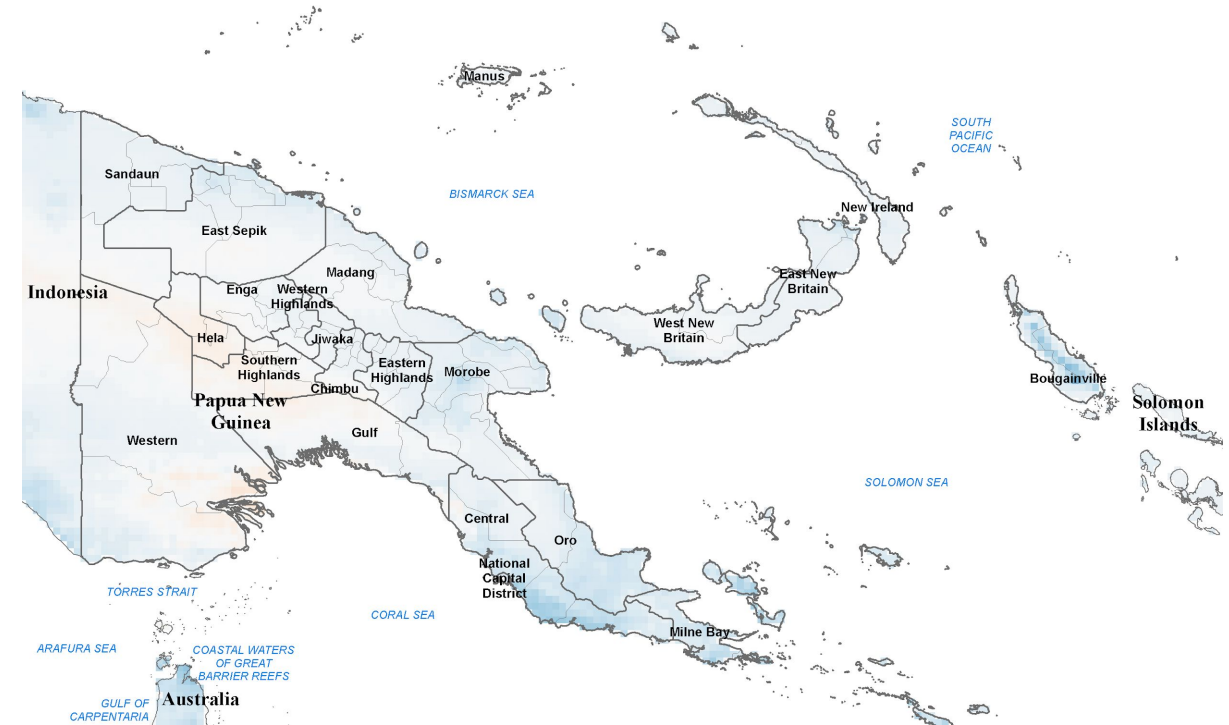
Soil moisture content, Feb 2019



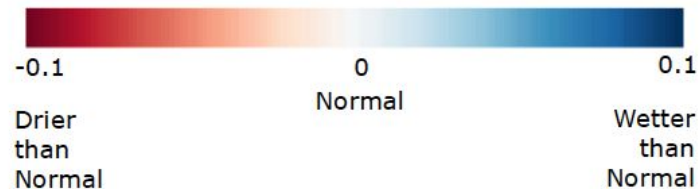
0-10cm below-ground



40-100cm below-ground



Soil moisture anomaly (m-3 / m-3)



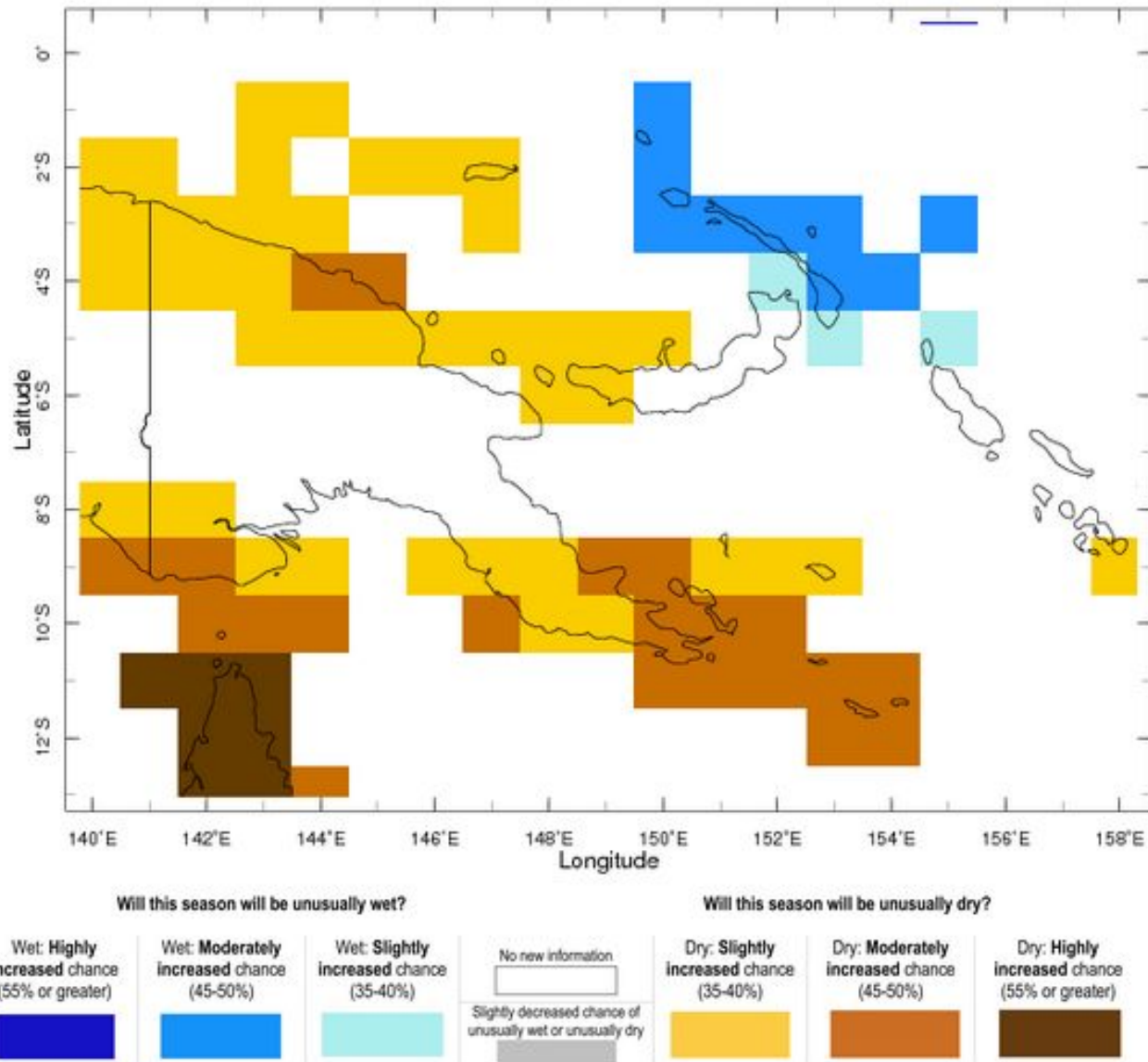
Surface Hydrology

SMC for 0-10 cm below-ground in most areas of the country is relatively normal. Drier condition is detected only in coastal areas in the southern part of the country. Soil water content is secured (that usually contributes to normal water storage, irrigation, lower risk of wildfire).

Further in 40-100 cm below-ground layer of soil, the moisture is maintained normal throughout the country. **Data: NOAA FLDAS**

Rainfall outlook for 2nd quarter of 2019

Forecast for Apr-Jun 2019, Forecast Issued Mar 2019



Forecast from the IRI Columbia University for the period April to June 2019 indicate below average rainfall along the coastline in northern and southern areas, but most of areas in the highland and New Britain indicate normal rainfall. New Ireland province will receive above normal rainfall.

IRI Columbia University probabilistic seasonal forecast for Apr - Jun 2019, it shows the likelihood that total 3-month rainfall will be unusually high or low.

Source: http://iridl.ldeo.columbia.edu/maproom/IFRC/FIC/prcp_fcst.html?bbox=bb%3A139.78%3A-13.04%3A158.31%3A0.53%3Abb

Key message and recommendation

- Large areas of PNG are not affected by ENSO, especially when changes in SST of NINO 3.4 is less than 1.0°C (weak signal of ENSO)
- Affected area by ENSO are mainly around Gulf and Western area. Yet changes in monthly rainfall is not extreme, only about 20-40 mm
- Changes in rainfall intensity are not necessarily reflected in vegetation response
- EVI in the northern part of mainland is maintained at above average condition without indication of dryness even the rainfall is below average
- Soil moisture at both near ground (0-10 cm) and deeper (40-100 cm) are relatively well maintained throughout the country. Slightly drier than normal condition is detected only in coastal areas in southern part of PNG
- Data on planting and harvesting would complement better analysis on the impact of rainfall to agriculture in PNG and for decision making purposes
- The analysis is merely based on remote sensing data. Ground check is necessary to ensure if satellite and field situation data are corresponding

Question?



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CONTACT

Nicolas Bidault
Senior Regional Adviser - VAM
nicolas.bidault@wfp.org

Saidamon Bodamaev
Programme Coordinator - PNG
saidamon.bodamaev@wfp.org

Benny Istanto
GIS and Climate
benny.istanto@wfp.org