



The 12th Asia-Oceania Meteorological Satellite Users' Conference  
11 - 18 November 2022

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# **WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) for East Asia and Western Pacific**

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# Outline

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WMO SWCEM (Space-based Weather and Climate Extremes Monitoring):

- SWCEM demonstration project in the Asia-Pacific region
- Global satellite data providers: JAXA and NOAA/CPC
- SWCEM products

# WMO SWCEM

- Recognizing high impact of weather and climate extremes on society, the WMO established the Space-based Weather and Climate Extremes Monitoring (SWCEM) International Initiative.
- Provision of timely and accurate information on monitoring extreme events helps to build greater resilience of society against drought, floods, storms and other hydro-meteorological hazards.

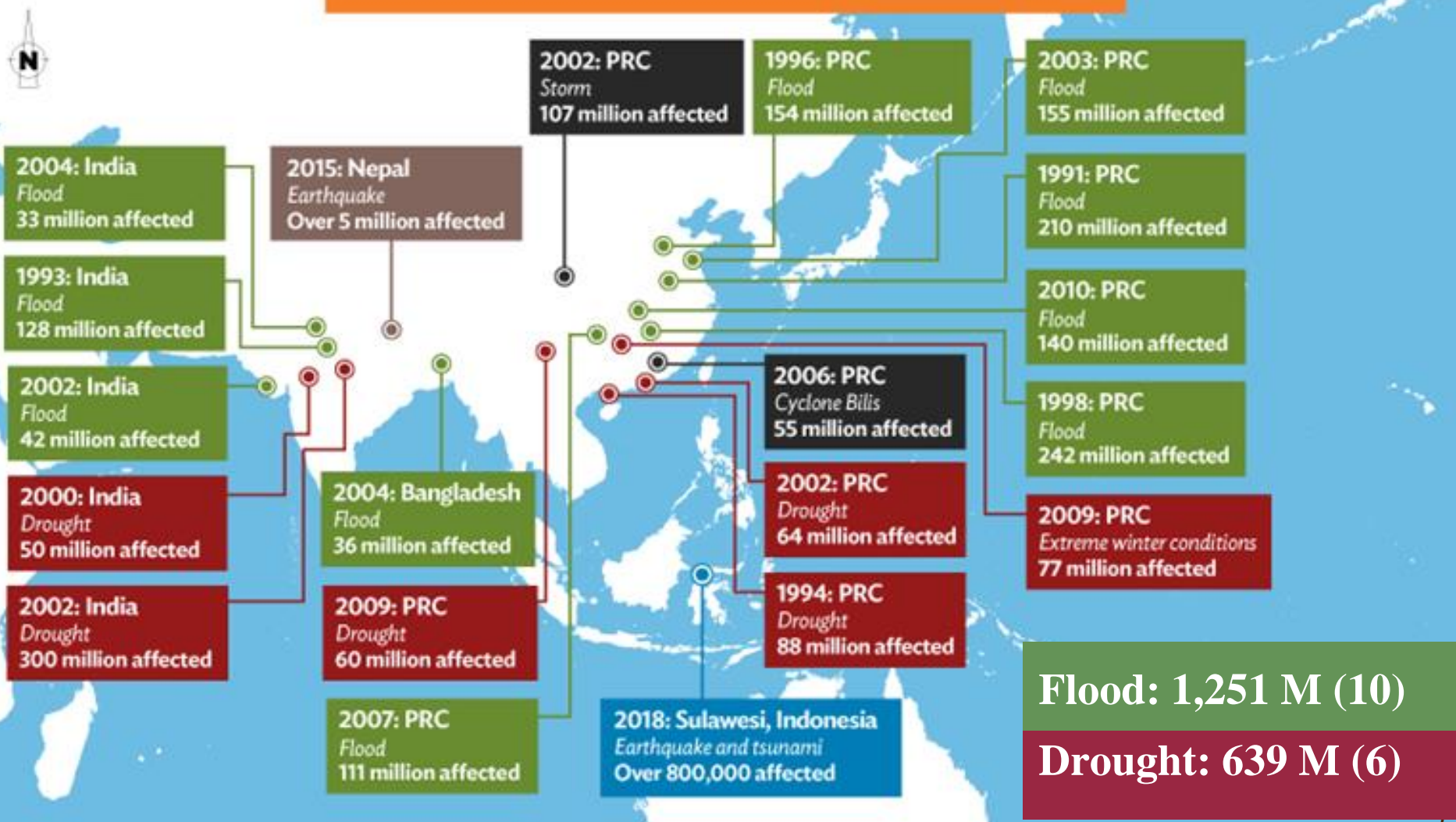




The Workshop on Operational Space-based Weather and Climate Extremes Monitoring (SWCEM) was held in Geneva, Switzerland on 15-17 February, 2017.

# Asian Development Bank: Significant Disasters in the Asia and Pacific Region (1991 – 2018)

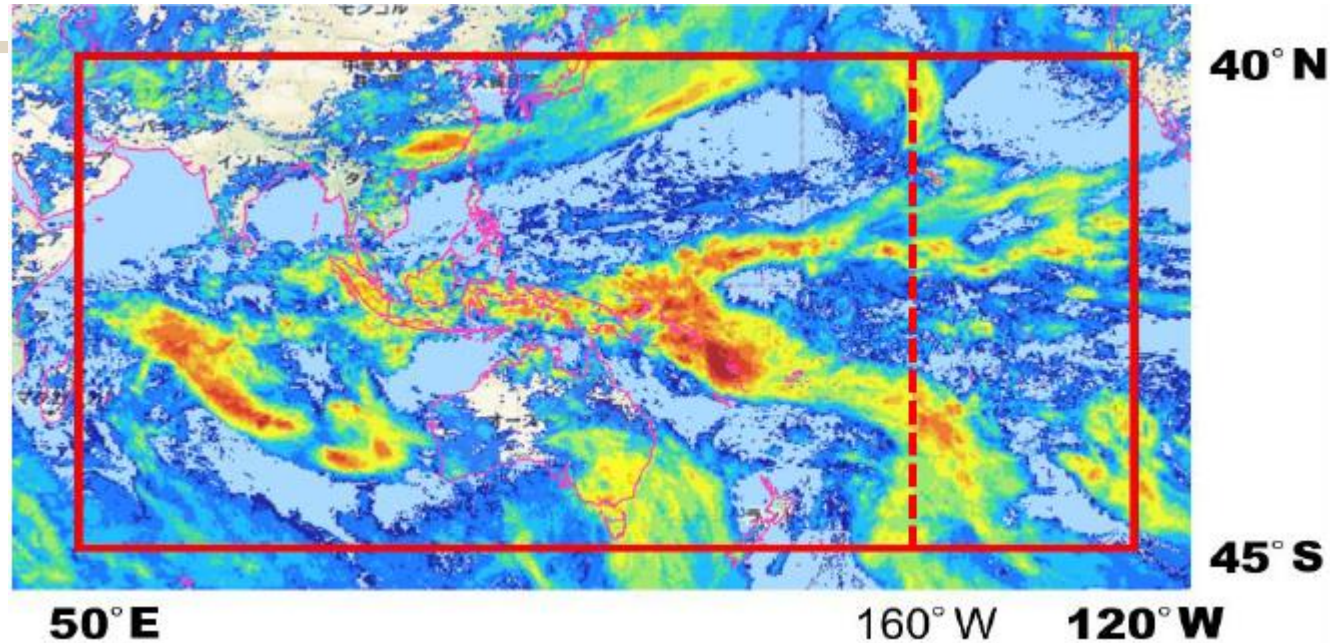
## BY NUMBER OF PEOPLE AFFECTED



**Flood: 1,251 M (10)**

**Drought: 639 M (6)**

# SWCEM Demonstration Project in RA-II and V



The first SWCEM demonstration project was successfully implemented in WMO Region II (Asia) and Region V (the South-West Pacific) in 2018-2019. The project was focused on monitoring **drought** and **heavy precipitation** and implemented in geographical domain which covers the **South-East Asia** region and the **Western Pacific Ocean** area from 40°N to 45°S; 50°E to 120°W.

# Global Satellite-derived Product Providers

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- Global Satellite-derived Product Providers for the SWCEM – JAXA and NOAA
- JAXA provides the Global Satellite Mapping of Precipitation (GSMaP; Kubota et al. 2007) data for detecting extreme precipitation
- GSMaP data are available from March 2000; thresholds for detecting the extreme events are calculated using the GSMaP data during 22 years (2000 – 2022).

Kubota T, Shige S, Hashizume H, Aonashi K, Takahashi N, Seto S, Hirose M, Takayabu YN, Ushio T, Nakagawa K, Iwanami K, Kachi M & Okamoto K. Global Precipitation Map Using Satellite-borne Microwave Radiometers by the GSMaP Project: Production and Validation. *IEEE Transactions on Geoscience and Remote Sensing*. 2007;45(7, part 2):2259-2275. DOI: 10.1109/TGRS.2007.895337

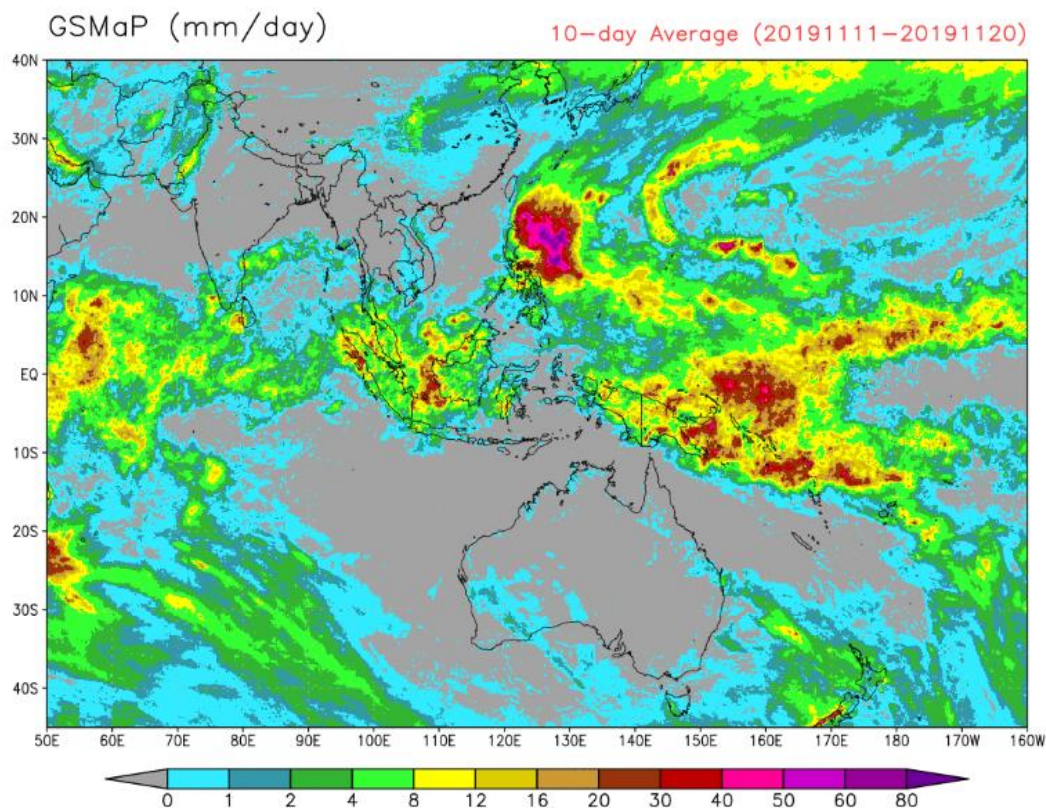
# Global Satellite-derived Product Providers

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- NOAA/CPC provides products using the Climate Prediction Center morphing technique (CMORPH; Xie et al. 2017); satellite precipitation estimates are available from 1998.
- SWCEM precipitation products include mean precipitation estimates for hourly, daily, pentad, weekly, 10 days and monthly precipitation. In addition, statistics for daily, pentad and weekly extreme precipitation and percentage of rainy days in a month is provided.
- In addition to precipitation estimates, derived products – the SPI, the NDVI and the VHI are also available for the SWCEM region.



# SWCEM Operational Products



## Mean precipitation estimates

- hourly
- daily (00-23UTC)
- pentad (5-day)
- weekly (Monday– Sunday)
- 10-days
- monthly

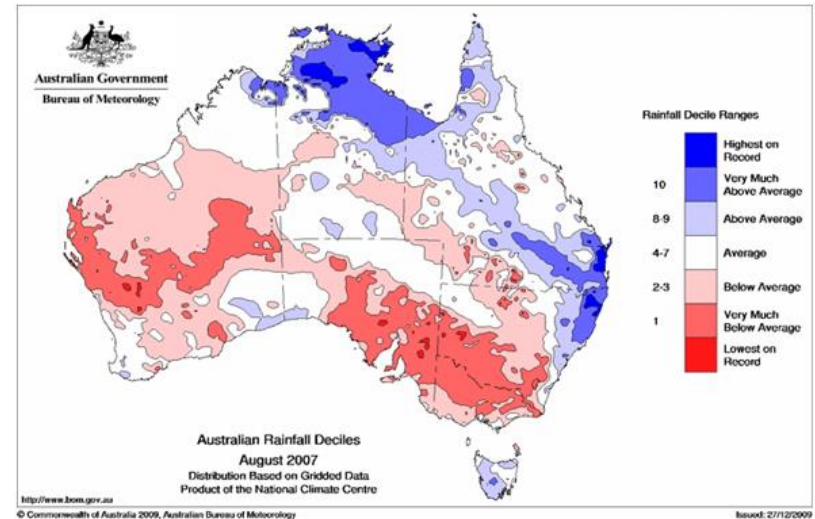
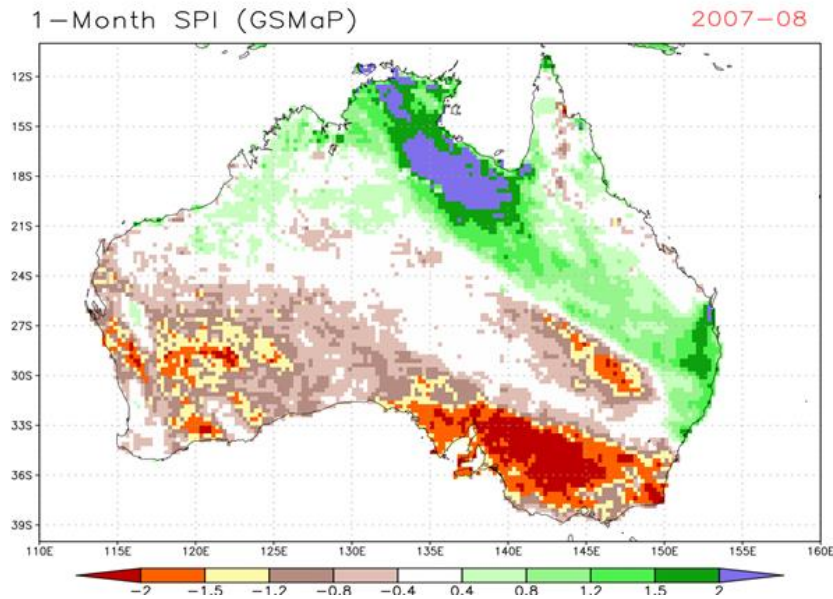
## Statistics:

- Climate normal
- 90th ~ 99th Percentiles
- Percentage of rainy days ( $\geq 1$ mm/day) in a month

JAXA GSMaP 10-day average precipitation, mm/day (11-20 Nov 2019)

**Indices:** SPI, NDVI, VHI

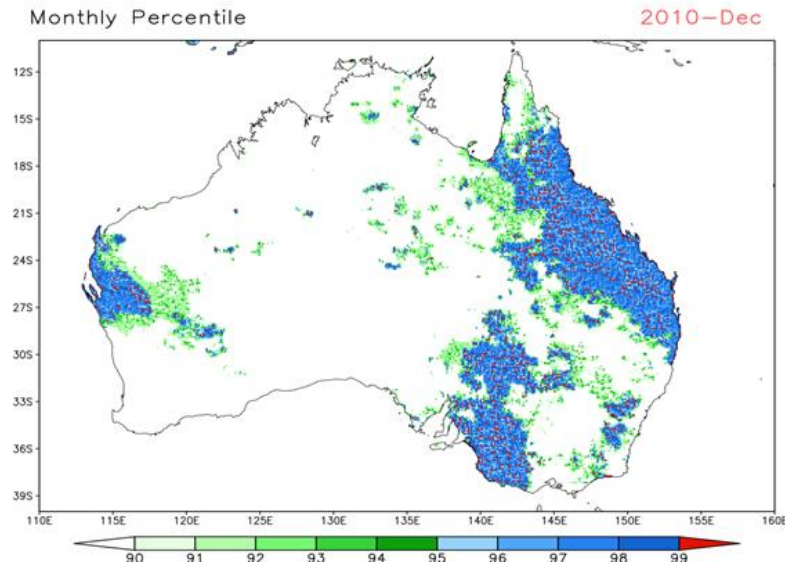
# Drought Monitoring Using SWCEM Products



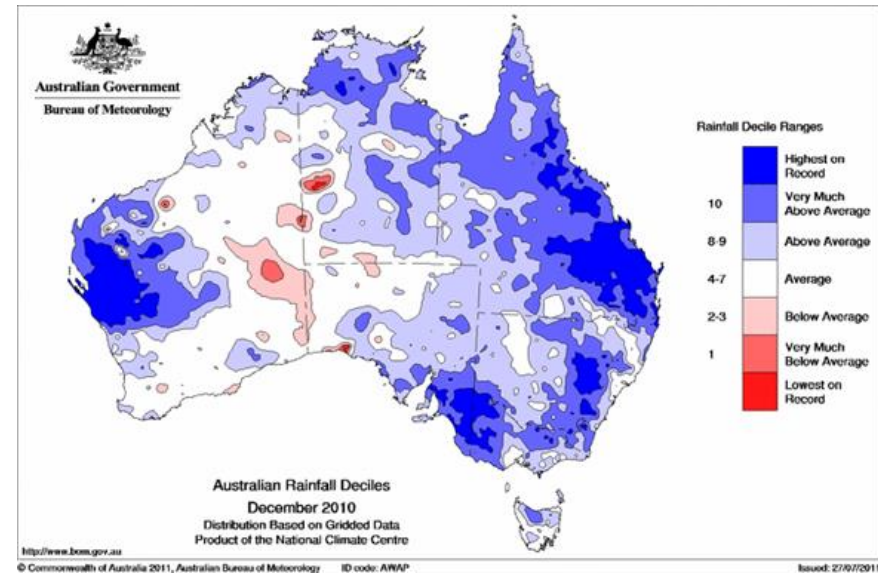
SPI for Australia in August 2007 derived from JAXA GSMaP data.

Rainfall deciles for Australia in August 2007; BoM rain gauge observations.

# Heavy Precipitation Monitoring Using SWCEM Products



JAXA GSMaP rainfall percentile over Australia for December 2010.



Australian rainfall deciles for December 2010; BoM rain gauge observations.

# SWCEM Contribution to CREWS

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- SWCEM observations of precipitation have been incorporated into other WMO projects strengthening capacity of Members, especially Small Island Developing States (SIDS) and Least Developed Countries (LDCs), in climate change adaptation and disaster risk reduction.
- Satellite precipitation estimates and derived products are significant contribution to strengthening Multi-Hazard Early Warning Systems. Currently, we are implementing this through the Climate Risk and Early Warning Systems (CREWS) projects with focus on Asia - Oceania.

# CREWS

- Developing and least developed countries are particularly vulnerable to the impact of climate extremes, including drought.
- Recognizing the urgency of enhancing early warning systems to assist vulnerable countries with climate change adaptation, the Climate Risk and Early Warning Systems (CREWS) international initiative has been established at COP-21 in Paris in 2015.



# CREWS

“CREWS has proven that it is on the ground and efficient, **saves thousands of lives**, and saves millions in assets.”

— Stéphane Crozet, French Climate Ambassador, Remarks at the Climate Adaptation Summit Disaster Risk Management Anchoring Event, 25 January, 2021

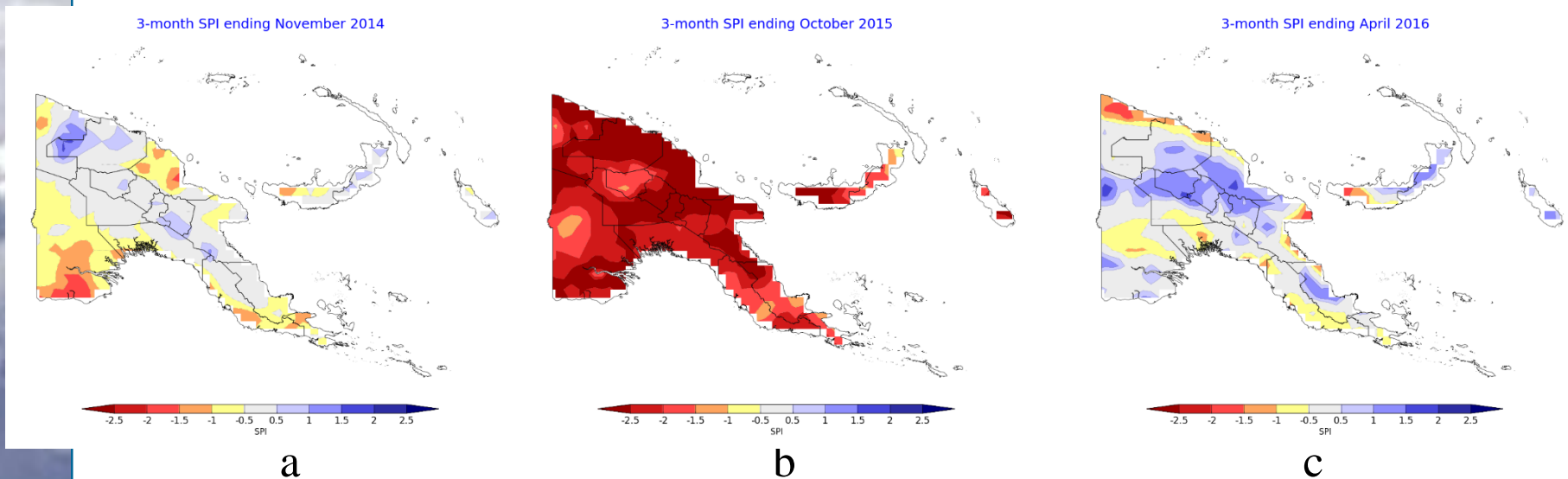


CREWS has already supported 73 countries through

- 9 country projects
- 7 regional projects
- 1 global project.



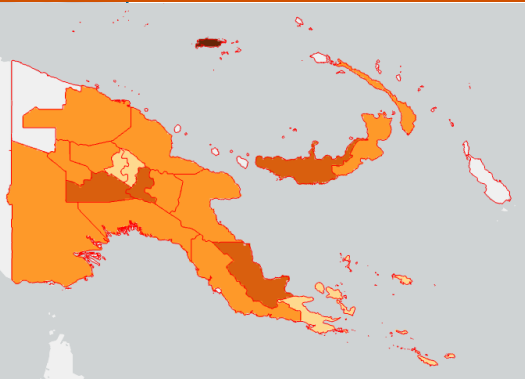
# Drought Monitoring Using SWCEM Products: WMO RA-V, Papua New Guinea (PNG)



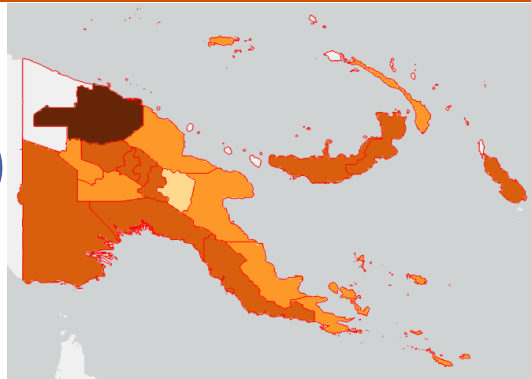
3-month SPI showing the progression of drought event in PNG: (a) November 2014 showing initial signs of dry conditions towards the southeast of the mainland; (b) October 2015 showing widespread severely dry conditions; (c) April 2016 showing the easing of dry conditions.

# CREWS: Drought Risk Assessment

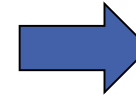
## Drought Hazards Index (DHI) Inputs



WMO SWCEM: SPI



WMO SWCEM: VHI



SPI + VHI => DHI

Drought Risk Assessment: WMO SWCEM satellite-derived products – SPI and VHI - are combined using GIS, to produce maps of Drought Hazard Index (DHI) for PNG at the provincial level.



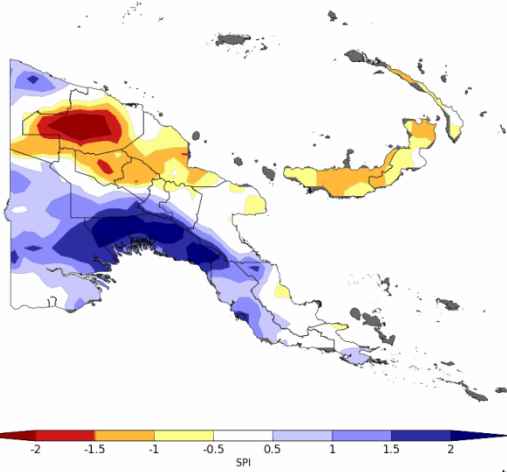
# CREWS: Drought EWS

## Monitoring Inputs

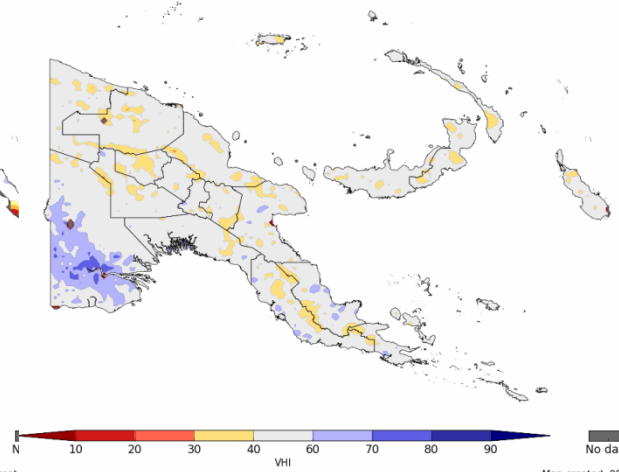


## Forecasting Inputs

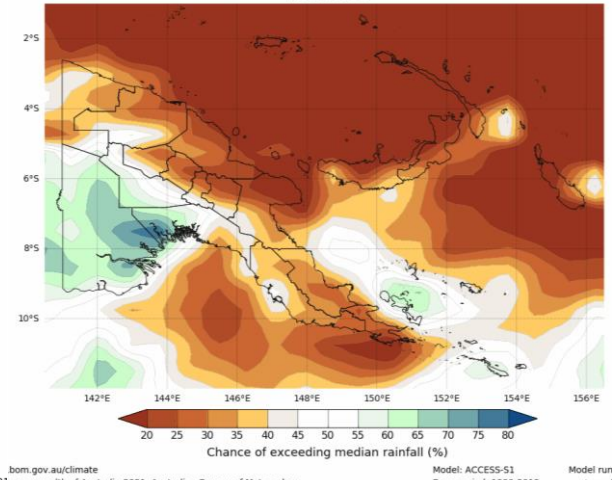
3-month SPI ending January 2021



3-month VHI for January 2021



Chance of exceeding the median rainfall for March 2021



WMO SWCEM: SPI

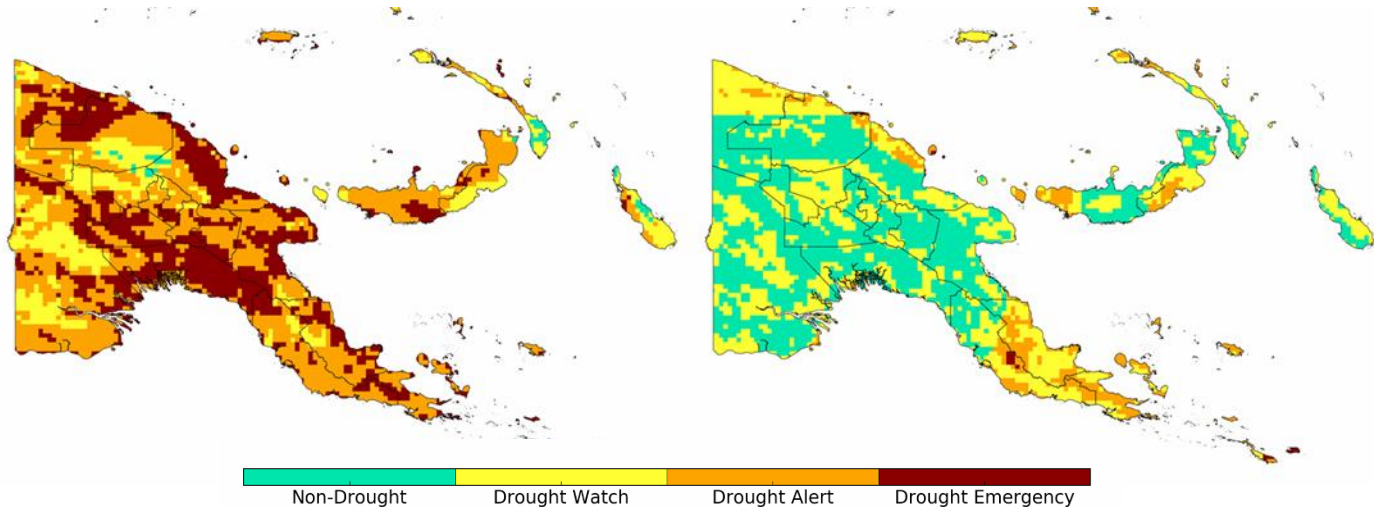
WMO SWCEM: VHI

WMO GPC LRFs: Rain

Drought EWS: WMO SWCEM satellite-derived products - monitoring component and ACCESS-S S2S products – forecasting component

# CREWS PNG

- The CREWS-PNG project developed an improved drought monitoring and early warning system (EWS) for Papua New Guinea.



- EWS for drought will enable better strategic decision making for agriculture, water management, health and other climate-sensitive sectors.

# SWCEM in Operations

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- The Eighteenth World Meteorological Congress (Cg-18) - recognizing significant achievements of SWCEM in Asia-Pacific, adopted project implementation plan for 2020-2021
- Cg-18 – to progress with the implementation of the SWCEM regional **operational** subproject in East Asia and Western Pacific
- Cg-18 – to consider the possibility of implementing similar projects in Africa (RA I) and South America (RA III)

# SWCEM Web Portal



WORLD  
METEOROLOGICAL  
ORGANIZATION  
Weather - Climate - Water

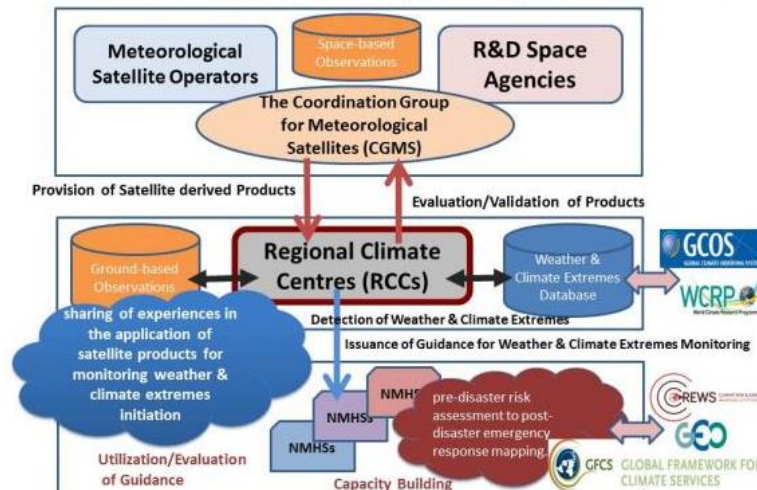
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Home — Programmes — WMO Space Programme — Space-based Weather and Climate Extremes Monitoring (SWCEM)

## A Cross-cutting Scheme for Implementing SWCEM



## Space-based Weather and Climate Extremes Monitoring (SWCEM)

Contact: [swcem-help-desk@wmo.int](mailto:swcem-help-desk@wmo.int)

It is recognized that there is a need to better utilize and improve the monitoring of weather and climate extremes from space. Stakeholders to pursue this objective include satellite operators, WMO Regional Climate Centres (RCCs), National Meteorological and Hydrological Services (NMHSs) and other relevant institutes. The pivotal role to be played by WMO was the reason to give visibility of the Space-based Weather and Climate Extremes Monitoring (SWCEM) to WMO members in accordance with the SWCEM Implementation Plan approved in the Eighteenth World

<https://public.wmo.int/en/programmes/wmo-space-programme/swcem>

# SWCEM Newsletter



WMO Space-based Weather and Climate  
**SWCEM Newsletter**

September 2019

1. Welcome
2. Background
3. SEMDP-EAWP
4. SWCEP-EAWP in Operation
5. SWCEM Portal

**Contact Us**

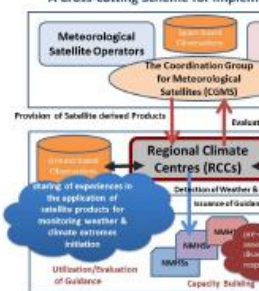
**Werner BALOGH**  
WMO Space Programme Office, Observation and Information System Department

**Peer HECHLER**  
Data Management Applications Division, Climate and Water Department

**1. Welcome**

Welcome to the first edition of the SWCEM Newsletter. We recognized that there is a need to better utilize weather and climate extremes from space. Stakeholders include satellite operators, WMO Regional Meteorological and Hydrological Service Institutes. The pivotal role to be played by WMO visibility of the Space-based Weather and Climate (SWCEM) to WMO members in accordance with Plan approved in the Eighteenth World Meteorological Conference in June 2019.

**A Cross-cutting Scheme for Implementation**



**2. Background**

WORLD METEOROLOGICAL ORGANIZATION



WMO Space-based Weather and Climate

**SWCEM Newsletter**

Issue 1 | April 2020

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4. WMO Regional Climate Centres (RCCs)
  - 4.1. Drought monitoring in Australia using WMO SWCEM products
5. WMO Secretariat
  - 5.1. WMO Statement on the state of the Global Climate in 2019 (p.24)
  - 5.2. WMO BULLETIN Vol. 69(1)-2020 (pp.60-66)

**Links**

- SWCEM Portal
- SWCEM Help desk

**1. EP-SWCEM-EAWP**

Recognizing needs to better utilize and improve weather and climate extremes from space, WMO put forward a new Weather and Climate Extremes Monitoring (SWCEM) was launched at the inception workshop.

We started SWCEM with the demonstration project and were able to bring clear benefits of transit



which covers the South-East Asia region and the 40°N to 45°S; 50°E to 120°W. The Japan Aerospace eopac the Climate Prediction Center, National Oceanic & (CPC/NOAA) provide satellite data and products for

SWCEM precipitation products produced by JAXA Mapping of Precipitation (GSMaP) and include derived from GSMaP version 6 for hourly, daily monthly precipitation. In addition, statistics for d precipitation and percentage of rainy days in a monitoring, the standardized precipitation index available. These data are accessible within a few

CPC/NOAA provides SWCEM users with a similar Prediction Center morphing technique (CMORPH). In addition to the SPI, weekly normalized differ

SWCEM Newsletter – Issue 1 | April 2020

WORLD METEOROLOGICAL ORGANIZATION



WMO Space-based Weather

**SWCEM Newsletter**

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  - 4.1. RAH RCC Beijing (RCC)

**Links**

- SWCEM Portal
- SWCEM Help desk

**1. WMO GLOBAL MULTI-HAZARD GMAS**

Jochen Luther, James Douris, Gavin Ikin Branch, Services Department, WMO

Early and authoritative warnings produced by National Meteorology to be very effective in reducing the foundation on which early act can be realized. As hydro-meteor vulnerable populations and their need for these warnings and relate easily accessible on time.

The WMO Global Multi-hazard framework for substantially increase warnings and information related water and climate events – region visible and accessible resource for (1) identifying gaps in capability, (2) and capacity development to (3) promoting outreach to those global mobility; (4) improving visibility – including NIMFS – by key net (5) harmonizing and standardizing promoting cross-border cooperati

To achieve these objectives, GMAS early warning systems (EWSs), governments, businesses and other advance of hazardous events and risk knowledge based on the assessments; (2) detection, monitor possible consequences; (3) dissemination of authoritative, timely, accurate information on likelihood and impact; and (4) prepared. These four interrelated coordinated within and across systems' to work effectively and improvement. While these system hazard cluster, multi-hazard EWSs

SWCEM Newsletter – Issue 2 | July 2020

WORLD METEOROLOGICAL ORGANIZATION



WMO Space-based Weather and Climate Extremes Monitoring

**SWCEM Newsletter**

Issue 3 | October 2020

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    - 3.2. RA V SEA RCC-Network (Data Services) – BMKG, Indonesia
    - 3.3. RA V SEA RCC-Network (long-range forecasting) – MSS, Singapore
    - 3.4. RA V Pacific RCC-Network (Operational Data Service) – BoM, Australia

**1. UNITED NATIONS ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC (ESCAP)**

**Space Applications and Disaster Resilience for Sustainable Development: Activities and examples from ESCAP**

Rapid digital innovation continues to augment the availability of geospatial information, providing Asia-Pacific countries, particularly those with special needs, with an expanded choice of tools to implement the 2030 Agenda. Despite advances in the availability and quality of geospatial information, several gaps and challenges remain: the effective use of integrated geospatial information at the regional and national levels, including a lack of capacity and financial resources, availability of space-derived data, knowledge and expertise, specific tools and well-trained human resources.

In view of this, the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018-2030) was adopted by the Third Ministerial Conference on Space Applications for Sustainable Development in Asia and the Pacific in 2018 to address these gaps and challenges [https://www.unescap.org/sites/default/files/3rdMC-SASD-Plan-of-Action.pdf]. Since then, member States have made progress to actively support the implementation of the Plan. The Plan proposed 188 actions relating to research and knowledge sharing, capacity building and technical support, and intergovernmental discussions and regional practices, across six thematic areas: disaster risk reduction and resilience, management of natural resources, connectivity, social development, energy and climate change.




Figure 1. Six priority thematic areas of the Plan of Action support the implementation of the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction [https://www.unescap.org/sites/default/files/3rdMC-SASD-Infograph\_0.pdf]

SWCEM Newsletter – Issue 3 | October 2020

# Early Warning and Early Action

UN unveils ambitious target to adapt to climate change and more extreme weather



**António Guterres**  
Secretary-General of the United Nations

“ We must boost the power of prediction for everyone and build their capacity to act. On this World Meteorological Day, let us recognize the **value of early warnings and early action** as critical tools to reduce disaster risk and support climate adaptation. ”

WORLD METEOROLOGICAL ORGANIZATION



WMO SWCEM and CREWS are important contributors to new UN target "Early warning systems must protect everyone within five years"

# Summary

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- ✓ WMO SWCEM
- ✓ Demonstration project for the Asia-Pacific region
- ✓ Satellite precipitation estimates – JAXA and CPC/NOAA
- ✓ Derived products and indices e.g. SPI, NDVI, VHI
- ✓ SWCEM products - encouraging results for drought and heavy precipitation monitoring
- ✓ SWCEM outstanding achievements – thanks to international cooperation !