Remote Sensing, Agriculture and Drought Indicators

Robert Stefanski

World Meteorological Organization

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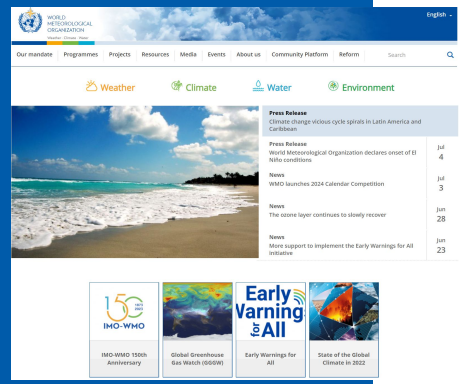
WORLD METEOROLOGICAL ORGANIZATION

1950-2025 SCIENCE for ACTION

About WMO

The World Meteorological Organization (WMO) is a specialized agency of the United Nations with 193 Member States (National Meteorological and Hydrological Services (NMHSs)) and Territories. It is the United Nations system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources.

- 1873: International Meteorological Organization founded to facilitate the exchange of weather information across national borders.
- 1950 WMO established
- 1951: WMO becomes a specialized agency of the United Nations



- ➔ Observations to collect weather-, climate- and water-related data
- ➔ Data management, processing, forecasting, warning; and telecommunication systems
- ➔ Norms, standards, regulations to ascertain the quality and homogeneity of data and services
- ➔ Research, science & technology in operational meteorology and hydrology to transport (air, land & maritime), water, agriculture, energy, health, disaster risk reduction and other focus sectors
- ➔ Global and regional cooperation between NMHSs
- ➔ The coordination of research and training in meteorology and related fields and regional/national project implementations

WMO 1873 2023 IMO-WMO

WMO Priorities in Agricultural Meteorology 2024-27

Provide guidance to Members on weather and climate applications for agriculture and food security

Enhance integration of local and indigenous agroclimatic knowledge for countries

Provision of agrometeorological knowledge and guidance products, technical advice, and appropriate tools to stakeholders

Provide online, innovative capacity building on agrometeorology to WMO Members

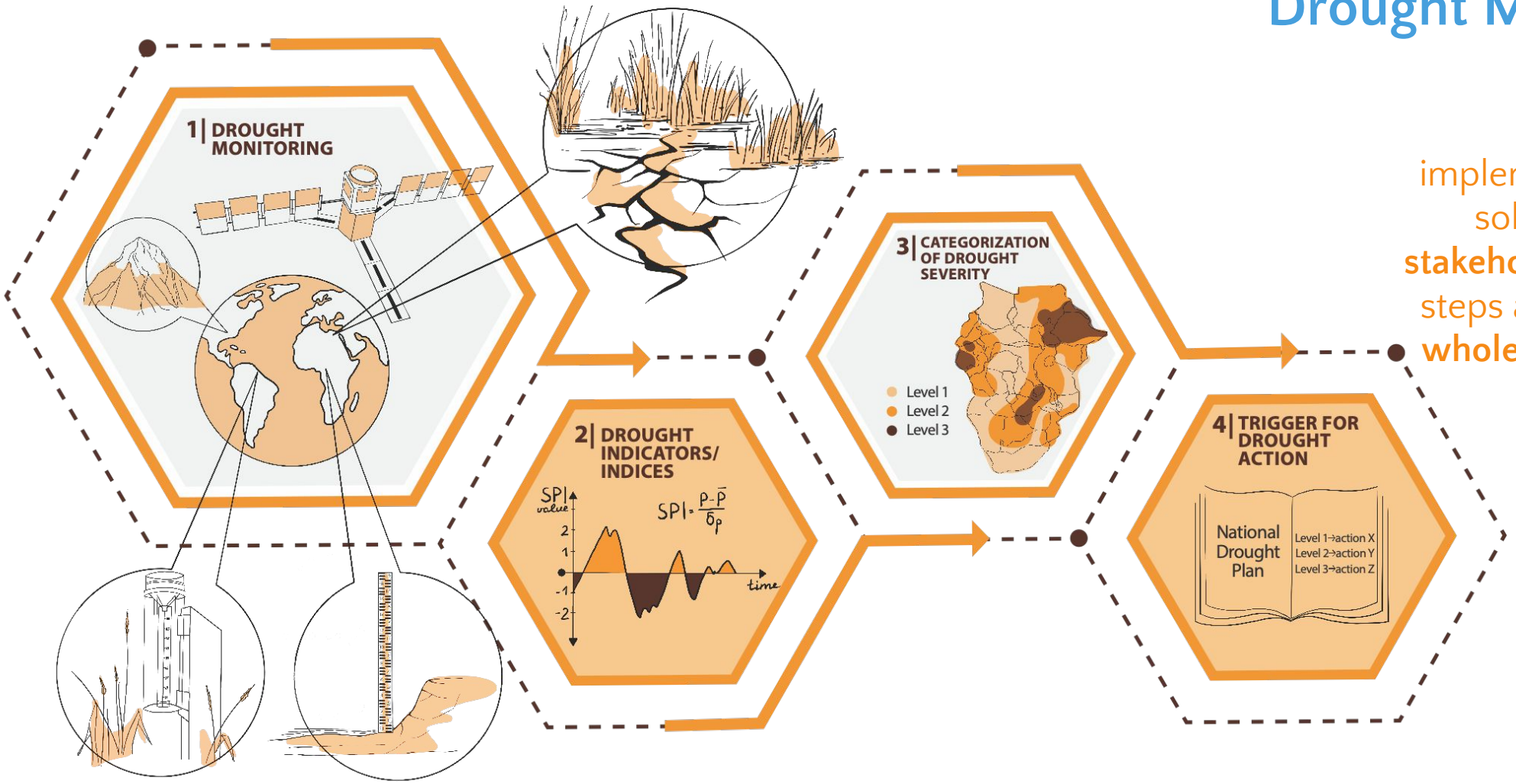
Assistance to countries on drought monitoring and early warning systems; and development of national drought plans/policies

Early Warnings for All

Continued links with donor projects and programmes on weather and climate services for agriculture

ORGANIZATION

Drought monitoring for Integrated Drought Management



The design and implementation of technical solutions is based on **stakeholder engagement** at all steps and using an inclusive **whole-of-society approach**

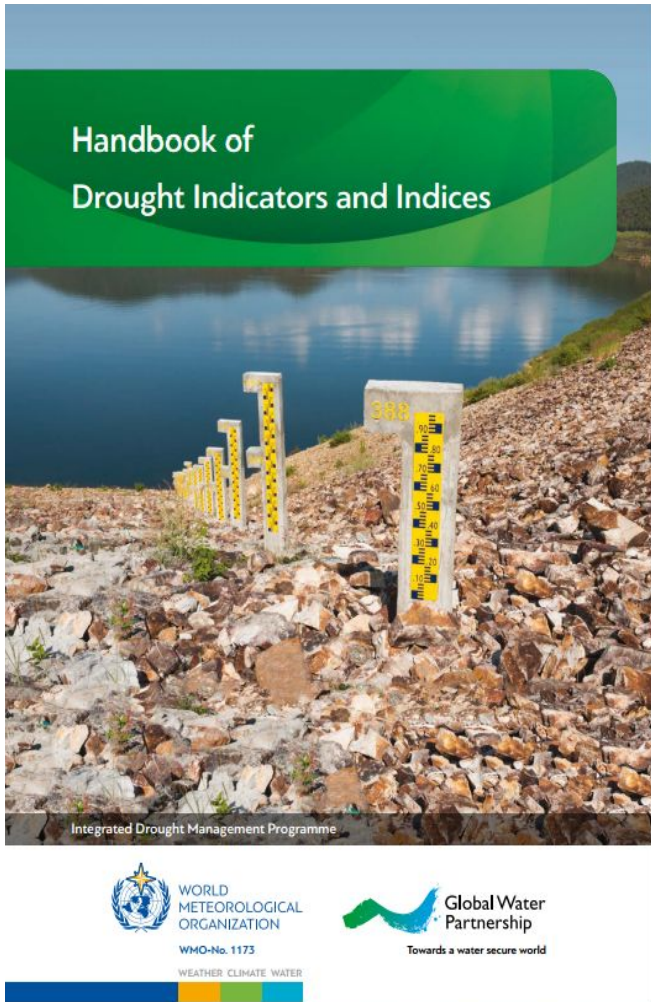
WORLD METEOROLOGICAL ORGANIZATION

INTEGRATED DROUGHT MANAGEMENT PROGRAMME

Global Water Partnership

Handbook of Drought Indicators and Indices

- Handbook is a resource to cover most commonly used drought indicators/indices
- A starting point to describe and characterize the most common indicators and indices and their applications
- Does not recommend a ”best” set of indicators and indices, given research requirements for appropriate application in location in question.



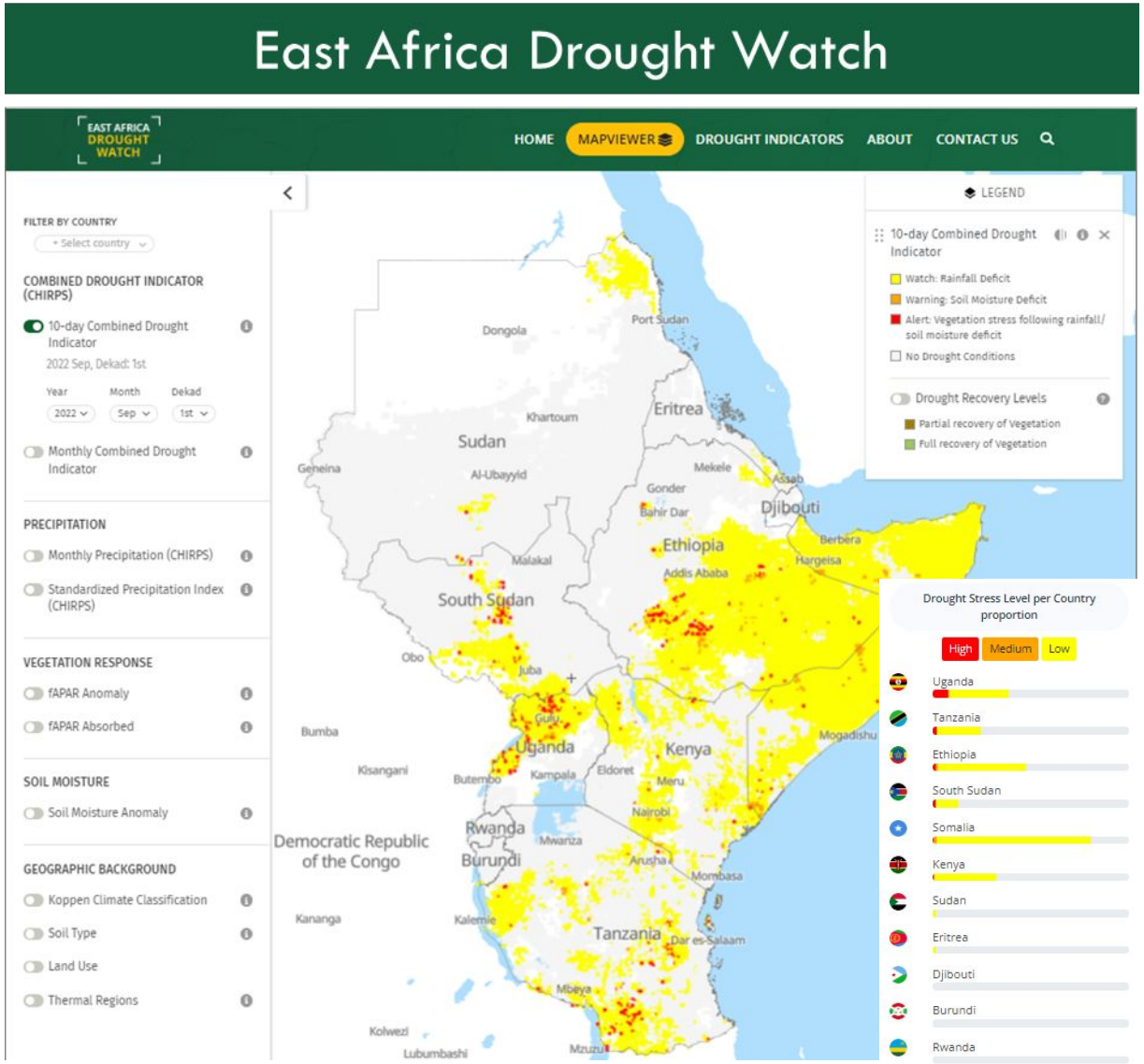
Selected Drought Indices

Meteorology	*Page*	*Ease of use*	*Input parameters*	*Additional information*
Aridity Anomaly Index (AAI)	11	Green	P, T, PET, ET	Operationally available for India
Deciles	11	Green	P	Easy to calculate; examples from Australia are useful
Keetch–Byram Drought Index (KBDI)	12	Green	P, T	Calculations are based upon the climate of the area of interest
Percent of Normal Precipitation	12	Green	P	Simple calculations
Standardized Precipitation Index (SPI)	13	Green	P	Highlighted by the World Meteorological Organization as a starting point for meteorological drought monitoring
Weighted Anomaly Standardized Precipitation (WASP)	15	Green	P, T	Uses gridded data for monitoring drought in tropical regions
Aridity Index (AI)	15	Yellow	P, T	Can also be used in climate classifications
China Z Index (CZI)	16	Yellow	P	Intended to improve upon SPI data
Crop Moisture Index (CMI)	16	Yellow	P, T	Weekly values are required
Drought Area Index (DAI)	17	Yellow	P	Gives an indication of monsoon season performance
Drought Reconnaissance Index (DRI)	18	Yellow	P, T	Monthly temperature and precipitation are required
Effective Drought Index (EDI)	18	Yellow	P	Program available through direct contact with originator

Remote sensing	Page	Ease of use	Input parameters	Additional information
Enhanced Vegetation Index (EVI)	32	Green	Sat	Does not separate drought stress from other stress
Evaporative Stress Index (ESI)	33	Green	Sat, PET	Does not have a long history as an operational product
Normalized Difference Vegetation Index (NDVI)	34	Green	Sat	Calculated for most locations
Temperature Condition Index (TCI)	34	Green	Sat	Usually found along with NDVI calculations
Vegetation Condition Index (VCI)	35	Green	Sat	Usually found along with NDVI calculations
Vegetation Drought Response Index (VegDRI)	35	Green	Sat, P, T, AWC, LC, ER	Takes into account many variables to separate drought stress from other vegetation stress
Vegetation Health Index (VHI)	36	Green	Sat	One of the first attempts to monitor drought using remotely sensed data
Water Requirement Satisfaction Index (WRSI and Geo-spatial WRSI)	36	Green	Sat, Mod, CC	Operational for many locations
Normalized Difference Water Index (NDWI) and Land Surface Water Index (LSWI)	37	Green	Sat	Produced operationally using Moderate Resolution Imaging Spectroradiometer data
Soil Adjusted Vegetation Index (SAVI)	38	Red	Sat	Not produced operationally

East Africa Drought Watch

- Public online system for drought monitoring and early warning
- **Uses Earth Observation and Weather information**
- Provides **automatic 10-day warnings** for:
  - Developing and actual drought events
  - Recovery from drought conditions
- Developed jointly by **ICPAC** and the **Joint Research Centre (JRC)** of the European Commission.
- Hosted at the IGAD Disaster Operations Centre
  - IDOC: A state-of-the-art situation room tasked with providing regional multi-hazard monitoring and early warning to improve response and disaster risk management
  - Covers 11 Eastern Africa countries; Burundi, Djibouti, Ethiopia, Eritrea, Kenya, Somalia, South Sudan, Sudan, Tanzania, Uganda



https://droughtwatch.icpac.net/

INTEGRATED DROUGHT MANAGEMENT PROGRAMME

ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

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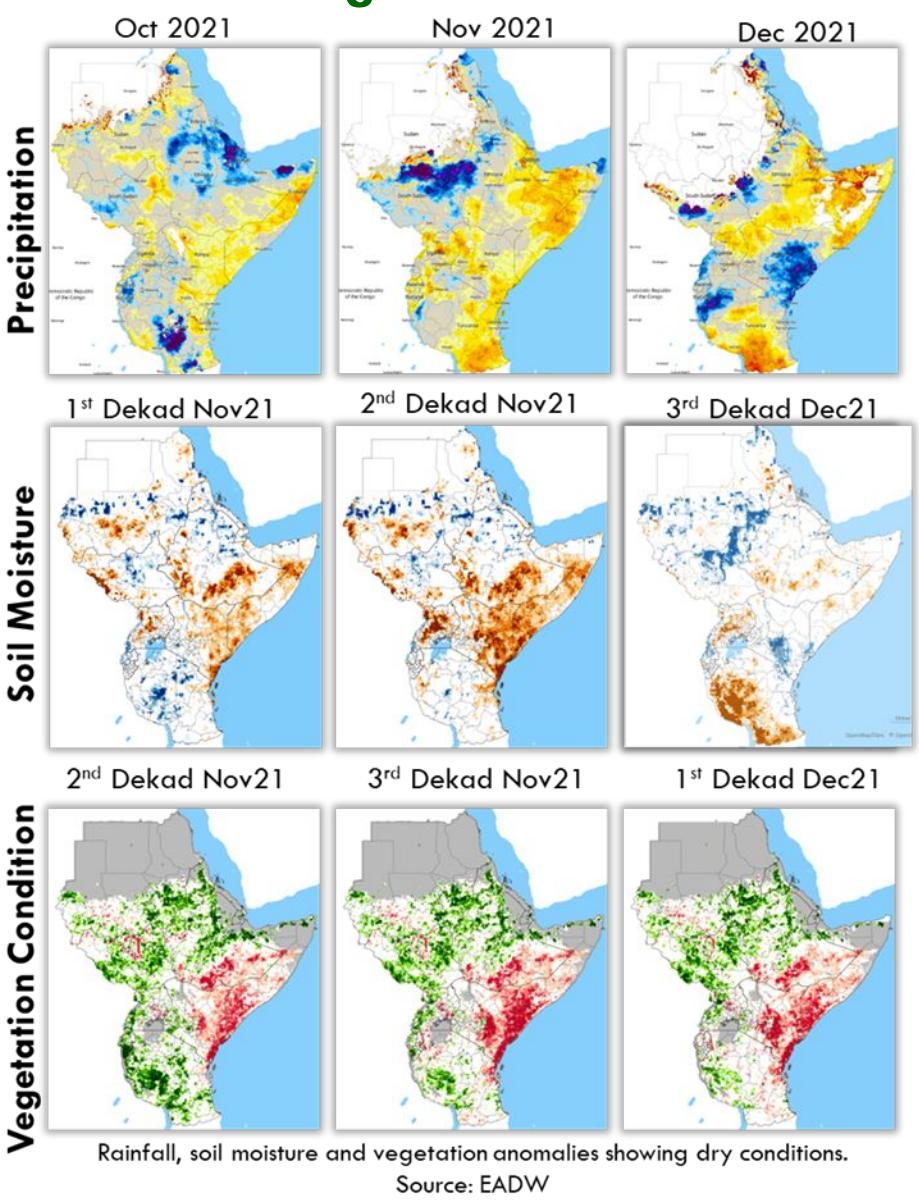
Global Water Partnership

Drought Indicators

- **Three indicators:**
  - Precipitation anomalies
  - Soil moisture anomalies
  - Vegetation anomalies
- **Standardised Precipitation Index (SPI)**
  - SPI-1, SPI-3, SPI-9/SPI-12
  - Source: CHIRPS
- **Soil moisture anomaly**
  - Source: LISFlood model
- **Vegetation anomaly**
  - Source: MODIS/VIIRs
- **Combined Drought Indicator**

  {SPI, soil moisture, vegetation anomalies}



Rainfall, soil moisture and vegetation anomalies showing dry conditions.
Source: EADW

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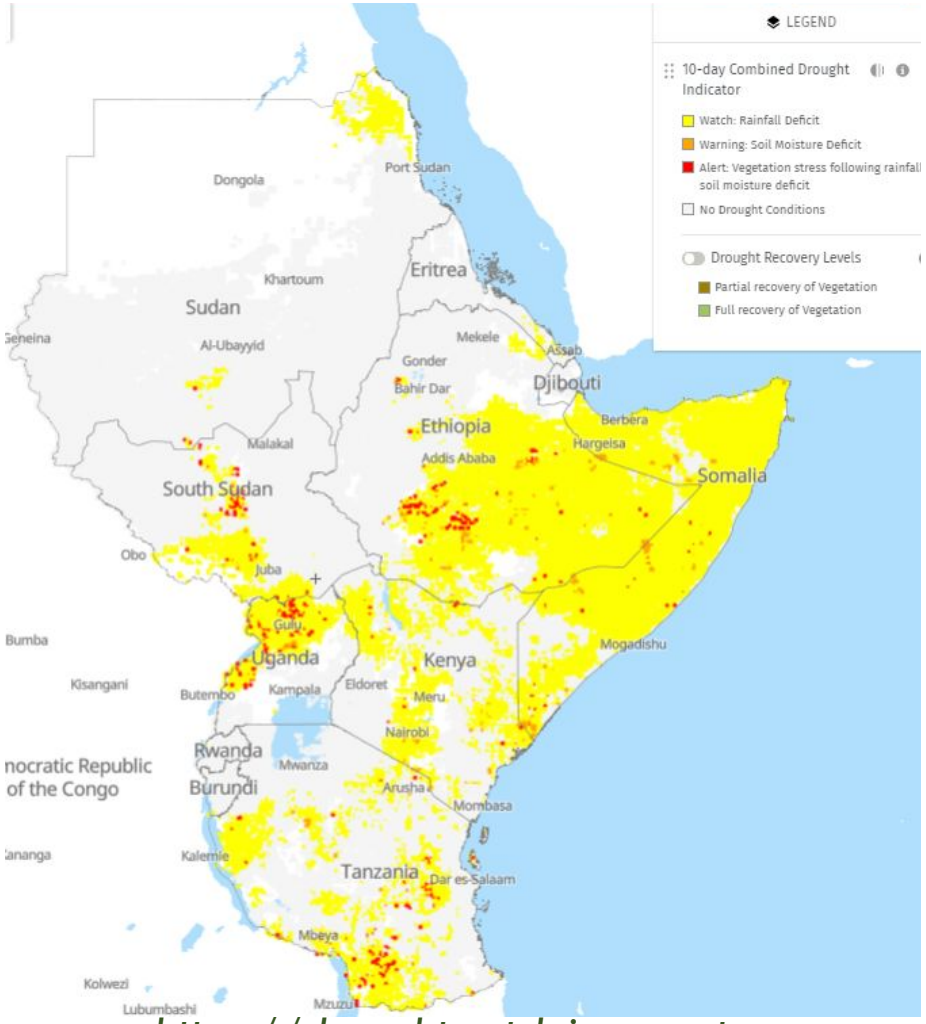
Combined Drought Indicator (CDI)

The Combined Drought Indicator (CDI) identifies areas with the potential to suffer agricultural drought, areas where the vegetation is already affected by drought conditions, and areas in the process of recovery to normal conditions after a drought episode.

Colour	Level	Classification description
	Watch	A relevant precipitation deficit is observed
	Warning	The above precipitation deficit is accompanied by soil moisture deficit
	Alert	The above two conditions are accompanied by a negative anomaly of vegetation growth
	Partial recovery	When after a drought episode, the meteorologivcal conditions are recovered to normal but the vegetation conditions are yet to recover
	Full recovery of vegetation	When after a drought episode both the meteorological and vegetation conditions have recovered to normal
	No drought conditions	



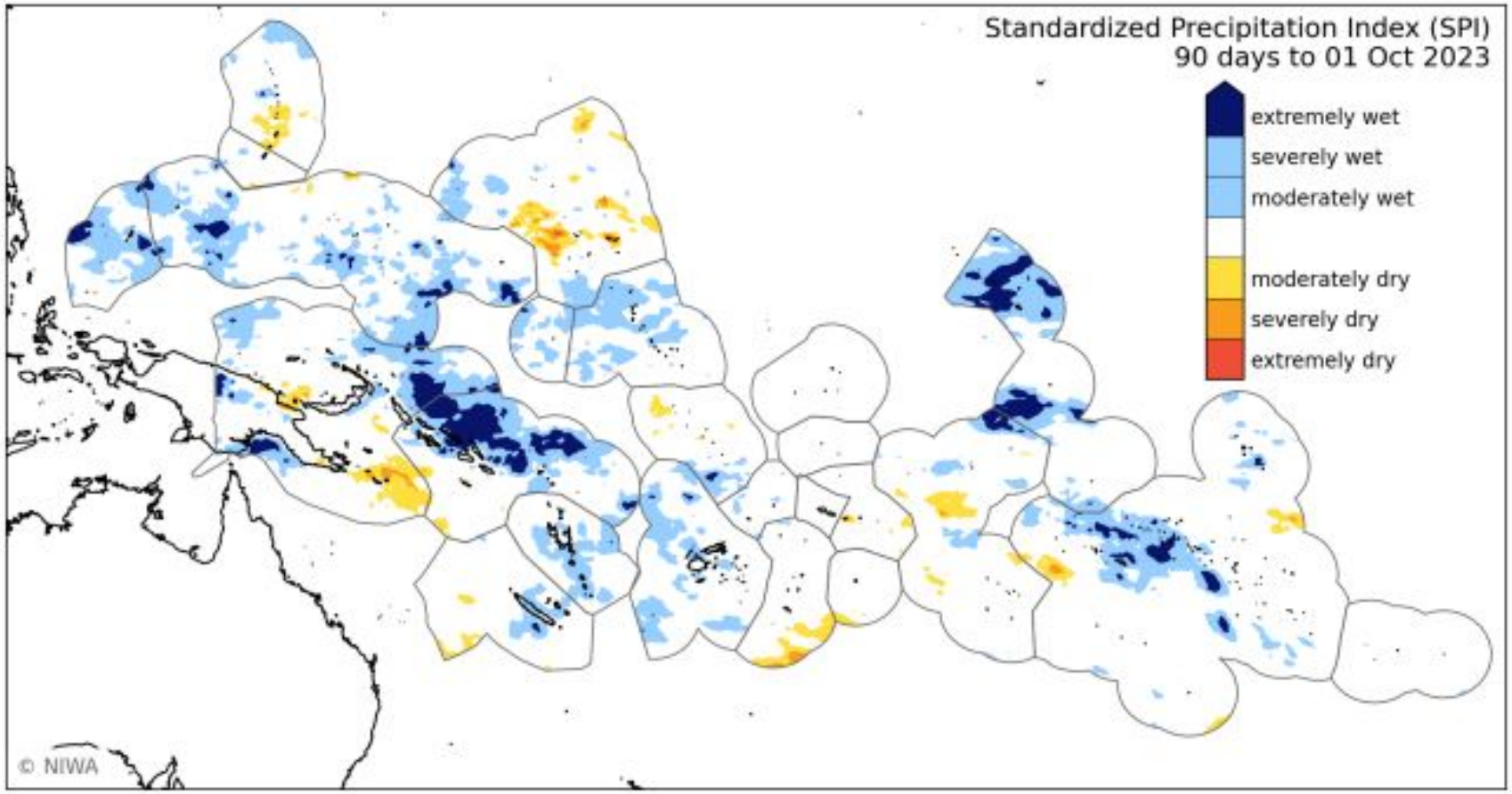
https://droughtwatch.icpac.net

SPI Regional situation summary (1 October 2023)

The Standardized Precipitation Index (SPI) thresholds for cumulative rainfall over the last 90 and 30 days are shown in the plots below.

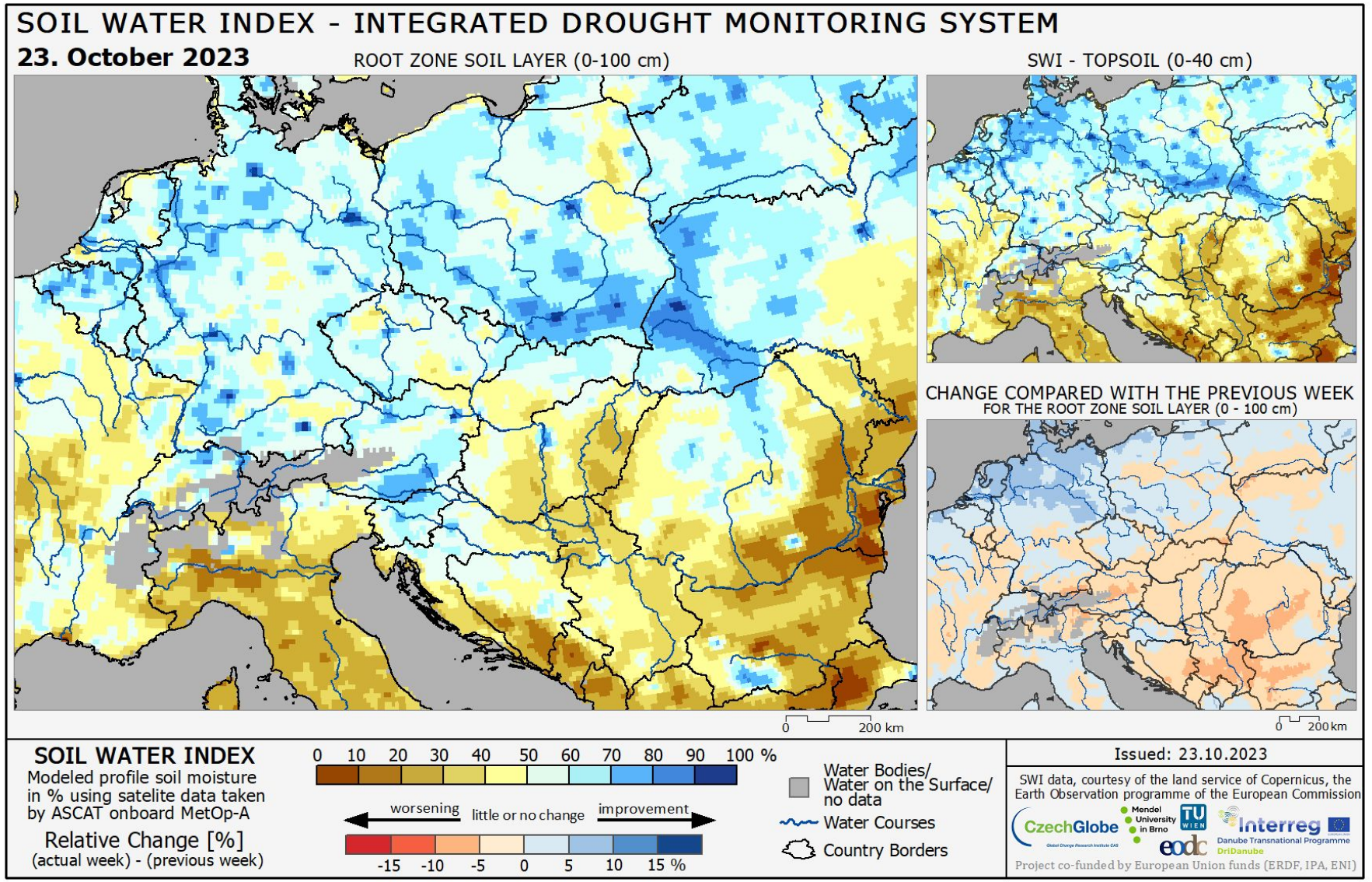
During July-September (top plot), extremely or severely dry conditions occurred in parts of Northern Marianas, the Marshall Islands, PNG, and American Samoa.

During September (bottom plot), extremely or severely dry conditions occurred in western FSM, parts of the Marshall Islands, the Solomon Islands, Wallis & Futuna, eastern Fiji, Tonga, and Niue.



Source: NIWA Island Climate Update

Central Europe



Source: Integrated Drought Monitoring System – Central Europe

Community of Practice on Agricultural Meteorology

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https://waterclimatecommunities.info/group/76/stream