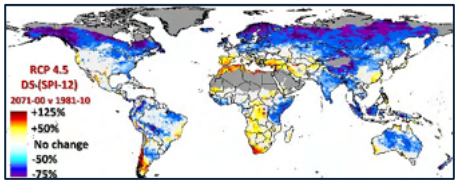
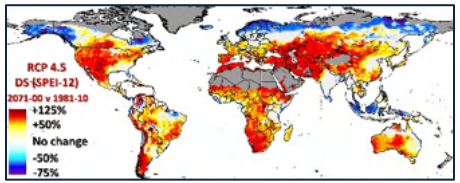

DROUGHTS
European (EDO) and Global (GDO) Drought Observatories
Drought Team- Paulo Barbosa
On-demand mapping
Rapid Mapping
Risk and Recovery Mapping
Early warning and monitoring
Floods
Fires
Droughts

Emergency Management

Gllobal Drought Observatory - Introduction

- Why? *Droughts are …*
  - Increasing in frequency and severity in many parts of the world, likely to aggravate in the future.
  - A global hazard with significant economic, societal and environmental impacts (e.g. 9 billion Euros/year in EU+UK[1]).





- What?
  - **Early warning**, **monitoring and forecasting of droughts** and their likely **impacts**, based on satellite data, hydro-meteorological modelling and in-situ observations.
  - Based on a conceptual model of drought risk

- For Whom?
  - European **Emergency Response Coordination Centre (ERCC)**
  - Global Disaster Alert and Coordination System (GDACS)
  - International aid organizations, UNCCD

1 Naumann, G., Cammalleri, C., Mentaschi, L. et al. Increased economic drought impacts in Europe with anthropogenic warming. Nat. Clim. Chang. (2021). https://doi.org/10.1038/s41558-021-01044-3

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Drought Observatory - Introduction

- Slow onset, “creeping” phenomenon
- Affects all compartments of the hydrological cycle (rainfall, soil moisture, groundwater, reservoirs, river flows)
- Impacts are non-structural, spread over large areas and long time periods (direct and indirect), affect many people, and depend on the exposure and the societal and environmental vulnerability

Agriculture

Public Water Supply

Energy Production

Waterborne Transport

Terrestrial & Freshwater Ecosystems

Forestry/ Wildfires

Tourism

Human Health

GDO Home Page

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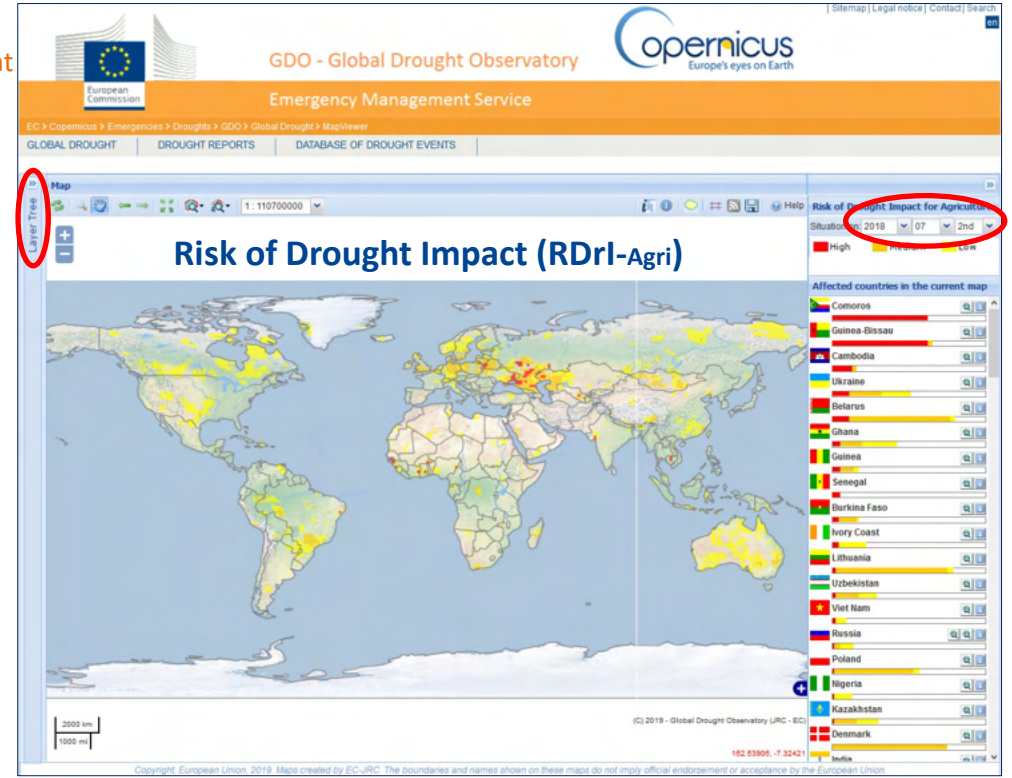

https://edo.jrc.ec.europa.eu/gdo

Hierarchical list of affected countries

The **risk of drought impact** is evaluated based on the **drought hazard, exposure** and the **vulnerability**.

Updated every 10 days

Drought Risk Concept

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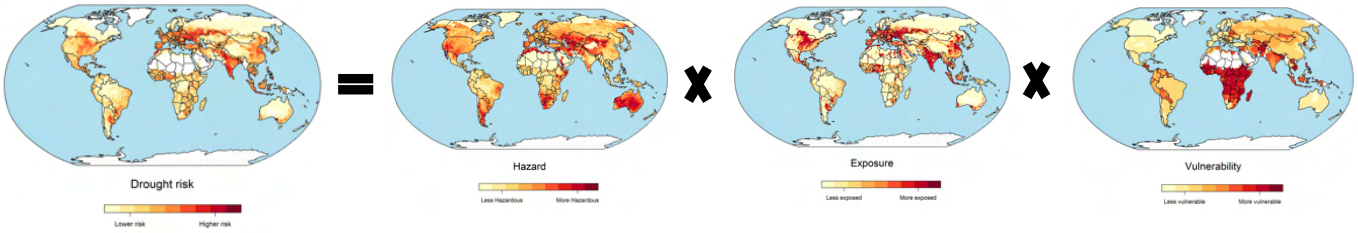
Risk = Hazard x Exposure x Vulnerability



Risk or Likelihood of drought impact

Probability of a drought event with a certain severity.

Amount of population, livelihoods, assets, resources, services potentially affected.

Susceptibility to suffer adverse effects

Sensitivity

Coping Capacity

Risk is sector specific!

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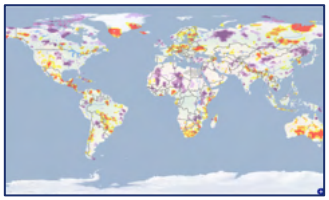
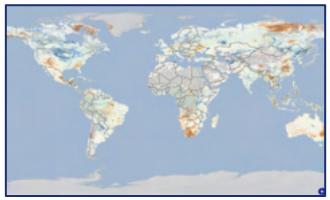
Hazard – Indicators & Conceptual Framework

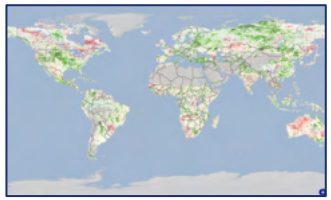
Precipitation Anomalies (SPI)

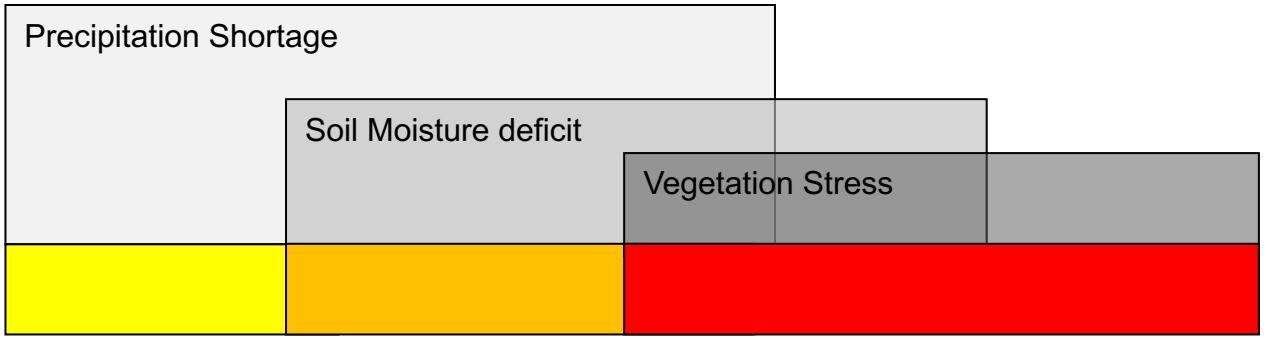


Soil Moisture Anomalies



Vegetation Anomalies (fAPAR)





6 Hazard Classes (from VL to VH)

Increasing Hazard

Time

Sepulcre et al., 2102, Nat. Hazards Earth Syst. Sci., 12, 3519–3531

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Exposure Indicators

Population:

- Number of persons per grid, 2015, 1 km; Global Human Settlements Layer (GHSL) , JRC (https://ghsl.jrc.ec.europa.eu/)

Agriculture:

- Global Agricultural Lands, 2000, 10 km; Ramankutty *et al.* 2008, FAO Aquastat
- Gridded Livestock of the World, 2010, 10 km; Gilbert *et al.* 2018

Water Stress:

- Baseline Water Stress, 2010, sub-basin; WRI Aqueduct (total freshwater withdrawal_{2010}/total $\text{renewable water resources}_{1950\text{-}2010}$)

Carrão et al., 2016, Glob. Env. Change 39, 108–124
Naumann et al., 2014, HESS 18, 1591-1604
Gilbert et al., 2018, Sci. Data 5, 180227
Ramankutty et al. 2008, Global Biogeochemical Cycles 22, GB1003

Vulnerability Indicators

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Social Factor:
Level of well-being of individuals and communities

Economic Factor:
Economic status of individuals, communities and nations

Infrastructural Factor:
Infrastructures needed to support the production of goods and sustainability of livelihoods

$$dv_i = \frac{Soc_i + Econ_i + Infr_i}{3}$$

- Rural population (% of total population), 2018; World Bank
- Refugee population (% of total population), 2018; World Bank

- Improved water source (% of rural population), 2018; World Bank
- Life expectancy at birth (years), 2018; World Bank
- Population ages 15-64 (% of total population), 2018; World Bank
- Literacy rate (% of people aged 15 and above), 2018; World Bank
- Government Effectiveness, 2013; WGI
- Disaster Prevention & Preparedness (US$/Year/capita), 2014; OECD

Proxy Indicators at Country Level

- Agriculture (% of GDP), 2018; World Bank
- Poverty headcount ratio at $1.90 a day (PPP) (% of total population), 2018; World Bank

- GDP per capita (current US$), 2018; World Bank
- Energy Consumption per Capita (kg of oil equivalent/capita), 2018; World Bank

Proxy Indicators at Subnational Level

- Agricultural irrigated land (% of total agricultural land), 2014, 10km; FAO
- Percent of retained renewable water, 2010, catchment; FAO
- Global map of Accessibility (travel time to major cities), 2015, 10km; JRC

Carrão et al., 2016, Glob. Env. Change 39, 108–124
Naumann et al., 2014, HESS 18, 1591-1604

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Risk Assessment

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Hazard

HAZARD CLASS		CDI VALUE
0	Null	0
VL	Very Low	from 1 to 2
L	Low	3
M	Medium	from 4 to 6
H	High	from 7 to 8
VH	Very High	from 9 to 10

Combinations of

- SPI-1
- SPI-3
- SM*Anomaly*
- fAPAR*Anomaly*

Exposure & Vulnerability

Definition/optimization of thresholds

Weighting and Aggregation

Risk Matrix

Carrão et al., 2016, Glob. Env. Change 39, 108–124
Naumann et al., 2014, HESS 18, 1591-1604

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Risk Assessment

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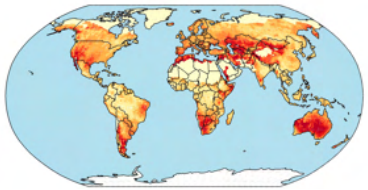
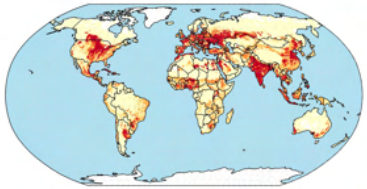
Hazard

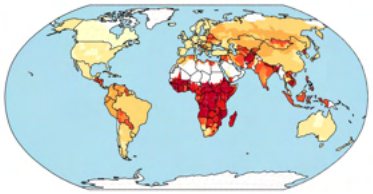


Updated every 10 days

Exposure

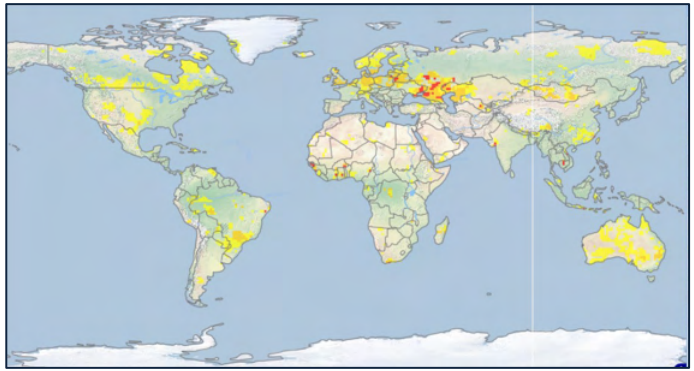


Vulnerability



Updated periodically

Dynamic Risk



Updated every 10 days

Note: Drought risk is not an absolute measure of actual economic loss or damage, but a relative statistic suitable for ranking regions and prioritize actions.

Note: While the methodology is scale-independent, the results are scale dependent (local data & relative ranking!)

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GDO Indicator Menu- Standardized Precipitation Index

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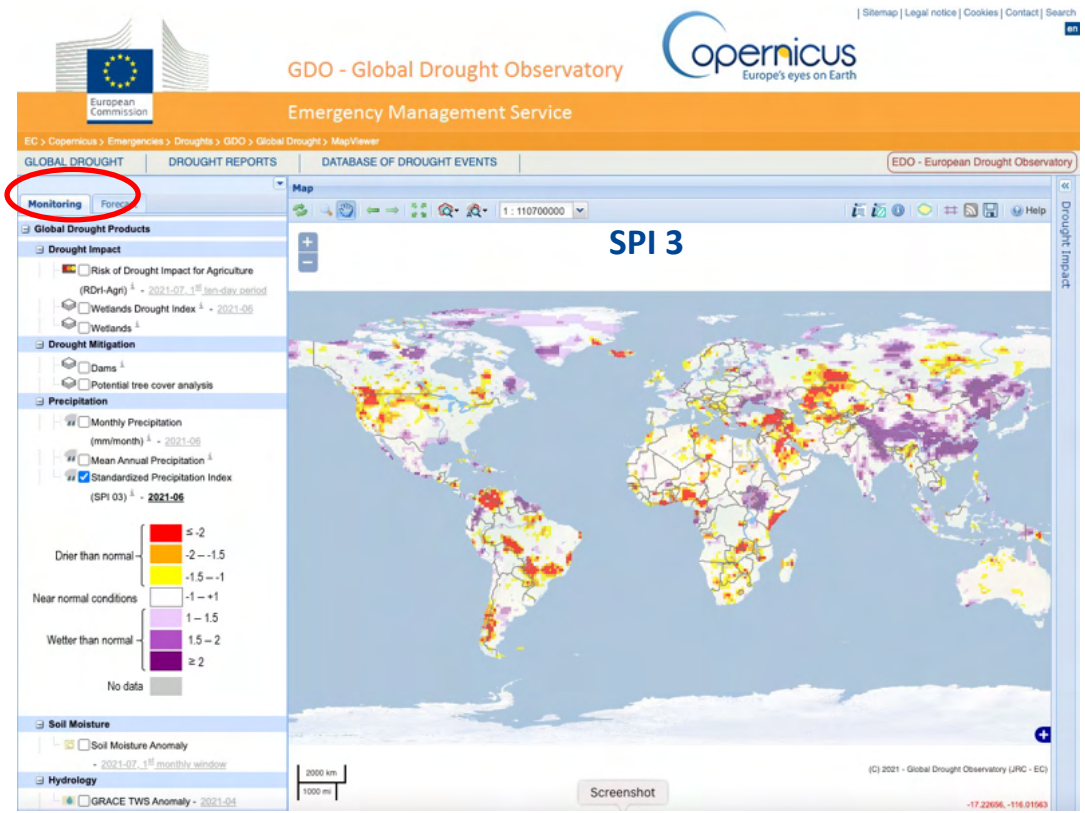
Monitoring & forecasting menu open

Access to indicators and other information layers



GDO Indicator Menu- Soil Moisture Anomaly

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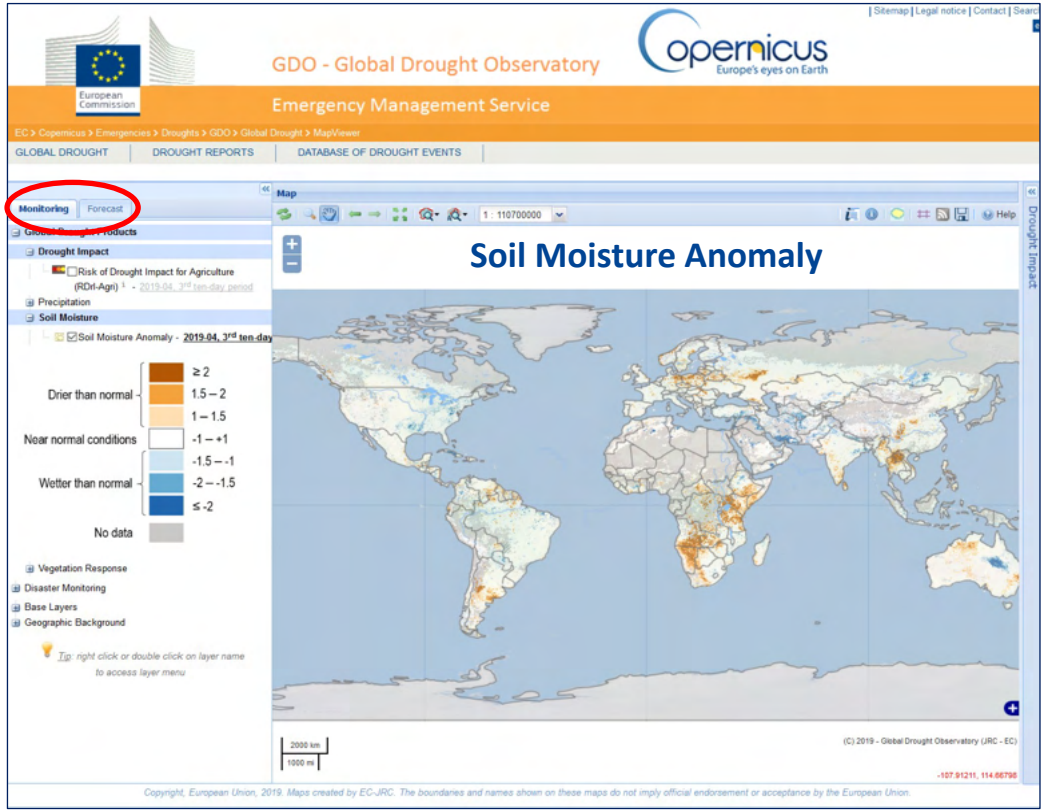
Monitoring & forecasting menu open

Access to indicators and other information layers



GDO Indicator Menu- Vegetation Anomaly

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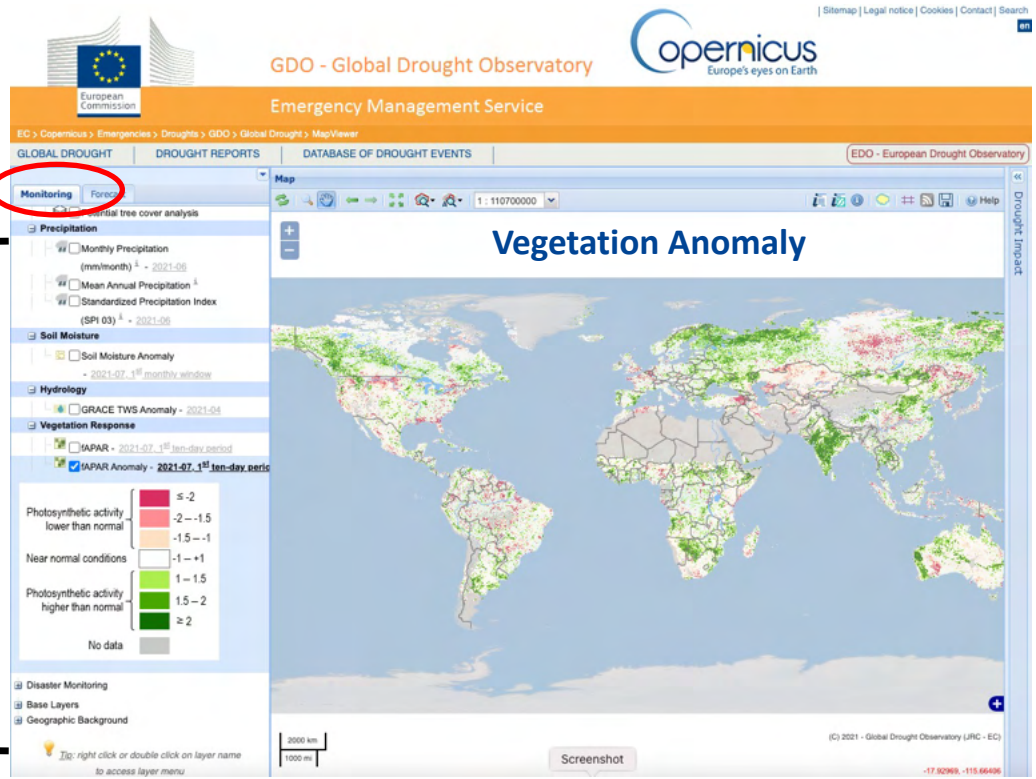
Monitoring & forecasting menu open

Access to indicators and other information layers



GDO Indicator Menu- Total Water Storage Anomaly

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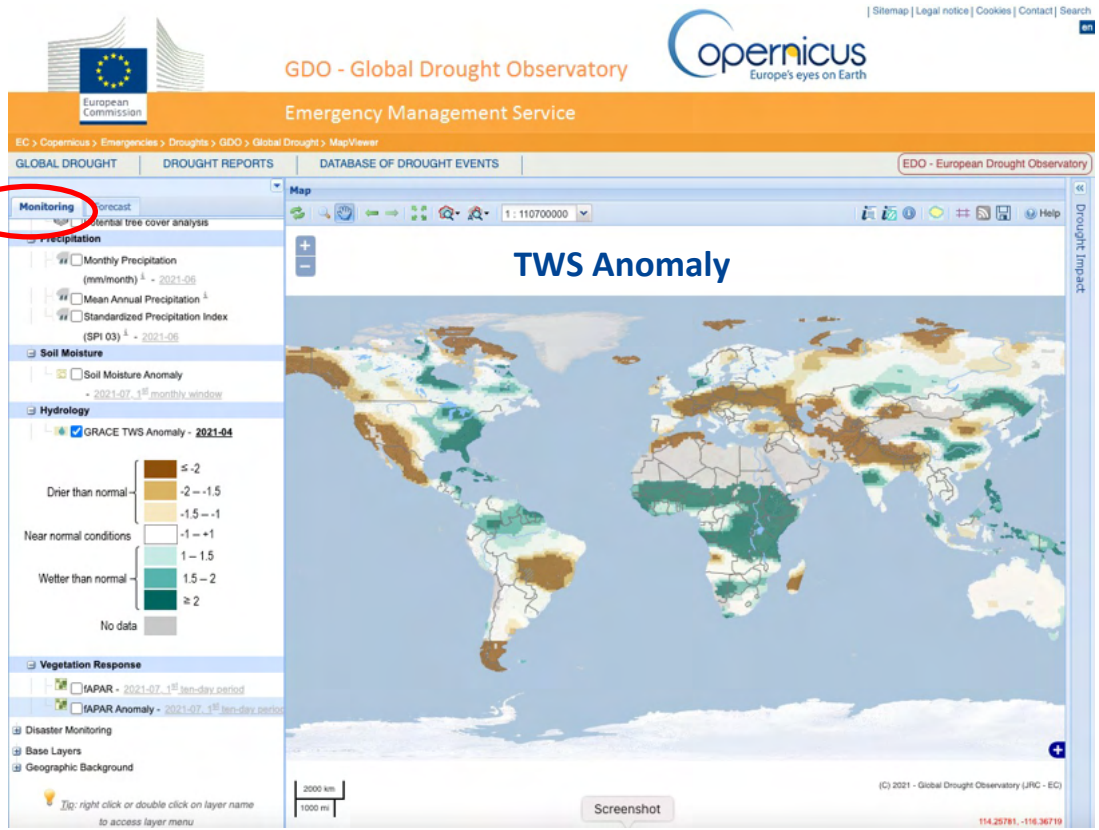
Monitoring & forecasting menu open

Access to indicators and other information layers



Cammalleri et al., 2019, Water 11(8), 1672
https://grace.jpl.nasa.gov

GRACE-FO satellite data (JPL Tellus, level 3 Release 6.0) are used to monitor Total Water Storage (TWS), as proxy of long-term (groundwater) drought.

GDO Early Warning of Extreme Wet/Dry Conditions

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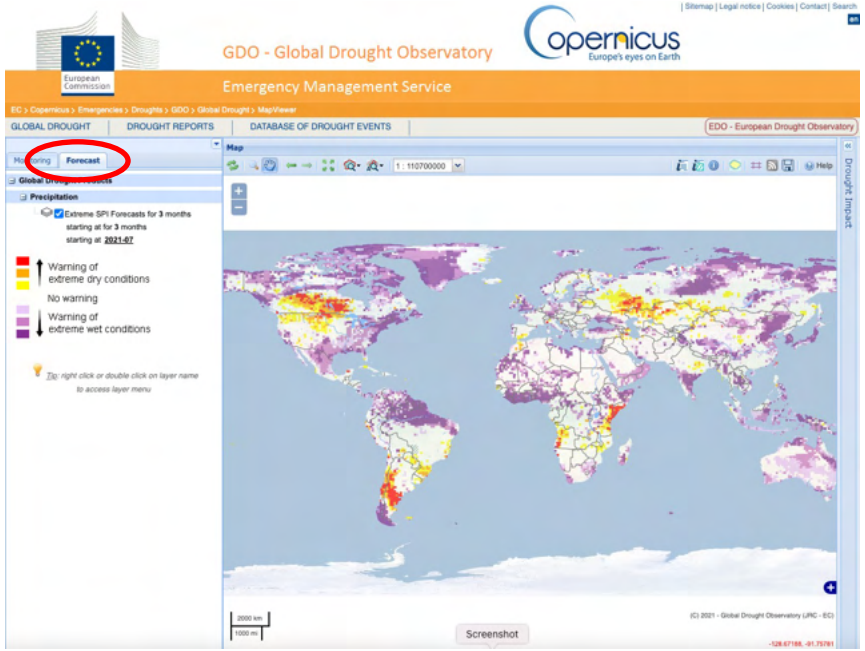
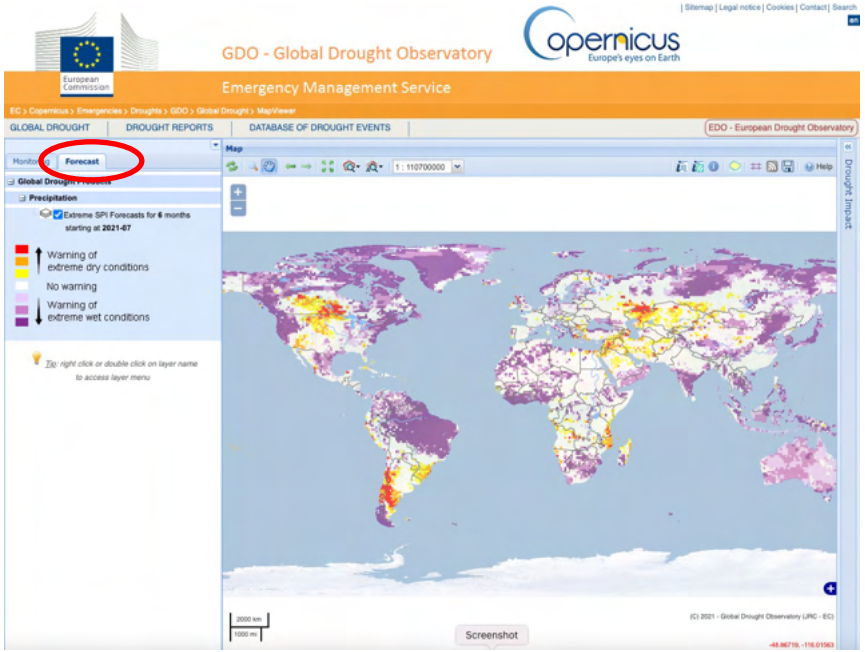
- 1-month to 6-months lead time (i.e. SPI1, SPI3 and SPI6)
- Derived from Seasonal S5 model of ECMWF



Forecast for July to September 2021



Forecast for July to December 2021

Warning levels increase with the intensity (median) and the coherency (spread) of the ensemble forecast

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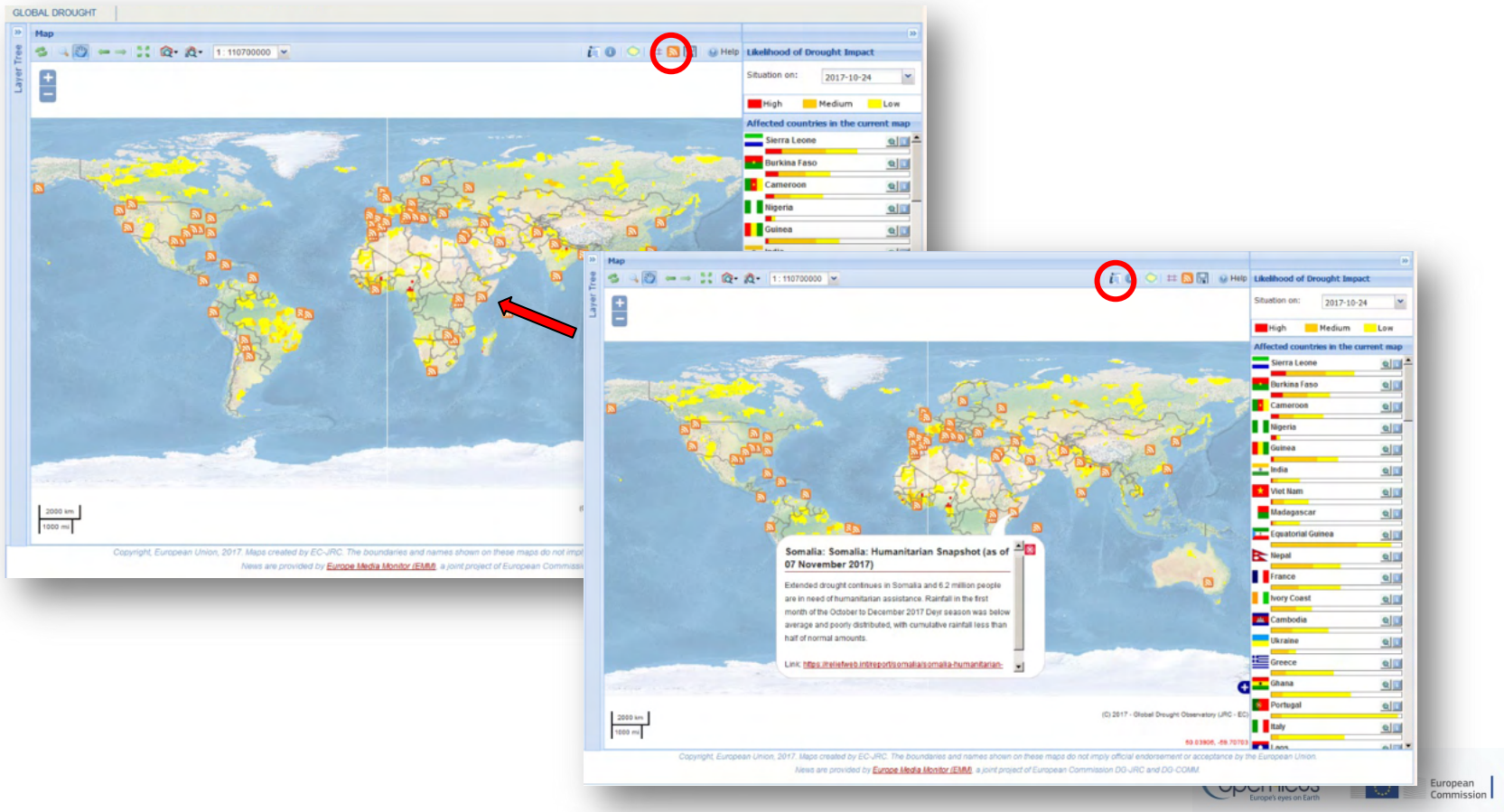
Geo-located News



Automatic Report Generation

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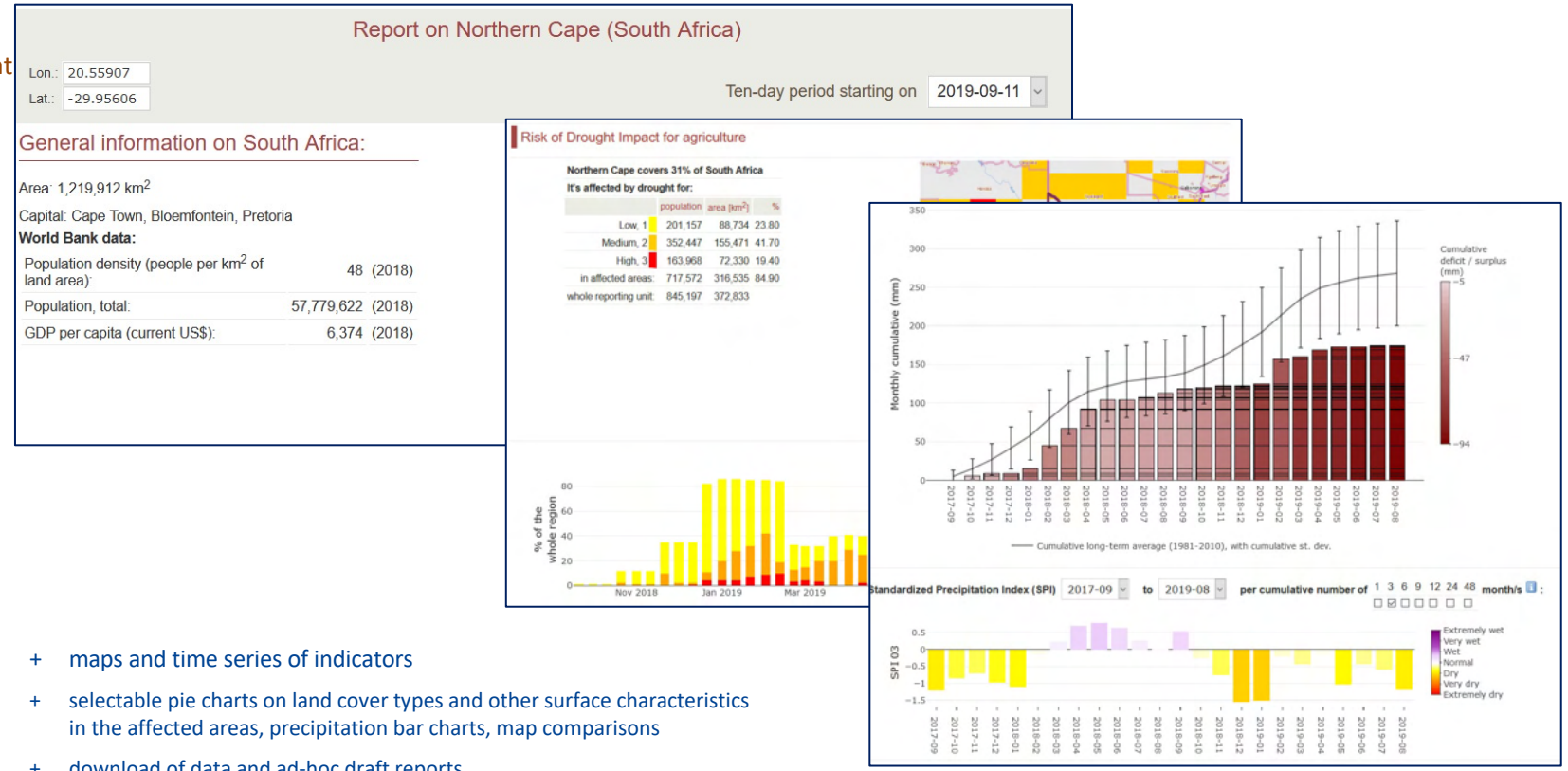

+ maps and time series of indicators
+ selectable pie charts on land cover types and other surface characteristics in the affected areas, precipitation bar charts, map comparisons
+ download of data and ad-hoc draft reports

→ Targets the ERCC duty officers and the ERCC Analytical Team

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Analytical Reports and Outreach

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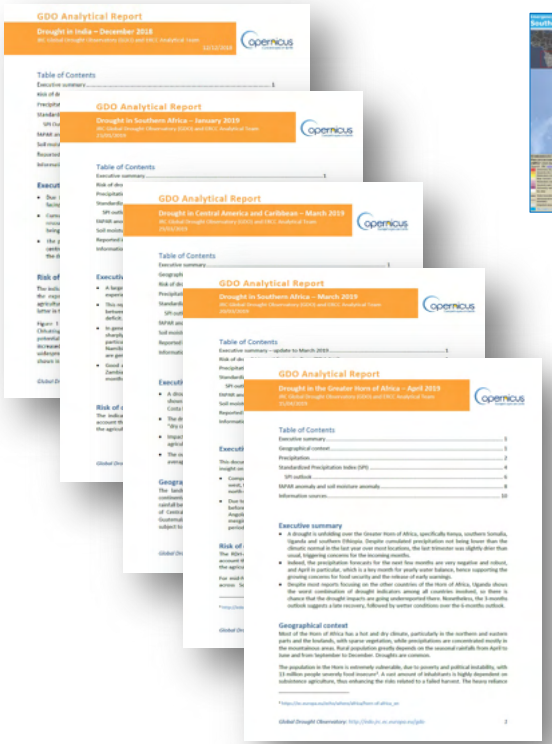
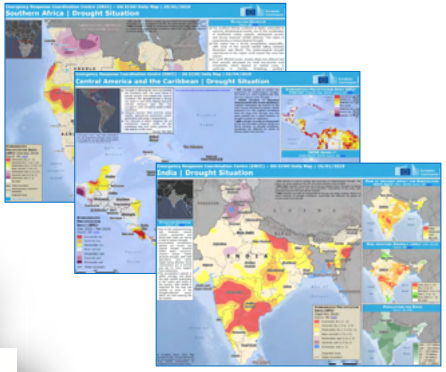
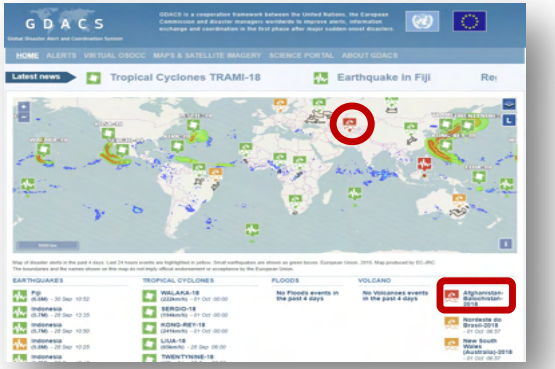


Analytical Reports

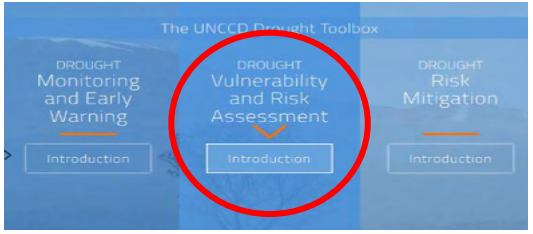


Maps



GDACS

Global Disaster Alert and Coordination System
www.gdacs.org



UNCCD Drought Toolbox

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Analytical Reports

2019

- **Southern Angola** (10-2019)
- South-East Australia (10-2019)
- Central America (09-2019)
- Southern Africa (08-2019)
- Europe (08-2019)
- Mainland South-East Asia (07-2019)
- **Sudan** (06-2019)
- **South Sudan** (06-2019)
- India (06-2019)
- **Greater Horn of Africa** (04-2019)
- **Southern Africa** (03-2019)
- Central America & Caribbean (03-2019)
- **Southern Africa** (01-2019)

2020/2021

- Europe (09-2020)
- Mainland_Southeast_Asia (08-2020)
- **Mozambique_and_neighbours** (07-2020)
- Europe (06-2020)
- Great_Chaco_and_Paraguay_basin (04-2020)
- Mainland_Southeast_Asia (03-2020)
- **Zimbabwe_Zambia_Mozambique** (02-2020)
- Brazil (06-2021)
- Iran_Afghanistan_Turkmenistan_Uzbekistan_Pakistan (05-2021)
- Syria_Iraq (04-2021)
- **Angola** (03-2021)
- Turkey (02-2021)
- **Madagascar** (01-2021)

Case Southern Africa, 2018-2019

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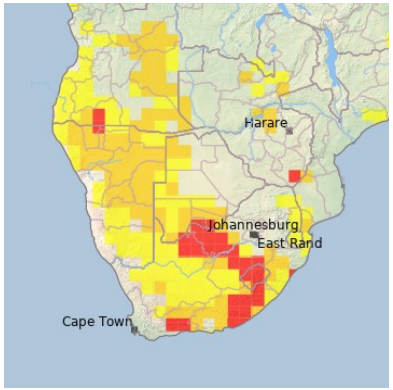
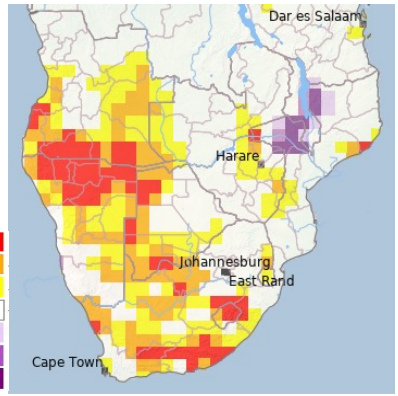
Event features and context

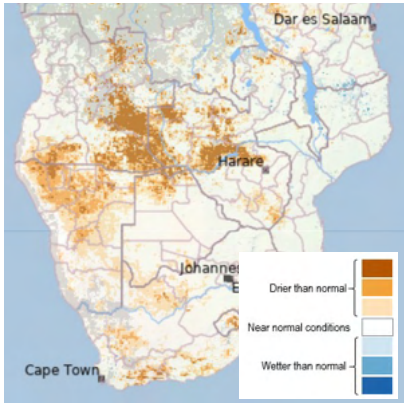
- Multiyear drought
- High precipitation seasonality
- Low-income subsistence agriculture
- Political economic instability
- Chronic malnutrition
- Heavy reliance on hydropower



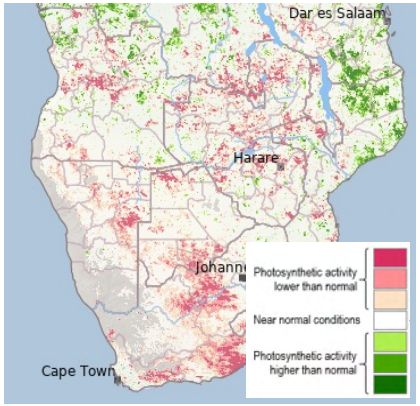
RDrI (mid February 2019)



SPI-9 (June 2018 to February 2019)



Soil Moisture Anomaly (mid Feb. 2019)



Vegetation Stress (mid February 2019)

Impacts

- Delayed sowing, reduced yields and livestock famine
- Widespread food insecurity, worsening of chronic malnutrition
- Local conflicts amongst communities for water access (and with wildlife too)
- Rise of grain and animal feed prices
- Depleted reservoirs, intermittent water supply
- Lack of clean water (risk of diseases)

GDO reports at: https://edo.jrc.ec.europa.eu/gdo/php/index.php?id=2050

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Gaps and Challenges

- Higher resolution meteorological data
- Exposure and vulnerability data of high quality and spatial resolution
- Selection and weighting of vulnerability indicators (better understand the drivers of vulnerability)
- Availability of standardized Impact data (Inclusion of an impact database)
- Adding additional sectors (e.g., public water supply, energy production)
- Link to (sub-)continental systems (e.g., US Drought Monitor, South Asian Drought Monitor)
- Transfer regionally adapted systems (e.g. ICPAC)
- Integration with other natural hazards (multi-hazard alert systems) and analysis of systemic risks
- Based on past trends and future projections analyze adaptation options

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Thank You!

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Paulo Barbosa

paulo.barbosa@ec.europa.eu

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