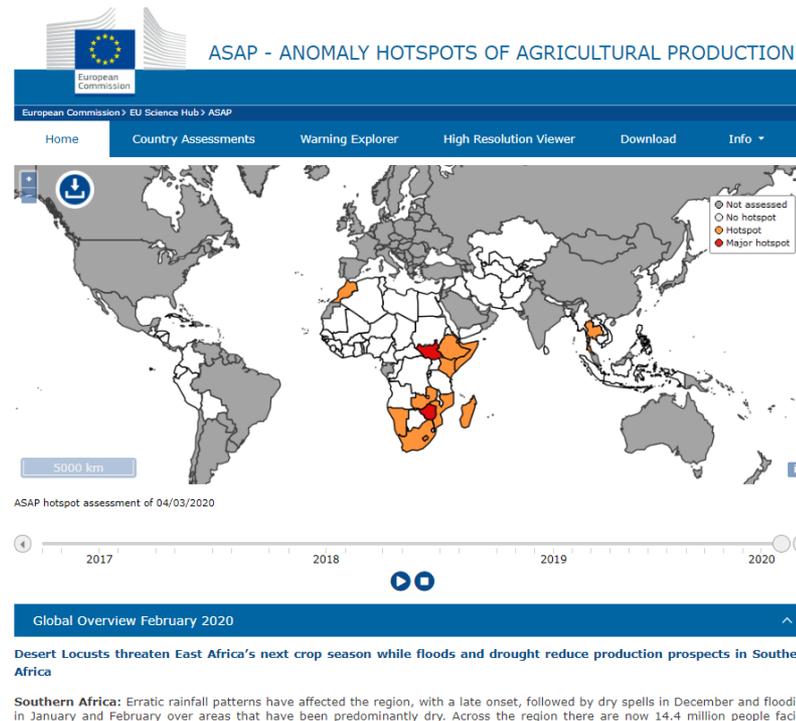


Using global remote sensing and weather data efficiently for agricultural hotspots monitoring anywhere anytime: the ASAP online system

M. Meroni, F. Rembold, F. Urbano, G. Lemoine, H. Kerdiles, A. Perez-Hoyos, G. Csak, M. Dimou, P. Vojnovic.

European Commission, Joint Research Centre, Directorate D – Sustainable Resources

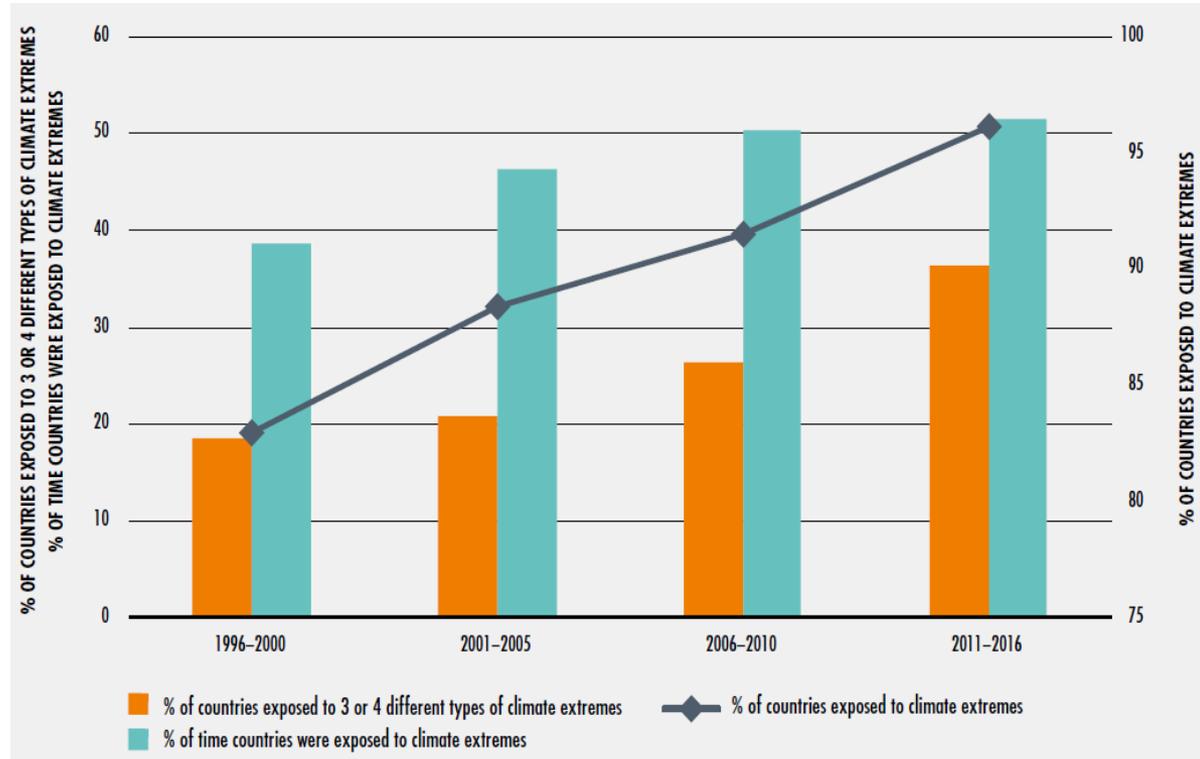


<https://mars.jrc.ec.europa.eu/asap/>



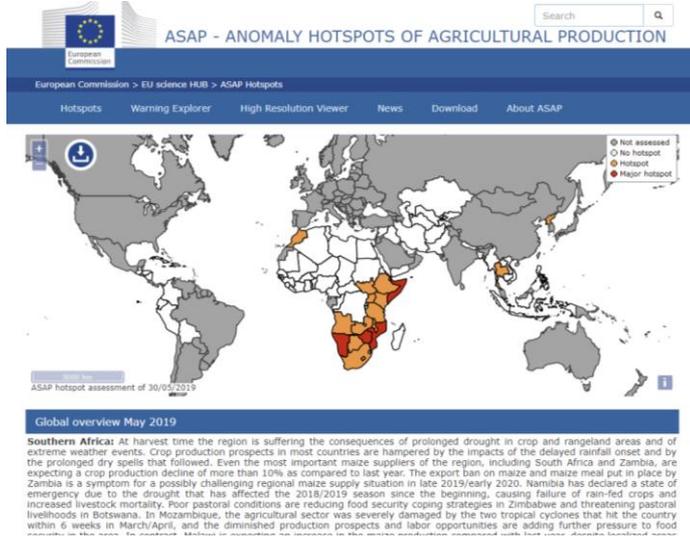
Increased exposure to more frequent and multiple types of climate extremes

- Extreme climate events remain one of the two major drivers of food crises (conflicts being the other one)

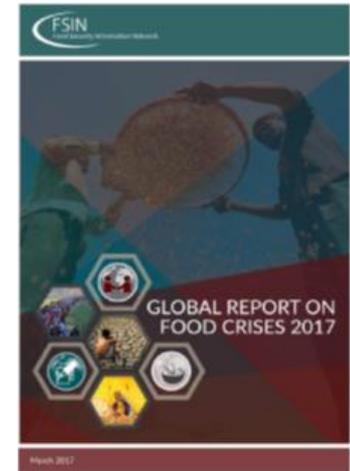


- Improved early warning information is needed for earlier food security response planning
- Out of 5 investment areas with the highest potential return for climate adaptation, Early Warning Systems are the area with the highest benefit-cost ratio (10:1, source: Global Commission on Adaptation's 2019 flagship report)  Commission I

What is ASAP?



- A free and on-line Decision Support System to further improve Early Warning of food production problems for food security assessments and contribute to existing international initiatives (GEOGLAM, IPC, Global Report on Food Crises, African Postharvest Losses Information System, etc...)



Goals:

- focus on agricultural droughts
- exploit in a coherent, continuous and timely way global Earth Observation and climate data
- go beyond anomaly maps and make available analyzed information and evidence to policy makers while at the same time providing complete information to analysts through **three integrated information platforms**



User friendly

- Working operationally since mid 2016
- 500-600 unique visits/month
- Web help and tutorials
- Newsletter
- Twitter

ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

European Commission > EU Science Hub > ASAP > Download

Home Country Assessments Warning Explorer High Resolution Viewer **Download** Info

Data Download

This section makes available data sets used or generated by the ASAP system for download. In addition to the data which can be downloaded from this page, background information on the ASAP system and methodologies used, are available for download here: [About ASAP](#) page. For access to other data sets which are part of the ASAP system, or for additional information on the data listed below, please [contact us](#). When using data downloaded from this web page, please refer to the source or to other sources possibly indicated in the data description.

HOTSPOTS AND WARNINGS

REFERENCE DATA

INDICATOR STATISTICS

Software Download

As part of its agricultural monitoring for food security activities, the JRC, in collaboration with external partners, has developed several open access desktop applications. In this section, you can download the image time series processing tool SPIRITS (Software for Processing and Interpretation of Raster Image Time Series) and the yield forecasting tool CST (CGMS Statistical Tool). SPIRITS is used for producing some of the anomaly indicators behind the ASAP warnings, whereas selected ASAP indicators can be used as yield proxies by the CST tool.

SPIRITS

CST

ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

European Commission > EU Science Hub > ASAP > Documentation

Home Country Assessments Warning Explorer High Resolution Viewer Download **Info**

Documentation material

MANUALS AND REPORTS

[ASAP warning classification scheme v 4.0](#)

This document illustrates the ASAP methodology for the automatic calculation of the warning levels at provincial level, including the model, the data used by the system, and the way it is implemented. Version 4.0.

[ASAP Water Satisfaction Index - Technical Manual of WSI version 2.0](#)

This document describes the Water Satisfaction Index model.

[Climate summary report in 2018](#)

Summary of climate variability and extremes and their main impacts on agricultural production in 2018.

VIDEO TUTORIALS

PAPERS

PRESENTATIONS

Everything can be downloaded and is fully documented

Agricultural Systems 148 (2019) 247-257

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

Remote Sensing of Environment 221 (2019) 508-521

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Remote Sensing Letters

ISSN: 2152-764X (Print) 2152-7658 (Online) journal homepage: <http://www.elsevier.com/locate/rslet>

ASAP: A new global early warning system to detect anomaly hot spots of agricultural production for food security analysis

Felix Rembold^a, Michele Meroni, Ferdinando Urbano, Gabor Csak, Hervé Kerdlies, Ana Perez-Hoyos, Guido Lemoine, Olivier Leo, Thierry Negre

Near real-time vegetation anomaly detection with MODIS NDVI: Timeliness vs. accuracy and effect of anomaly computation options

Michele Meroni^{a,*}, Dominique Fasbender^a, Felix Rembold^a, Clement Atzberger^a, Anja Kilsch^b

Evaluation of the Standardized Precipitation Index as an early predictor of seasonal vegetation production anomalies in the Sahel

Michele Meroni, Felix Rembold, Dominique Fasbender & Anton Vrieling



European Commission

Platform 1: Hotspot analysis

<https://mars.jrc.ec.europa.eu/asap/>

Global overview

ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

European Commission

European Commission > EU Science Hub > ASAP

Home Country Assessments Warning Explorer High Resolution Viewer Download Info

ASAP hotspot assessment of 04/03/2020

2017 2018 2019 2020

Global Overview February 2020

Desert Locusts threaten East Africa's next crop season while floods and drought reduce production prospects in Southern Africa

Southern Africa: Erratic rainfall patterns have affected the region, with a late onset, followed by dry spells in December and flooding in January and February over areas that have been predominantly dry. Across the region there are now 14.4 million people facing acute levels of hunger, compared to 6 million at the same time in 2018 (RELIEFWEB). The food security situation in Zimbabwe is of major concern since the country was hit by multiple stressors including drought that affected 2019/20 agricultural activities and proper crop growth, flooding that followed in some provinces, a challenging economic situation and low grain reserves. In February, heavy rainfall has triggered floods in central Matabeleland, affecting areas that were still recovering from Tropical Cyclone Idai and Kenneth.

Global Overview Archive

National overview

ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

European Commission > EU Science Hub > ASAP > Country Assessments

Home Country Assessments Warning Explorer High Resolution Viewer Download Info

Zimbabwe

Major hotspot Country News Country Map

The cumulative rainfall amounts from the start of the agricultural season in October until December, registered a decline of 35-50% below average, and although rainfall resumed in the first two dekads of January and in the first dekad of February, the rainfall deficits have severely affected the current agricultural season. The drought conditions have resulted in reduced planted area and poor crop growth, with reports of «permanent and near-permanent crop losses» (Special Report Zimbabwe GEOGLAM). Similarly, rangeland biomass conditions are below-average, and coupled with water availability challenges, pose a threat to livestock production. Moreover, Fall Armyworm is being reported «across most of the country with African Armyworm incidences reported in parts of the Midlands Province» (FEWSNET).

On top of the drought, parts of the country have experienced flooding in February, with Binga District in Matabeleland North province, and parts of Matabeleland province being affected (ReliefWeb). The critically low national maize supplies (only 100,000 tonnes of grain - RELIEFWEB) due to the poor performance of the previous agricultural season, coupled with a complex macroeconomic crisis (high inflation, cash shortages, increases in the costs of basic goods and services), are further impeding food security conditions in the country.

> Country Summary > Maps of Indicators > Land Cover & Phenology > Previous Assessments

Click on the image to enlarge

Country Summary

Warnings crop in Zimbabwe - Feb 2020 dekad 2

Warnings rangeland in Zimbabwe - Feb 2020 dekad 2

Every month based on expert analysis for 80 countries



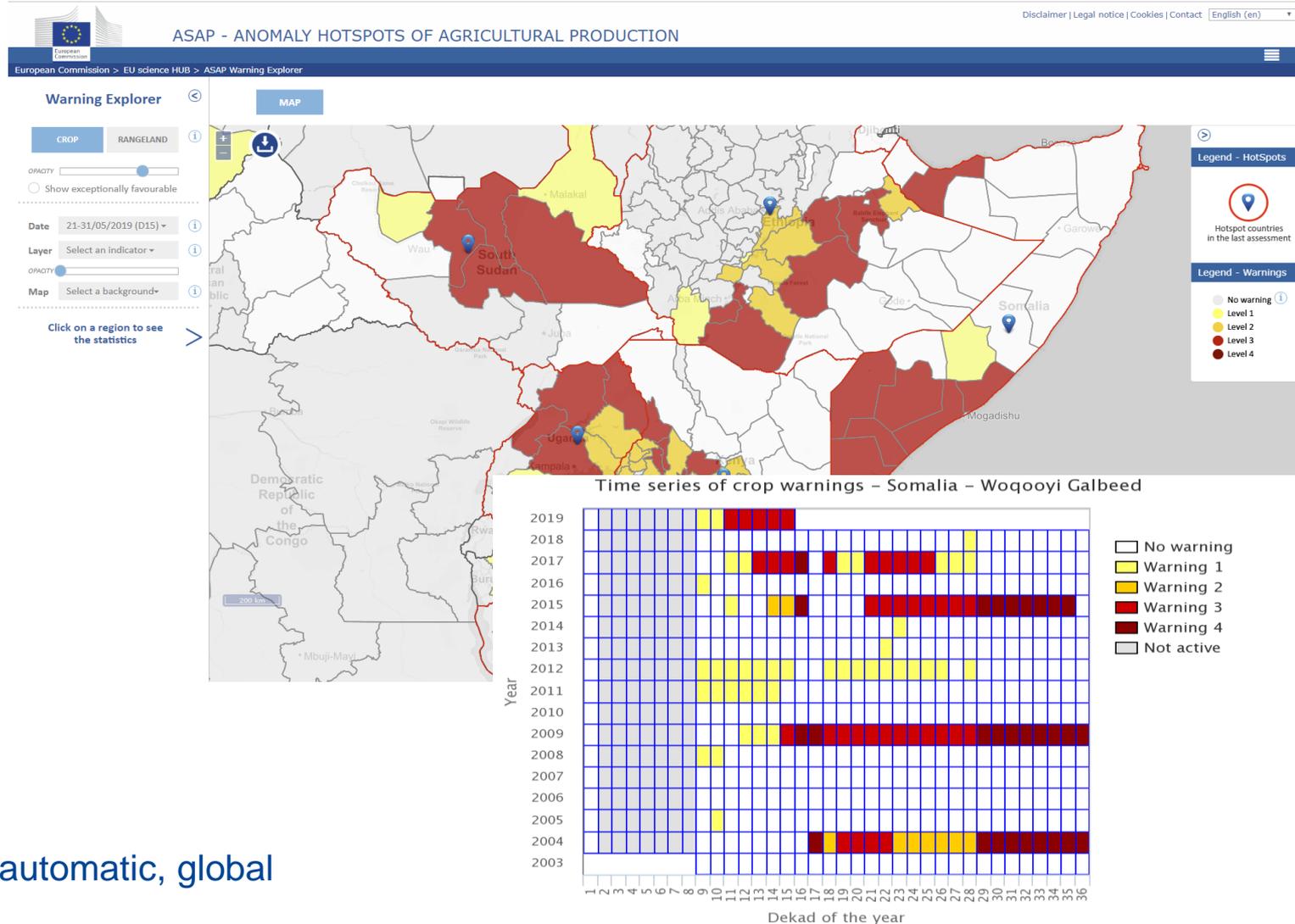
Platform 2: Warning Explorer

<https://mars.jrc.ec.europa.eu/asap/wexplorer/>

Maps and statistics for warnings and indicators (province level)

Example of automatic warning output for May 2019. Increasing level of alert from yellow (only rainfall deficit) to red (combined rainfall and NDVI anomalies).

The time series graphs shows when warnings happened since 2003

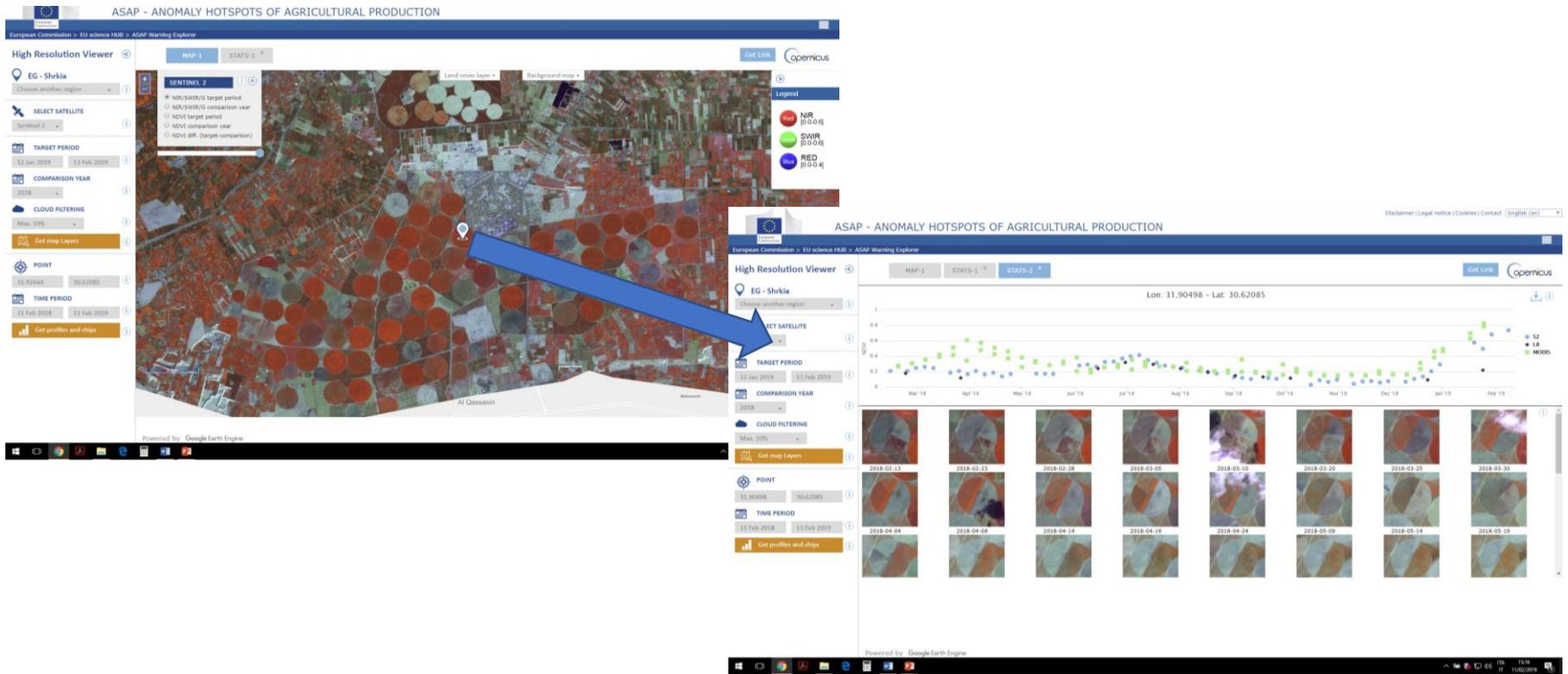


Every 10 days, fully automatic, global

Platform 3: High Resolution Viewer

<https://mars.jrc.ec.europa.eu/asap/hresolution>

A fully autonomous platform for **field level monitoring** at the global scale. Retrieves Sentinel-1/-2 and Landsat imagery quickly in a cloud computing environment and extracts time series statistics and image chips.



Powered by Google Earth Engine

New imagery every 5 days, global



What's behind? Workflows of platforms 1 and 2

Warning explorer

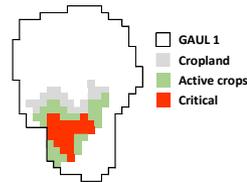
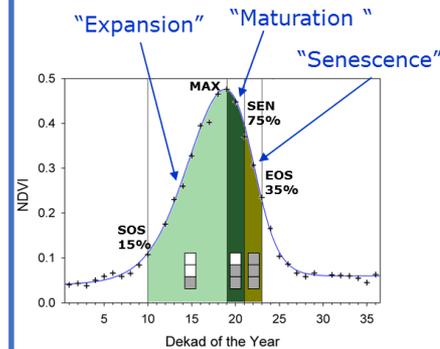
Detect active crop/rangeland season based on satellite imagery

Flag areas where precipitation, water requirement satisfaction, or biomass deficit is observed

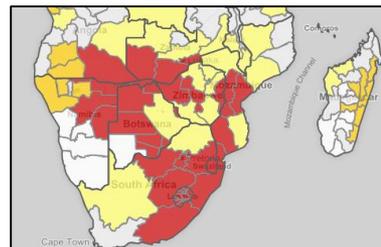
Determine area affected at sub-national admin. level

Classify type of warning

Automatic, every 10 days

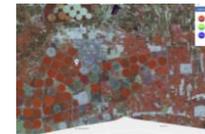


- | Level | Indicators concerned |
|-------|-----------------------------|
| 1 | Poor precipitation |
| 2 | Poor biomass |
| 3 | Poor biomass & prec. |
| 4 | Poor biomass @ end of seas. |

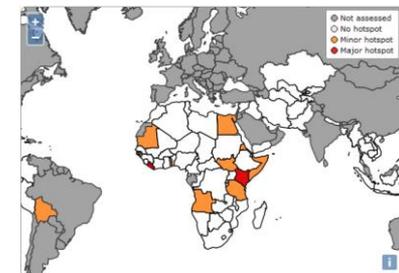


Hotspot assessment

Analyse warnings and auxiliary information and assign hotspot status at national level



online hotspots map, global overview, newsletter, JRC scientific update



Teamwork, every 30 days



Warning explorer

Detect active crop/rangeland season based on satellite imagery

Flag areas where precipitation, water requirement satisfaction, or biomass deficit is observed

Determine area affected at sub-national admin. level

Classify type of warning

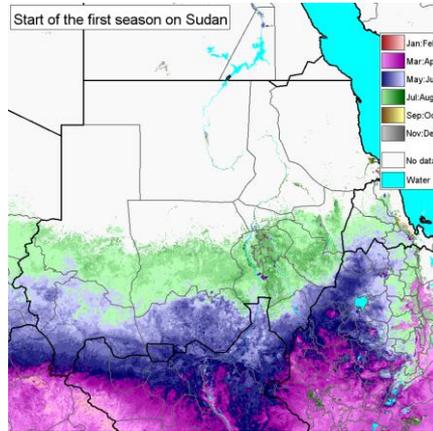
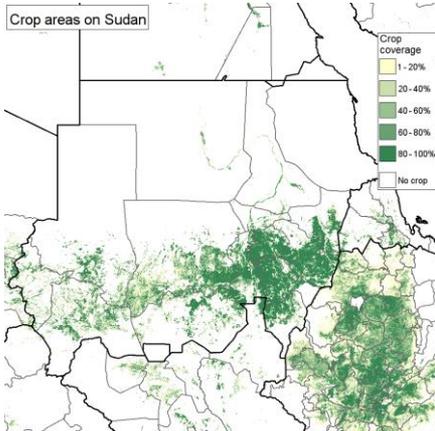
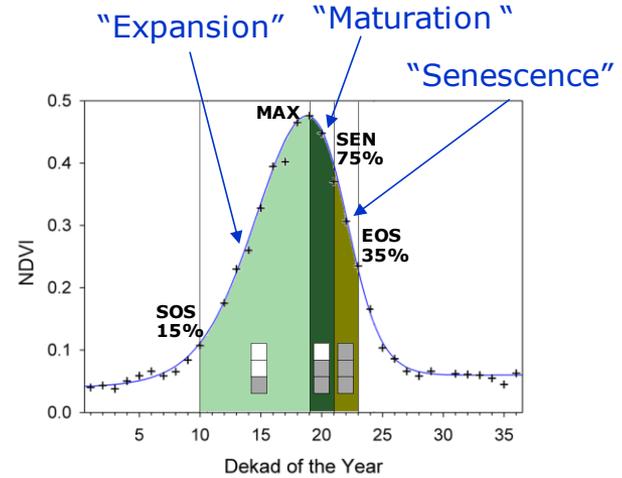
Automatic, every 10 days

Detect active crop/rangeland season

Pixel level

Based on:

- global pixel-level Land Surface Phenology retrieval on MODIS 1 km resolution
- crop and rangeland masks



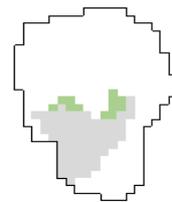
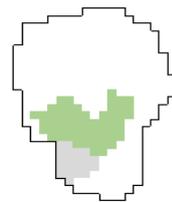
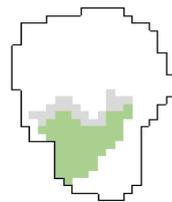
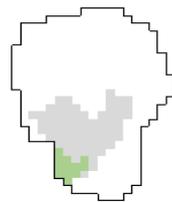
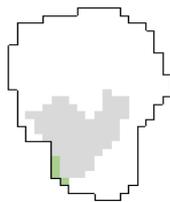
Dekad 10

Dekad 15

Dekad 20

Dekad 25

Dekad 30



GAUL 1

Cropland

Active crops

Active cropland pixels at each dekad (10-day period)



Warning explorer

Flag areas where deficit is observed

Detect active crop/rangeland season based on satellite imagery

Flag areas where precipitation, water requirement satisfaction, or biomass deficit is observed

Determine area affected at sub-national admin. level

Classify type of warning

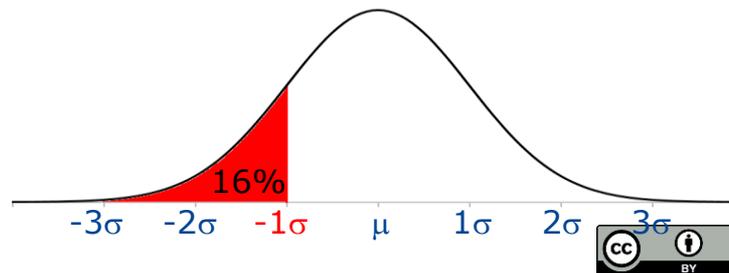
Automatic, every 10 days

Pixel level

Based on three anomaly indicators (all standardised)

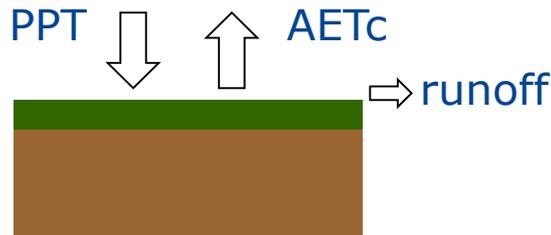
Indicator	Description	Temporal domain	Data Source
SPI3	Rainfall anomaly	Previous 3 months	CHIRPS (up to 50del Lat) 5 km, ECMWF (higher lats) 25 km
zWSI	Anomaly of Water Satisfaction Index (simple soil water balance)	From start of season	CHIRPS precipitation, ECMWF evapotranspiration, various ancillary data
zNDVIc	Anomaly of cumulative NDVI	From start of season	MODIS 1km

Flag as **critical** all pixels with standardized anomalies < -1 standard deviation



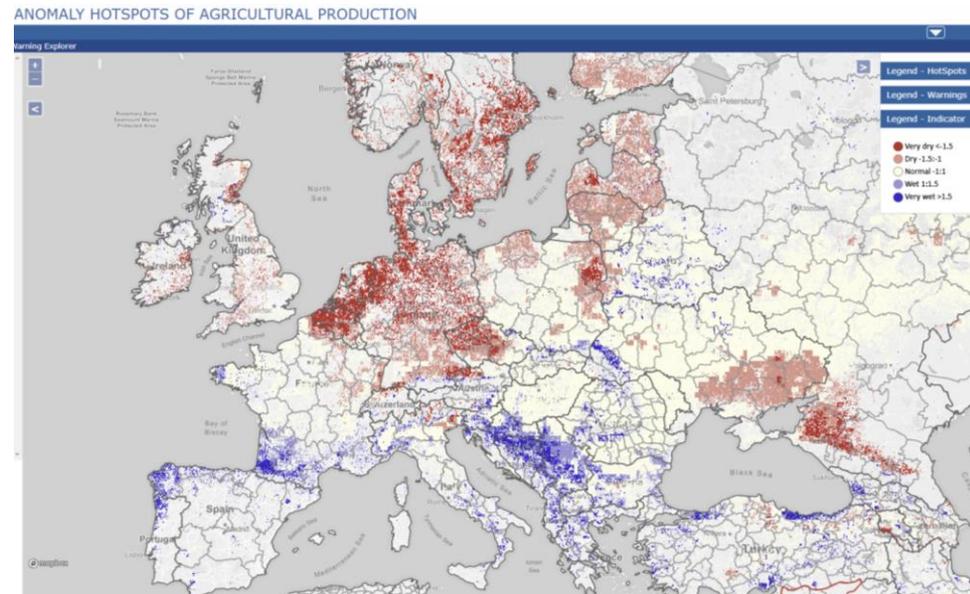
Global Water Satisfaction Index (WSI)

- Indicator of crop (or rangeland) performances based on the availability of water to the plant during the growing season
- It uses NRT precipitation (CHIRPS) and evapotranspiration (ECMWF) in a water balance accounting scheme to estimate water available to the plant



$$WSI = 100 * \frac{\sum_{i=SOS}^{EOS} AETc_i}{\sum_{i=SOS}^{EOS} PETc_i}$$

Example of the new GWSI showing the drought conditions in Northern Europe (1^o dekad of August 2018)



More detailed information in the Documentation Section of ASAP

<https://mars.jrc.ec.europa.eu/asap/documentation.php>



Warning explorer

Detect active crop/rangeland season based on satellite imagery

Flag areas where precipitation, water requirement satisfaction, or biomass deficit is observed

Determine area affected at sub-national admin. level

Classify type of warning

Automatic, every 10 days

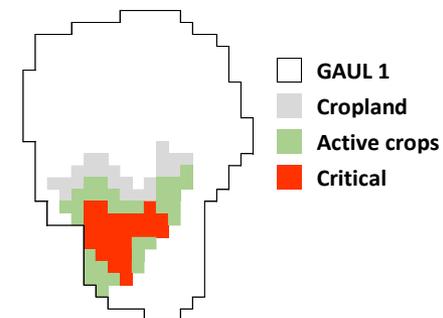
Determine area affected

Sub-national admin. Level

Retrieve the Critical Area Fraction (CAF) for each of the 3 indicators

$$CAF_x = \frac{\text{area flagged as critical for indicator } x}{\text{total area of active pixels}}$$

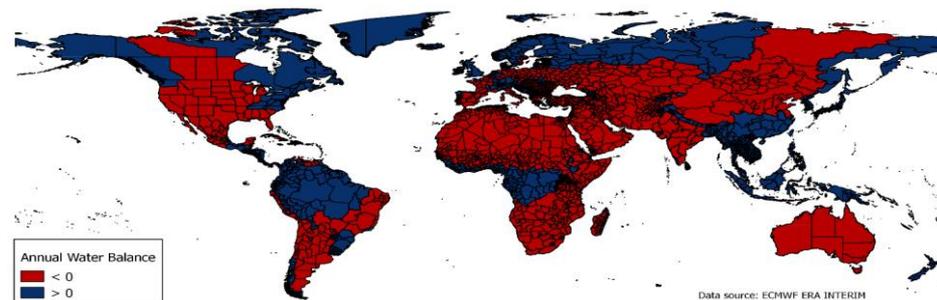
$x = \text{SPI3, zWSI, zNDVIc}$



•Any $CAF > 25\%$ will trigger a warning for that admin level

A warning is triggered only if: active crop or rangeland area is subject to a critical negative anomaly & the area concerned is relevant (>25%)

- Rainfall-based indicators contribute to warning level only for admin. areas with negative climatic water balance
- Warning levels differ for pheno stages



European Commission

Warning explorer

Classify type of warning, levels from 1 to 4

Detect active crop/rangeland season based on satellite imagery

Flag areas where precipitation, water requirement satisfaction, or biomass deficit is observed

Determine area affected at sub-national admin. level

Classify type of warning

Automatic, every 10 days

Phenological phase

Indicator with CAF > 25%		Expansion, maturation		Senescence	
--------------------------	--	-----------------------	--	------------	--

Water deficit possibly evolving into poor growth

Meteo-based	Water-balance	zWSI		● 1	-
	Rainfall		SPI3		
		zWSI	SPI3	● 1+	-

Evidence of poor growth

NDVI-based			zNDVIc	● 2	● 4
-------------------	--	--	---------------	-----	-----

Poor growth & negative prospects

Meteo & NDVI		zWSI	zNDVIc	● 3	● 4
			SPI3	zNDVIc	
		zWSI	SPI3	zNDVIc	● 3+

More detailed information in the Documentation Section of ASAP

<https://mars.jrc.ec.europa.eu/asap/documentation.php>

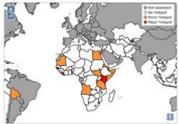


European Commission

Hotspot assessment

Analyse warnings and auxiliary information and assign hotspot status at national level

online hotspots map, global overview, newsletter, JRC scientific update

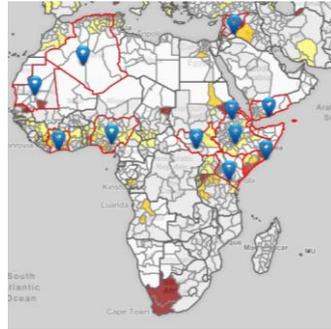


Teamwork, every 30 days

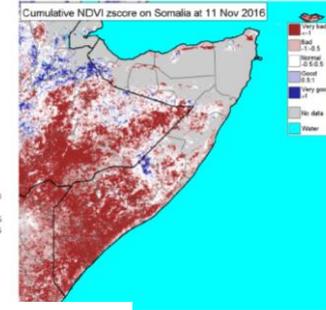
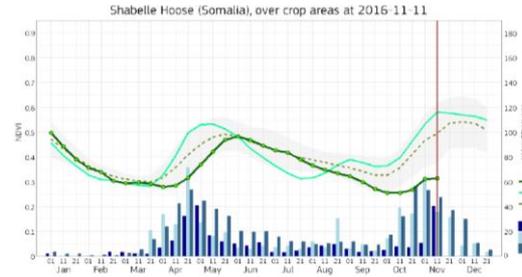
Hotspot assessment

Analyse warnings and auxiliary information and assign hotspot status at national level

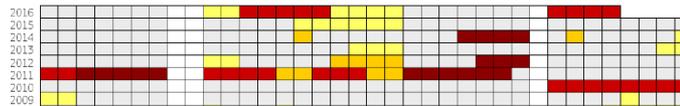
Warning Explorer



Maps and graphs



Overview of past warning levels



Local news by JRC Media Monitor tailored queries

Zoom in with high resolution satellite imagery (Sentinel-1-2, LS)



Multi scale analysis, the power of zooming in with Platform 3, the HR viewer

The warning explorer information is based on coarse resolution satellite and model information that provides rapid overview information at Gau1-2 level.

For hotspot and areas with warnings, the HR Viewer uses **Sentinel-1, -2** and **Landsat** and allows zooming in to the field level for detecting and visualizing mainly:

- Presence of active vegetation (S2 and LS) and difference with reference years (useful information about planting and performance monitoring, crop failure etc...)
- Presence of land surface changes (S1) and water surface changes (S1 and S2, useful for detecting land preparation, flooding, surface water extent, flood impact)
- Detection of land use changes (clearing, agric. encroachment into natural vegetation, implementation of infrastructure including irrigation infrastructure)
- Access to land (e.g. in areas with limited humanitarian access)



High Resolution Viewer

MAP-1

Get Link Tutorial

IT - Lazio
Choose another region

SELECT SATELLITE
Sentinel 2

SELECT LAYER
NDVI

TARGET PERIOD
05 Jan 2020 04 Feb 2020

COMPARISON YEAR
2019

CLOUD FILTERING
Max. 10%

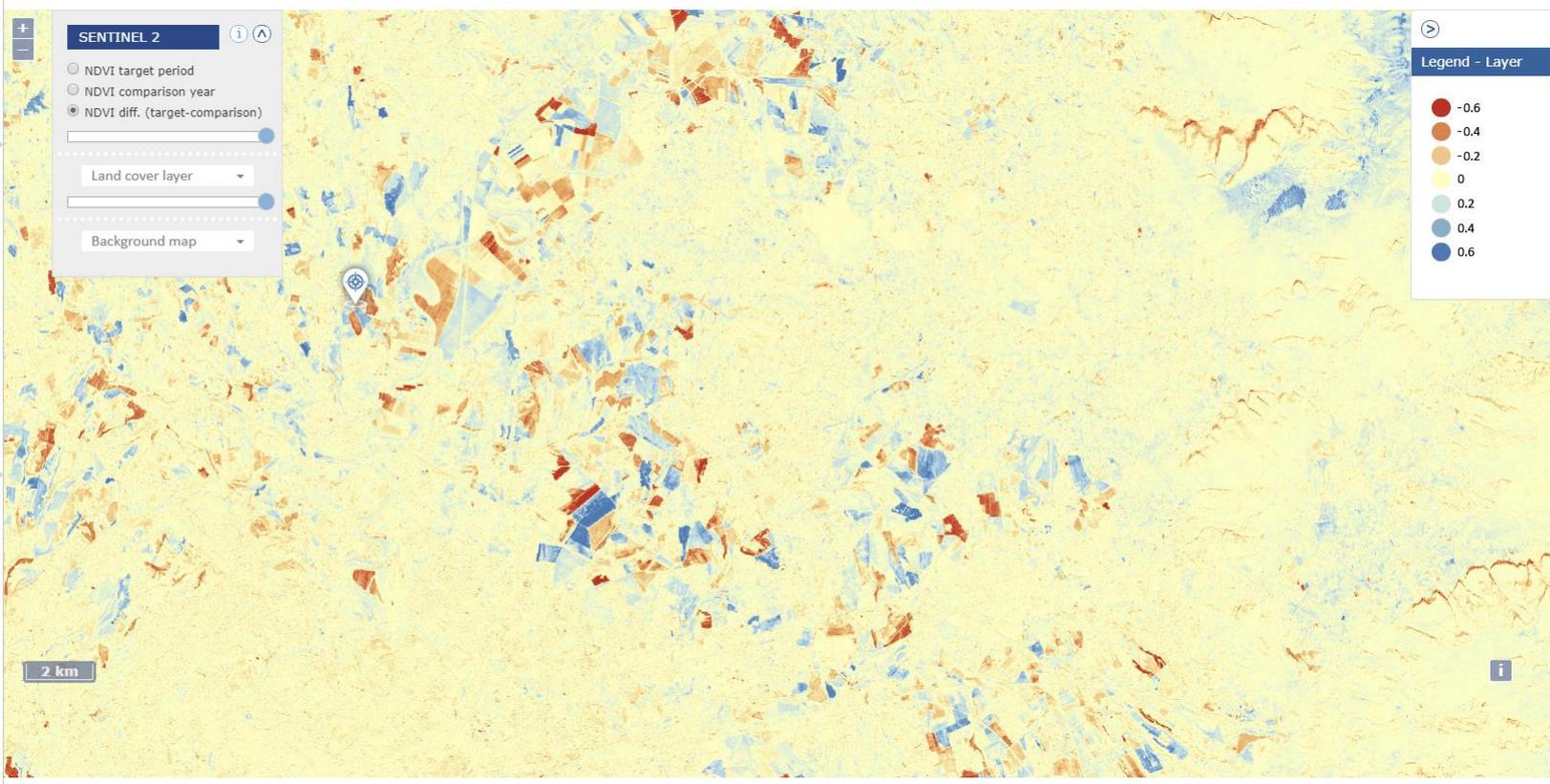
Get map Layers

POINT **AREA**

12.4923 42.0291

TIME PERIOD
04 Jan 2019 04 Feb 2020

Get stats



- Rapid online access to S1 and S2 mosaics
- Comparison with previous years
- On the fly NDVI and NDVI difference computation
- Time series profiles and image chips for points and polygons
- Area measurements polygon
- Share localization with web-link

ASAP HR viewer: zooming to the field level



ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

Disclaimer | Legal notice | Cookies | Contact | English (en)

European Commission > EU science HUB > ASAP Warning Explorer

HR explorer

EG - Shrkia
Choose another region

COMPOSITING PERIOD
05 Sep 2018 05 Oct 2018

COMPARISON YEAR
Select a year

BAND COMPOSITION
NIR/R/G

Get map Layers

POINT
31.72714 30.73313

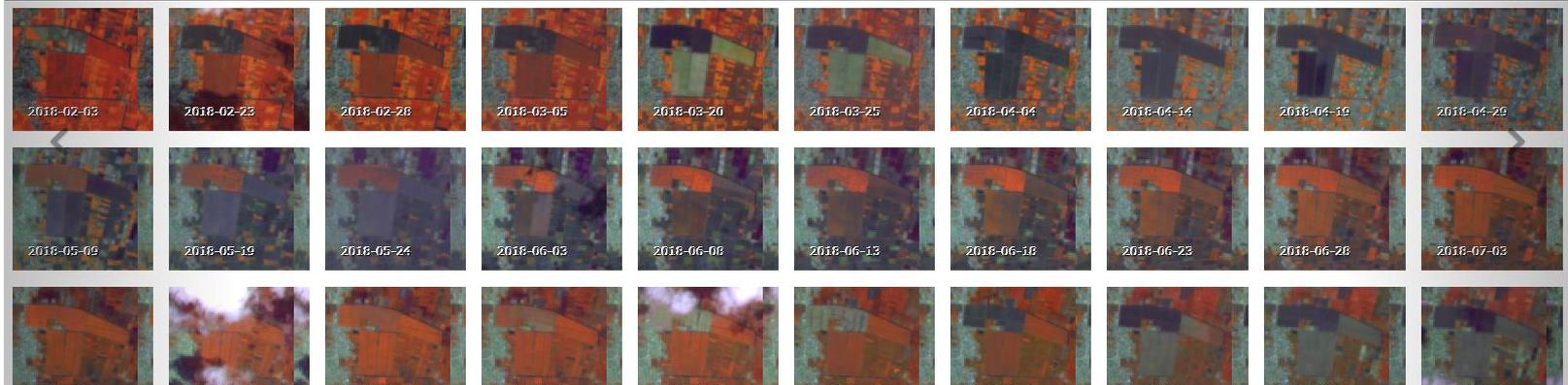
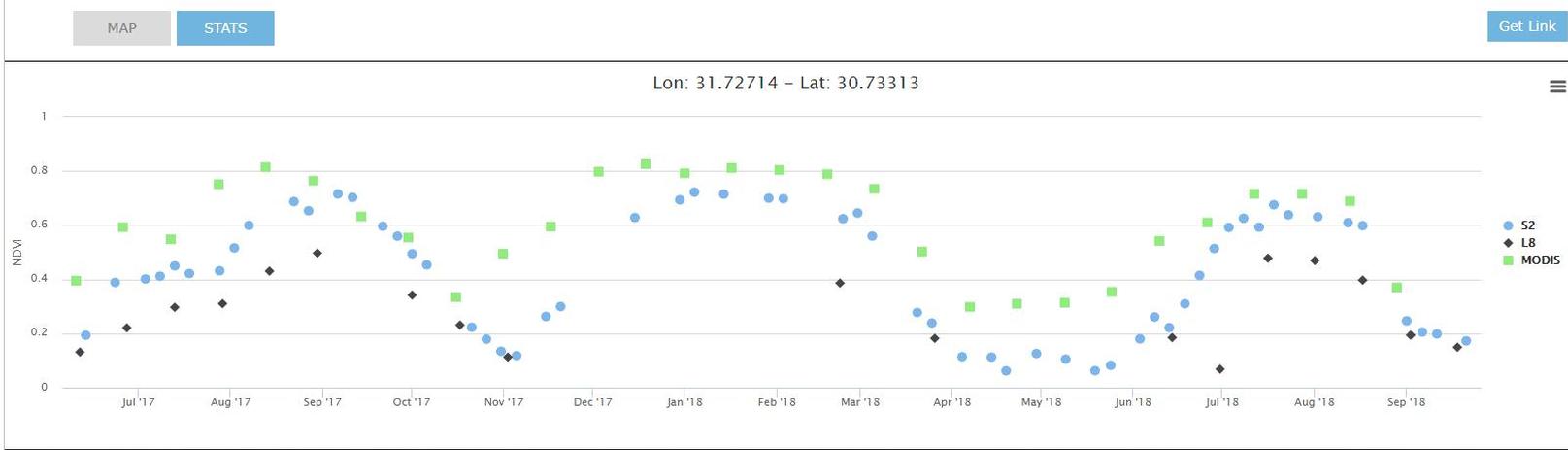
Window 1x1

TIME PERIOD
05 Jun 2017 05 Oct 2018

Get NDVI TS

Chip size

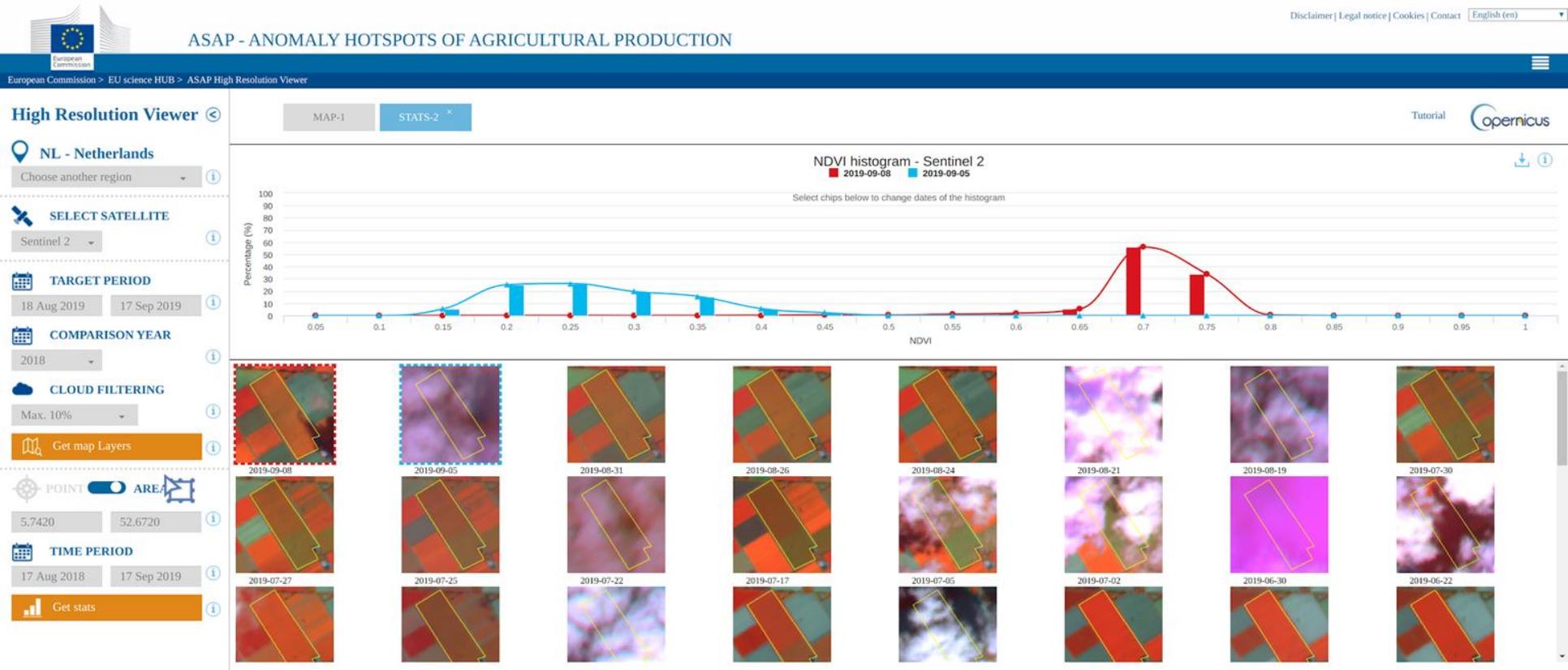
Get Chips



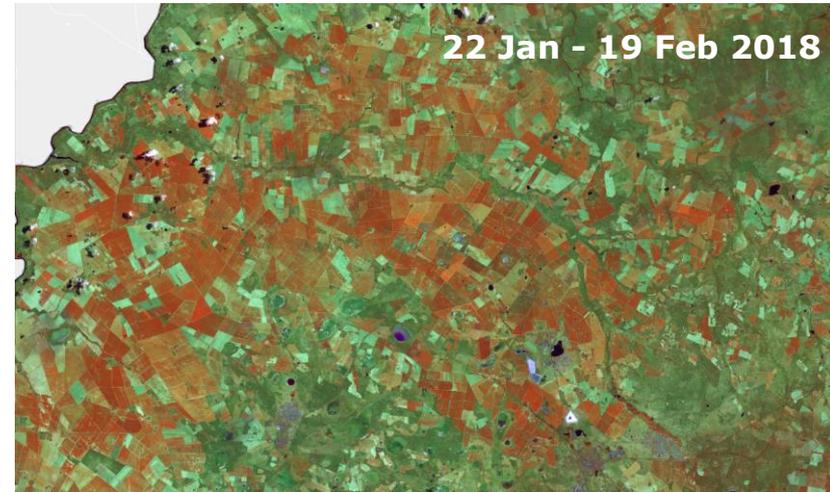
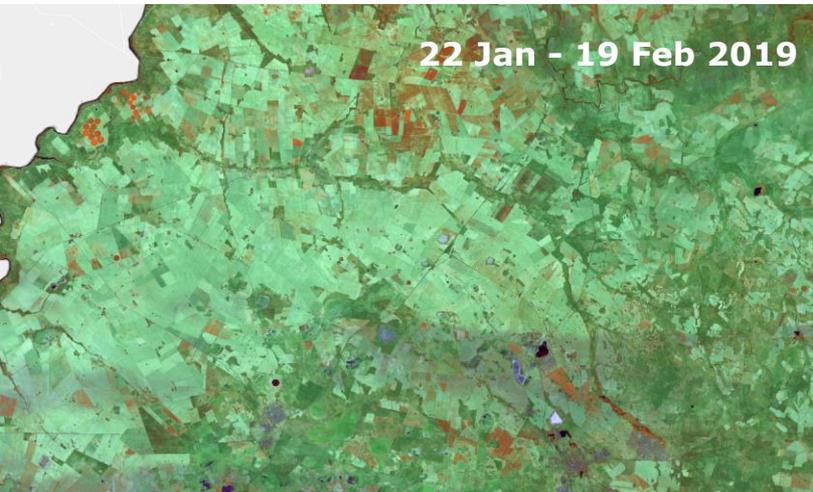
- The time series profile function compares SENTINEL2, Landsat8 and MODIS NDVI profiles at field level (approx.) and confirms that for this field, the 2018 Summer season (peak on the right) is shorter and has lower performance than in 2017 (peak on the left)
- The chip viewer provides a false color image for this field every 5 days (allows checking crop conditions, planting, harvesting, but also image quality or water on the field...)

ASAP HR viewer: zooming to the field level

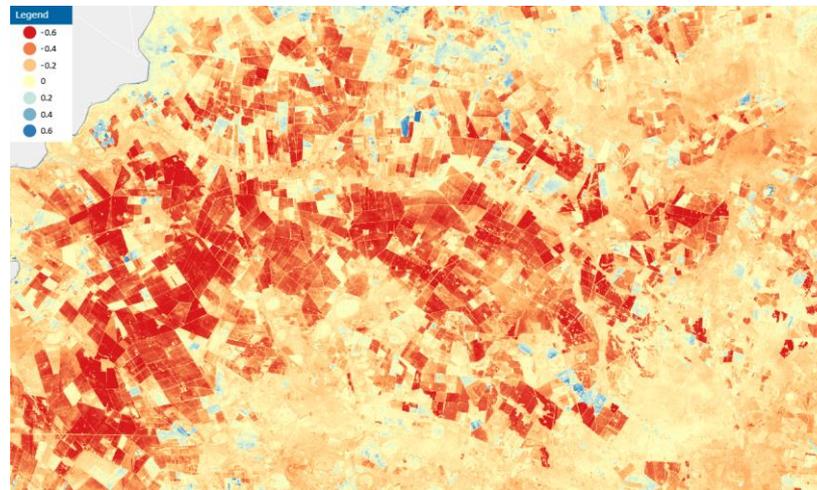
- Comparing NDVI value distribution of two different year for a user-defined polygon



ASAP HR viewer examples: Free State drought (South Africa) in 2019



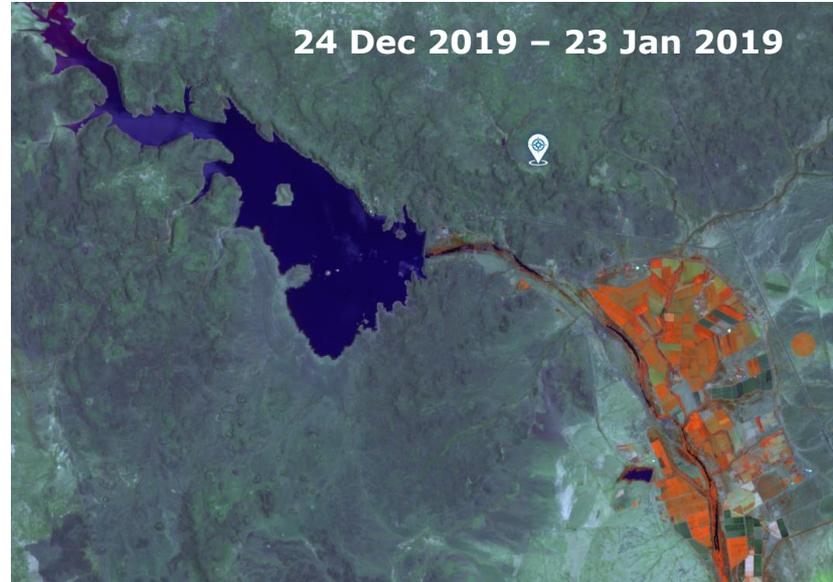
**NDVI
Difference**



Strong negative
NDVI anomalies in
2019.
Crop failure and
decrease in planted
area

<https://mars.jrc.ec.europa.eu/asap/s/d1b78928>

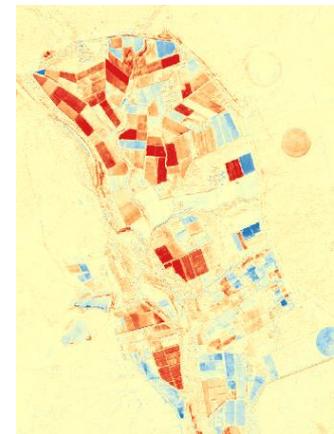
ASAP HR viewer examples: recent drought in Namibia



<https://mars.jrc.ec.europa.eu/asap/s/0c4b80df>

Clear reduction of Hardap Dam
water level and effect on crops

NDVI
Difference



ASAP HR viewer examples: areas with access restrictions, abandoned crop land in 2019 in North East Nigeria



ASAP - ANOMALY HOTSPOTS OF AGRICULTURAL PRODUCTION

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European Commission > EU science HUB > ASAP > High Resolution Viewer

High Resolution Viewer

NG - Borno

Choose another region

SELECT SATELLITE

Sentinel 2

TARGET PERIOD

30 Aug 2019 20 Sep 2019

COMPARISON YEAR

2018

CLOUD FILTERING

Max. 50%

Get map Layers

POINT AREA

13.6573 12.9865

TIME PERIOD

24 Dec 2018 24 Jan 2020

Get stats

MAP-1

SENTINEL 2

- NIR/SWIR/R target period
- NIR/SWIR/R comparison year
- NDVI target period
- NDVI comparison year
- NDVI diff. (target-comparison)

Land cover layer

Background map

1000 m

Get Link Tutorial Copernicus

Legend

- NIR [0.0-0.6]
- SWIR [0.0-0.6]
- RED [0.0-0.4]

<https://mars.jrc.ec.europa.eu/asap/s/6a18b85e>



Conclusions

- Continuous monitoring and frequent updates for timely early warning and evidence for detailed and multi-stakeholder assessments/analysis (IPC, Cadre Harmonisé, Global Crises report, GEOGLAM CM4EW...)
- Zoom into hotspot areas providing user friendly access to latest generation high resolution imagery for vegetation anomaly mapping at parcel level. Many other uses possible!
- All reference data, warnings and analysis summary are well documented (including video tutorials, presentations, scientific papers) and can be downloaded
- Base data such as crop and rangeland masks, crop calendars and phenology can be downloaded and use as base layer for other applications

Future developments

- Warnings available also at the second sub-national level
- Improved compositing and smoothing of HR time series
- Integration of ECWMF meteorological forecasts in the warning system
- Improved training material including new video tutorials



Thank you!

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