Food and Agriculture Organization
of the United Nations

Brief Guidelines to the Global Information and Early Warning System's (GIEWS) Earth Observation Website

ASIS

Agricultural Stress Index System

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Brief Guidelines to the Global Information and Early Warning System's (GIEWS) Earth Observation Website

Food and Agriculture Organization of the United Nations (FAO)

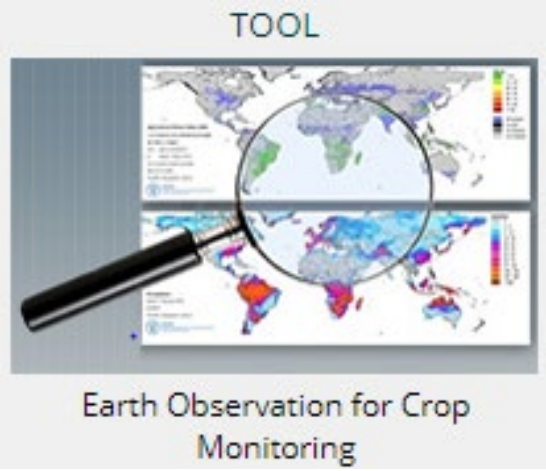
Rome, August 2018

Contents

How to navigate the website

Landing

Enter the *Earth Observation for Crop Monitoring* section on GIEWS Homepage:

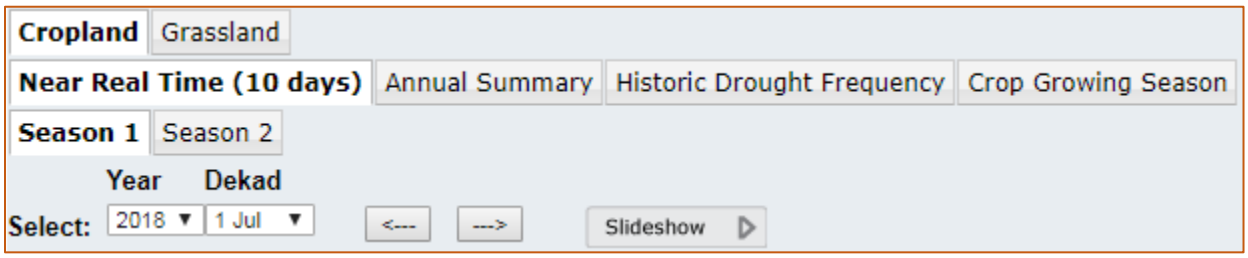


To support its analysis and supplement ground-based information, the Global Information and Early Warning System on Food and Agriculture (GIEWS) utilizes remote sensing data that can provide a valuable insight on water availability and vegetation health during the cropping seasons. In addition to the rainfall estimates and the Normalized Difference Vegetation Index (NDVI), GIEWS and FAO's CBC Division have developed the Agricultural Stress Index (ASI). Every ten days, the System generates a map showing the hot spots around the world, where crops are affected by water stress during the growing period and the information is verified with field observations to corroborate the remote sensing analysis.

You can access the following sections:

The early detection of drought is essential to minimize its impact on agriculture and food security. GIEWS recently updated its Agricultural Stress Index System (ASIS), whose new version significantly enhances drought monitoring capacities and contributes to minimizing the impact of weather shocks on food security.

Seasonal Global Indicators



You may choose to open the results for Cropland or Grassland, for season 1 and season 2 (some grains have more than one cropping season).

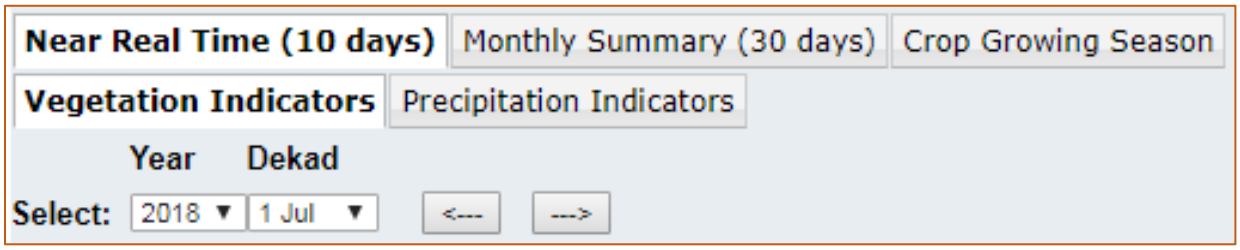
Near Real Time (10 days) allows to retrieve dekadal data (uploaded every ten days) from the first dekad of 1984 to the latest available.

Annual Summary shows annual data from 1984 to the latest available year.

Historic Drought Frequency depicts the frequency of severe drought in the areas where 30 percent or 50 percent of the cropped land has been affected. The historical frequency of severe droughts (as defined by ASI) is based on the entire time series (1984-2017).

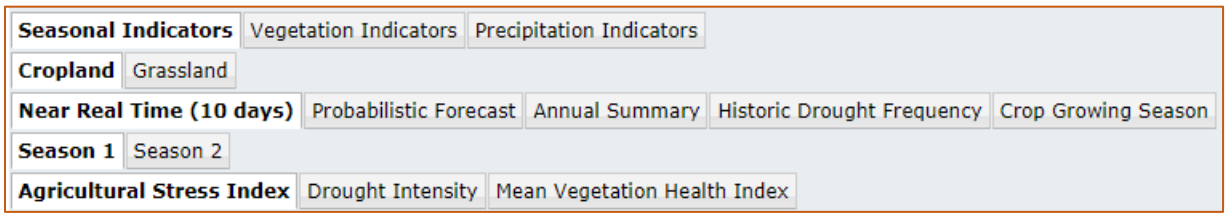
Crop Growing Season and **Grass Growing Season** depict the development of crops/pastures during the growing season identifying, at pixel level, the Start of Season, Maximum of Season and End of Season (SOS/MOS/EOS).

Global Indicators

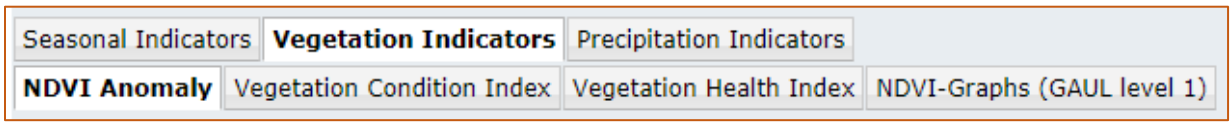


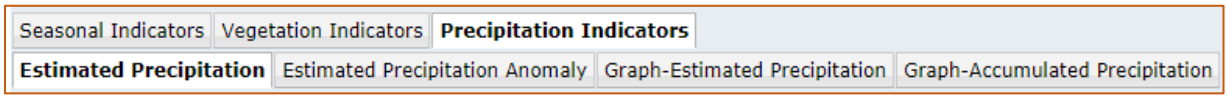
Here you can view **Vegetation Indicators** (NDVI anomaly, VCI, VHI) and **Precipitation Indicators** (Estimated Precipitation, Precipitation anomaly), selecting the year and dekad of interest.

Country Indicators

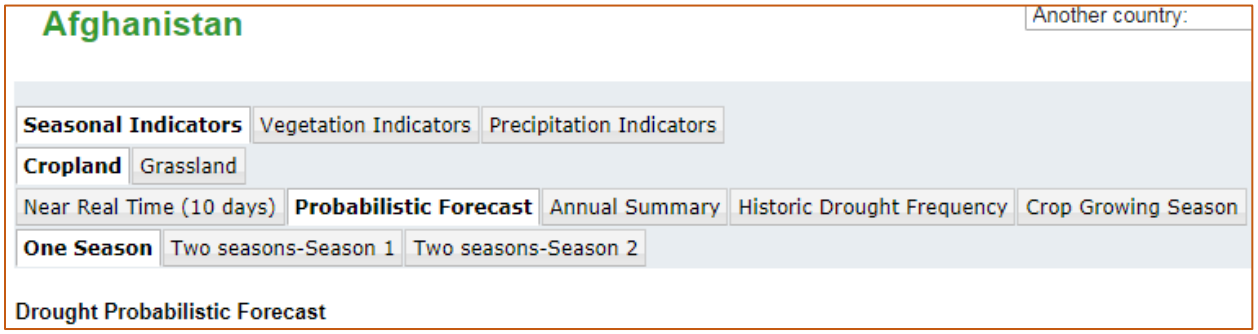


Here you may access country specific Vegetation and Precipitation Indicators and Graphs:





Also, at country level, another product is available in the Seasonal Indicators section, allowing for the early detection of agricultural droughts: the Drought Probabilistic Forecast.



Reference

In this section you may find:

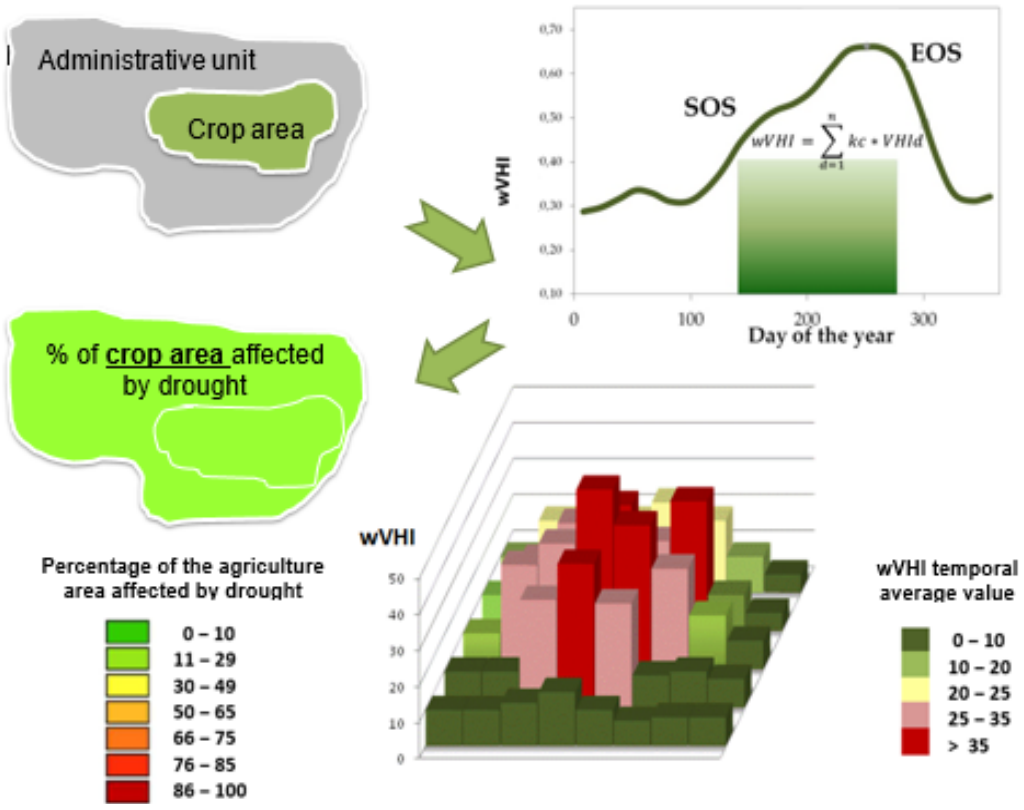
- Methodology and Progress Reports
- User manual and training materials
- Data source
- Selection of ASIS based research papers
- Related links

Brief technical description of the products

Agricultural Stress Index

The Agricultural Stress Index (ASI) is a quick-look indicator for the early identification of areas of cropped land with a high likelihood of water stress (or drought, in extreme cases). The Index is based on remote sensing data of vegetation and land surface temperature, combined with information on agricultural cropping cycles derived from historical data and a global crop mask. The final maps provide an at-a-glance view across the whole globe of where the agricultural areas are probably suffering from the lack of moisture, highlighting anomalous vegetation growth and potential drought, in crop zones during the growing season. This visualization of the Index can assist analysts in timely identifying the areas where in-depth monitoring is required.

ASI is based on the integration of the Vegetation Health Index (VHI) in two dimensions that are critical in the assessment of a drought event in agriculture: temporal and spatial. The first step of the ASI calculation is a temporal averaging of the VHI, assessing the intensity and duration of the dry periods occurring during the crop cycle at pixel level. The second step determines the spatial extent of drought events by calculating the percentage of pixels in arable areas with a VHI value below 35 percent (this value was identified as a critical threshold in assessing the extent of drought in previous research by Kogan, 1995). Finally, each administrative area is classified according to its percentage of the affected area to facilitate the quick interpretation of the results by analysts.



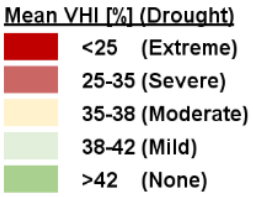
For further reading, access the Reference page.

Annual ASI

The Annual ASI depicts the percentage of arable land, within an administrative area, that has been affected by drought conditions over the entire cropping season. It differs from the ASI, which is based on conditions from the start of the season up to the current dekad.

Drought Intensity

Agricultural droughts are classified by their intensity and are categorized into four classes: Extreme, Severe, Moderate or Mild. The intensity of drought is calculated through the Weighted Mean Vegetation Health Index (μ*VHI), an Index that is the regionally-aggregated derivative of the Mean VHI (μVHI) and, in essence, indicates that the poorer the vegetation health the more severe the drought.



Drought Probabilistic Forecast

This indicator calculates the probability of drought conditions occurring at the end of the growing season. It is calculated mid-way through the cropping season - given the larger number of dekadal observations incorporated in the calculation, the reliability of the indicator improves - and is based on the full archive of VHI images (1984-present). In the map, the "greener" the cropped area (i.e. higher values of VHI indicating healthier vegetation), the lower the chance that it is likely to be affected by drought, while the areas highlighted as red indicate an 80 to 100 percent probability of the cropped area being affected by drought.

Caution: The reliability of the forecast increases **as the season progresses** (more observations incorporated in the calculation). It is strongly recommended to interpret the forecast taking into account the **progress of season** of the concerned area and use the forecast with great caution at the early stages of the agricultural growing season.

For further reading access the Reference page.

Estimated Precipitation

The map depicts cumulative rainfall volumes over a dekad (a 10-day period). Precipitation estimates are forecasts of rain levels and are obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF).

Historic Drought Frequency

The maps depict the frequency of severe drought in areas where: 30 percent of the cropped land or 50 percent of the cropped land has been affected. The historical frequency of severe droughts (as defined by ASI) is based on the entire time series (1984-2017).

Mean Vegetation Health Index

The Mean Vegetation Health Index (μVHI) allows the user to assess the severity of drought in relation to the vegetation health and the influence of temperature on plant conditions. The Mean VHI takes into account the sensitivity of a crop to water stress over its growing season and calculates the temporal impact of moisture deficits since the start of the growing season until the current dekad. In other words, it is an average of the dekadal VHI values over the crop growing season (from the start until the dekad of analysis), weighted by crop coefficients (k_c), assigned to VHI values at the dekades corresponding to the Start of the Season (SOS), Maximum of the Season (MOS) and End of the Season (EOS), while the weights at intermediate dates are linearly interpolated from the neighbouring values.

$$\mathrm{wVHI} = \sum_{\mathrm{SOS}}^{\mathrm{EOS}} \mathrm{VHI} * \mathrm{kc}$$

wVHI = Weighted vegetation health index cumulated from SOS up to EOS multiplied by crop coefficient;

VHI = Anomaly of VHI by dekad;

kc = Crop coefficient.

NDVI Anomaly

The NDVI anomaly indicates the variation of the current dekad to the Long Term Average (LTA), which refers to the period 1984-2014, where a positive value (for example 20 percent) would signify enhanced vegetation conditions compared to the average, while a negative value (for instance -40 percent) would indicate comparatively poor vegetation conditions.

Normalized Difference Vegetation Index

The Normalized Difference Vegetation Index (NDVI) measures the greenness of ground cover and it is used as a proxy to indicate the density and health of the vegetation. NDVI values range from +1 to -1, with high positive values corresponding to dense and healthy vegetation, and low and/or negative NDVI values indicating poor vegetation conditions or sparse vegetative cover.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Where Red and NIR stand for the spectral reflectance measurements acquired in the Red (visible) and near-infrared regions, respectively.

Precipitation Anomaly

The map illustrates the difference between the current rainfall volume and the average level. Rainfall levels are compared with the Long Term Average (LTA), which refers to the period 1989-2015. Warmer colours identify the areas which have received lower-than-average rainfall, while colder colours are given to the areas where precipitation has been above average. Precipitation estimates are obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF).

Vegetation Condition Index

The Vegetation Condition Index (VCI) evaluates how current vegetation health compares to historical trends. In other words it relates the current dekadal NDVI ($NDVI_i$) to its long term minimum and maximum, normalized by the historical range of NDVI values for the same dekad (i).

$$VCI_i = \frac{NDVI_i - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

The VCI was designed to separate the weather-related component of the NDVI from the ecological element.

Vegetation Health Index

The Vegetation Health Index (VHI) illustrates the severity of drought based on the vegetation health and the influence of temperatures on plant conditions. The VHI is a composite Index and the elementary indicator used to compute the ASI.

$$VHI = w * VCI + (1 - w) * TCI$$

The VHI combines both the Vegetation Condition Index (VCI) and the Temperature Condition Index (TCI). The TCI is calculated using a similar equation to the VCI, but relates the current temperature (T_i) to the long term maximum and minimum, as it is assumed that higher temperatures tend to cause a deterioration in vegetation conditions.

$$TCI_i = \frac{T_{max} - T_i}{T_{max} - T_{min}}$$

A decrease in the VHI would, for example, indicate relatively poor vegetation conditions (decline in the VCI) and warmer temperatures (increasing TCI), signifying stressed vegetation conditions, and over a longer period would be indicative of drought. The VHI components (VCI and TCI) are given equal weights when computing the Index ($w = 0.5$).

The VHI images are computed for the two main seasons and in three modalities: dekadal, monthly and annual.

Glossary

Cropland (FAO GLC-Share definition)

It represents any geographic area dominated by:

- Herbaceous Crops: Plants such as graminoids or forbs, herbaceous crops used for hay, all the non-perennial crops that do not last for more than two growing seasons and crops like sugarcane where the upper part of the plant is regularly harvested, while the root system can remain for more than one year in the field.
- Woody Crops: Permanent crops such as trees and/or shrub crops, including all types of orchards and plantations (fruit trees, coffee and tea plantation, oil palms, rubber plantation, Christmas trees, etc.).

Grassland (FAO GLC-Share definition)

It represents any geographic area dominated by natural herbaceous plants (grasslands, prairies, steppes and savannahs) with a cover of 10 percent or more, irrespective of different human and/or animal activities, such as: grazing, selective fire management etc. Woody plants (trees and/or shrubs) can be present assuming their cover is less than 10 percent.

Start of Season (SOS)

The Start of Season (SOS) indicates the early stage of crop/grass emergence, defined as the date when the rising NDVI-curve cuts the threshold $NDVI_s$:

$$NDVI_s = NDVImin_s + T_s * (NDVImax - NDVImin_s)$$

NDVImax is the NDVI at the maximum of the cycle, $NDVImin_s$ is the minimum before this maximum and threshold T_s is fixed to 0.25 for all land cover types. SOS is searched leftwards from NDVImax to $NDVImin_s$.

Maximum of Season (MOS)

The Maximum of Season (MOS) indicates when crop/grass foliage is fully developed, defined as the date when the NDVI is at its maximum value.

End of Season (EOS)

The End of Season (EOS) indicates when crop/grass has reached physiological maturity, defined as the date when the descending NDVI-curve crosses $NDVI_e$. This date does not necessarily correspond to the harvest period.

$$NDVI_e = NDVImin_e + T_e * (NDVImax - NDVimin_e)$$

NDVImax is the NDVI at the maximum of the cycle, $NDVImin_e$ is the minimum after this maximum and threshold T_e is set to 0.75 for cropland and to 0.25 for all other land. EOS is searched rightwards from NDVImax to $NDVImin_e$.

Progress of Season (POS)

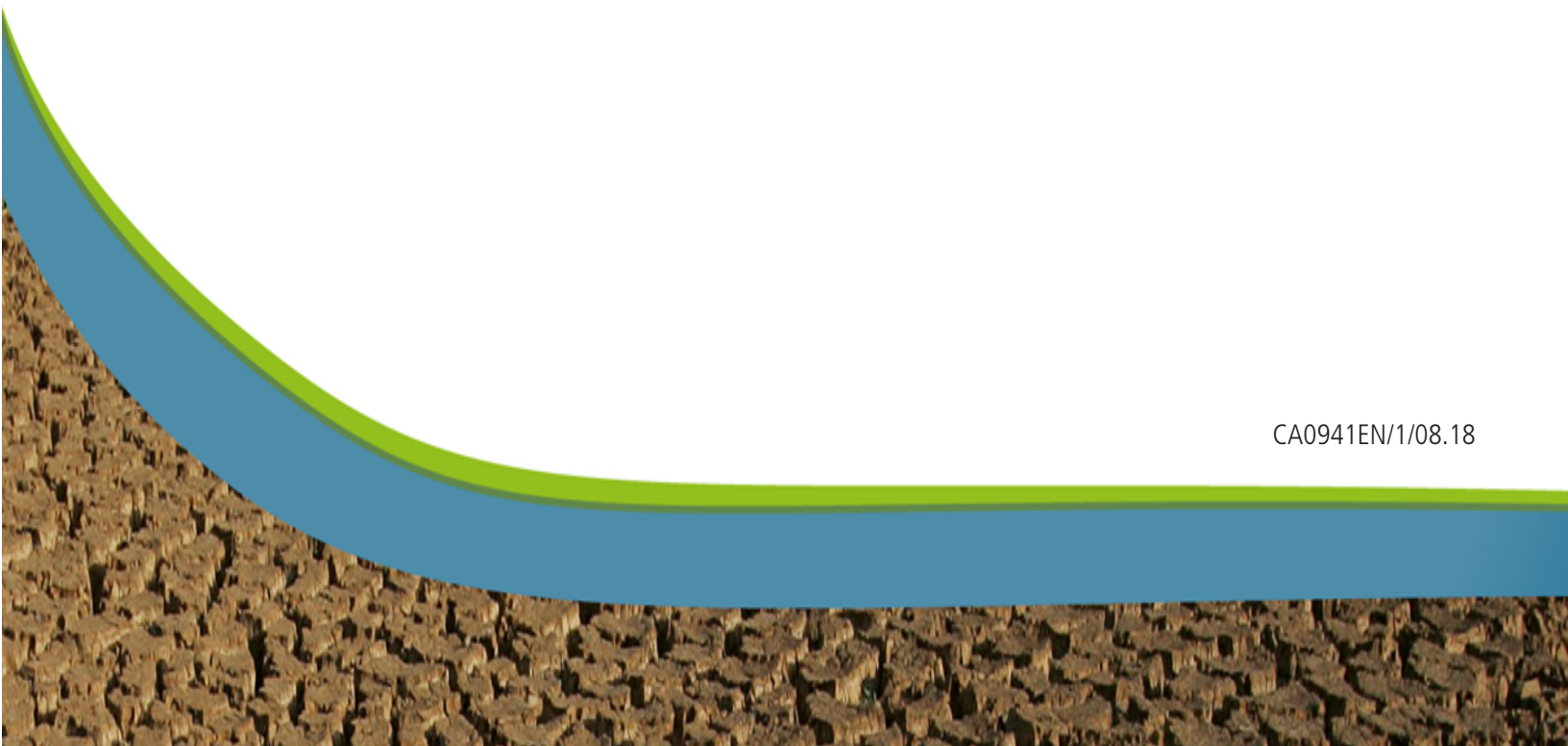
The Progress of Season (POS) depicts the development of crops/pastures during the growing season: for any dekad (a 10-day period), the map indicates how far the season has progressed. The POS is based on the Long Term Average (LTA) of vegetation phenology for each pixel. This simplification implies that the crop/pasture phenology is static and, therefore, the growing seasons progress at a constant rate each year. Each pixel's "normal" temporal behaviour in the course of the year is represented by 36 dekadal LTA images of NDVI. From these standardized curves, each pixel's phenology is then derived.

The "seasonal progress" is expressed in relative terms via a fixed set of "POS images". For any dekad in the year, they indicate for each pixel how the season has progressed. That can be a value between 0 and 100 percent (i.e. 50 percent is the mid-point of the growing season).

ASIS

Agricultural Stress Index System

Global Information and Early Warning System on Food and Agriculture (GIEWS) monitors the condition of major foodcrops across the globe to assess production prospects. To support the analysis and supplement ground-based information, GIEWS utilizes remote sensing data that can provide a valuable insight on water availability and vegetation health during the cropping seasons. In addition to rainfall estimates and the Normalized Difference Vegetation Index (NDVI), GIEWS and FAO's CBC Division have developed the Agricultural Stress Index (ASI), a quick-look indicator for the early identification of agricultural areas probably affected by dry spells, or drought in extreme cases.



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