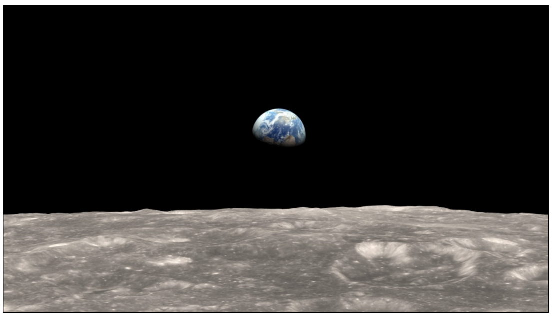
SM GEODIM
MODELOS DE INFORMACIÓN DE LA TIERRA

Crop production and agricultural drought monitoring



The World of remote sensing is the World (S. Montesinos)

Dr. Salomón Montesinos

Educational Training:

Universidad Complutense de Madrid
Doctorate in Geological Sciences, Geological Engineering, with distinction *"cum laude"* and Extraordinary Award
1995

UNIVERSIDAD COMPLUTENSE MADRID

Currently:

Managing Director
SM GEODIM
2013 – until now (5 years)

Associate Professor
CIVIL ENGINEER'S SCHOOL (UCLM)
2000 – until now (18 years), Ciudad Real, Spain

Coordinator of Technological Transfer
REMOTE SENSING SPANISH ASSOCIATION
2016 – until now

Master's Director of "UAV's Operational Applications in Engineering"
STRUCTURALIA
2018- until now

Maluenda 27°C 16°C

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SM GEODIM

MODELOS DE INFORMACIÓN DE LA TIERRA

About us | Agriculture | Civil works | Environment | Geology | Legal aspects | Water resources

Company Profile

Our Experience

Location and contact

Company Profile

SM GEODIM is a Spanish private company (SME) of RTD and innovation, specialized in the development of operational Remote Sensing and GIS (Geographical Information System) applications.

Founded in 1994, under the original denomination of SM Consultores, the company has developed its activity as second trademark of Geosys SL.

In 2013, as part of an internalization plan of its activities, the company name was changed to current one, SM GEODIM.

Company's background and know-how is backed by the 30 years of experience of its founder and current CEO Dr. Salomón Montesinos, together with a highly specialized and multidisciplinary technical team.

A broad network of partners and contacts throughout by Europe complements our capacities. Among the Spanish stand out: Civil Engineering School of University of Castilla-La Mancha; Research Institute of Agricultural and Food Development of Murcia Region (IMIDA) and GeoSpatiumLab (a spin-off of the University of Zaragoza).

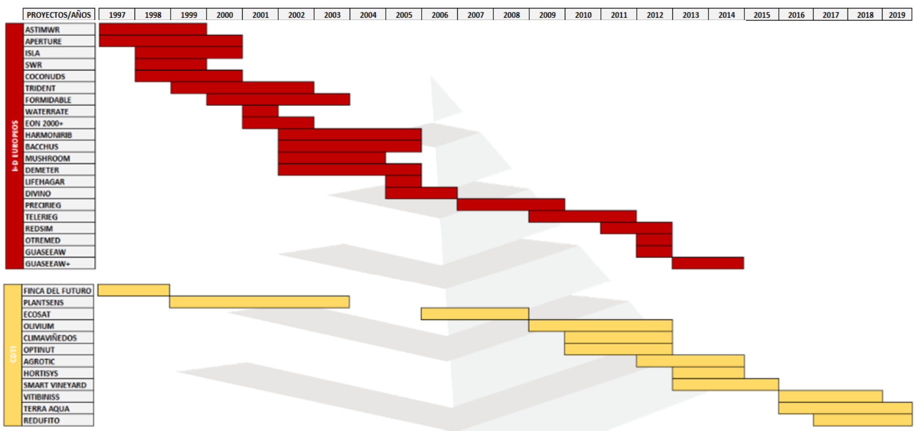
In 2009, we organized the XIII Congress of the Spanish Remote Sensing Association in Calatayud (Zaragoza, Spain), under the slogan: "*Water & Sustainable Development*".

SM GEODIM is founding member of FADOT (*Foundation for Development of Earth Observation of Aragon*), which is a non-profit organization established in 2010 together with Government of Aragon, to promote the development of research, use and awareness of Earth Observation Techniques and data.

Read more

- Publications
- Who is SM GEODIM? (2013)
- International experience (2013)

R&D Projects



Objectives

1. What is **Drought**?
2. Drought **indices**
3. **Satellite Monitoring** of Drought
4. What is **Copernicus**?
5. **Study cases**

What is Drought?

- **Period of abnormally dry weather which persists long enough** to produce a serious hydrologic imbalance (from NOAA).
- Usually indicated by **below-average precipitation** levels.
- It has an **adverse ecological effect and impacts human activities** like Agriculture and Water Supply recharge.

Defining Drought Conditions

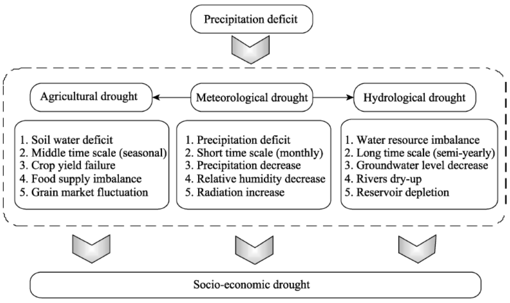
There are 4 definitions of Drought:

Meteorological: Precipitation below normal levels, region-dependent.

Agricultural: Soil moisture no longer supports crops.

Hydrological: Natural water resources are below normal levels.

Socioeconomic: Water shortages affect people.



Source: LIU et al, 2016)

Drought Impacts

(in the Horn of Africa)

- **Failure** in Agricultural and Livestock Production.
- **Lack of water** and pasture for livestock and domestic use.
- Failure in hydro-power based industries.
- **Loss of human and animal lives.**
- **Conflict** among agro-pastoralists and between humans and wildlife.



Source: Omondi P.A. (ICPAC, Kenya)

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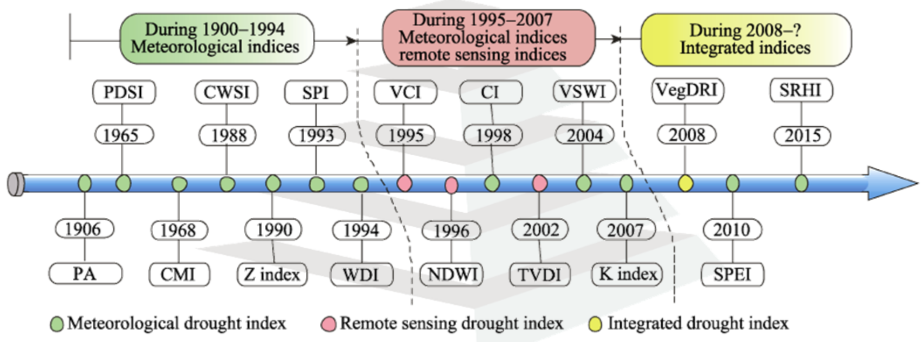
Drought Indices

- A **drought index** value is typically a single number far more useful than raw data **for decision making**.
- WMO defines a drought index as an index which is **related to some of the cumulative effects of a prolonged and abnormal moisture deficiency**.
- Choice of relevant drought indices depends on the socio-economic activity domain: **No universal drought index.**
- Drought monitoring can be based on a synthesis of multiple drought indices.
- The complexity of drought indices depends on the number of parameters taken into account.
- A huge **diversity of drought indices** are used.

Drought Indices Evolution



Source: LIU et al, 2016)

Table 1 Main meteorological and agricultural drought monitoring indices

Indices	Proposed time	Main author	Indices description
PA	1906	Henry (1906)	Drought occurs when precipitation during 21 days or a longer period is equal to or less than 30% of the normal precipitation.
PDSI	1965	Palmer (1965)	Water deficit of actual water supply continues to be less than the local climate water supply in a period.
CMI	1968	Palmer (1968)	Mainly used for agricultural drought monitoring and analyzing conditions of crop drought on the basis of a water balance model.
CWSI	1988	Jackson (1988)	Determines crop water deficit by considering the relationship between soil moisture and farmland evapotranspiration on the basis of the water and energy balance principle.
Z	1990	Me (1990)	Assumes that rainfall conforms to Person III distribution, and through precipitation normalization to determine drought index.
SPI	1993	McKee (1993)	Reflects the probability of precipitation occurring during a certain period, which is suitable for monthly or even longer-scale drought monitoring.
WDI	1994	Moran (1994)	This index is established by a combination of the differences between air and land surface temperature and vegetation index, considering the nearly linear relationship between vegetation cover and the most theoretical parameter in the crop water stress index.
VCI	1995	Kogan (1996)	Overcomes the shortage of anomaly vegetation and normalized vegetation index, which can effectively monitor the spatiotemporal variation in drought.
NDWI	1996	Gao (1996)	This index can effectively detect water content in vegetation canopy and respond promptly when vegetation undergoes water stress by introducing shortwave infrared bands.
CI	1998	Zhang (1998)	Integrates the standardized precipitation index and relative humidity index, which is suitable for near real-time and historical meteorological drought.
TVDI	2002	Sandholt (2002)	Characterizes crop water stress through the dry and wet equation determined by vegetation cover and surface temperature.
VSWI	2004	Haboudane	This index, combined with the land surface temperature index and vegetation index, is used for agricultural drought monitoring.
SC-PDSI	2004	Wells (2004)	This index is self-calibrated PDSI, which can determine model calibration parameters according to local climate characteristics.
K	2007	Wang(2007)	This index, used for meteorological and agricultural droughts, is defined as the ratio of the relative variability in seasonal rainfall and relative variability in evaporation.
VegDRI	2008	Brown (2008)	This is a synthesized drought index that includes information on vegetation, meteorology, and soil water capacity by using data mining.
SPEI	2010	Vicente-Serrano (2010)	This index is a modified SPI, which introduces evapotranspiration data for calculating drought.

Source: LIU et al, 2016)

Palmer Drought Severity Index, PDSI

The Palmer Index is a **soil moisture algorithm calibrated** for relatively homogeneous regions.

Many U.S. government agencies and states rely (relied) on the Palmer to help trigger drought relief programs. This is changing.

Inputs: **Precipitation, Temperature, AWHC if available**.

Pros: The first comprehensive drought index developed in the United States. Full derivative suite includes the Palmer (Z) and Palmer Hydrological Index (PHDI). Water balance approach.

Cons: Palmer values may lag emerging droughts by several months; less well suited for arid or mountainous land or areas of frequent climatic extremes; complex—has an unspecified, built-in fixed time scale; doesn't take snow into account. Not spatially consistent, difficult to understand.

Developed by W.C. Palmer, 1965.

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif

National Drought Mitigation Center

Standardized Precipitation Index

The SPI is an index based on the **probability of precipitation** for any time scale.

Many drought planners/decision makers appreciate the SPI's temporal versatility.

Pros: **Simple to compute/Only need precipitation** /Flexible: can be computed for multiple time scales, can provide early warning of drought and help assess drought severity, and is less complex (less data needed as well) than the Palmer. Spatially consistent; Probabilistic for historical context and decision making.

Cons: Precipitation-based only; no soil component; thus no ET/PET calculated.

Developed by: T.B. McKee, N.J. Doesken, and J. Kleist, 1993

Can be calculated from 1-month out to 72-months Statistically, **1-24-months is the best practical range** of application (Guttman).

https://drought.unl.edu/Climographs.aspx

https://hprcc.unl.edu/onlinedataservices.php

National Drought Mitigation Center

Standardized Precipitation-ET Index

SPEI is a new variation by Vicente-Serrano et al (Spain).

The Standardized Precipitation- Evapotranspiration Index (SPEI).

Inputs: **monthly precipitation and mean temperature** (and latitude of station site).

Standardized monthly climatic balance computed from the difference between the cumulative precipitation and PET (Thornthwaite).

Ability to depict changes due to climate change given the T and derived PET component vs. the regular SPI, which doesn't have T factored in.

Crop Moisture Index

A **Palmer derivative**, the CMI **reflects moisture supply in the short term across major crop producing regions** and is not intended to assess long-term droughts. Requires Mean weekly T and weekly total Precipitation.

Pros: Identifies potential agricultural droughts; quick response

Cons: Because it is designed to monitor short-term moisture conditions affecting a developing crop, the CMI is not a good long-term (multi-year) drought monitoring tool; resets to zero each year

The Crop Moisture Index (CMI) uses a **meteorological approach** to monitor week-to-week crop conditions

It was developed by Palmer (1968) from procedures within the calculation of the PDSI.

Crop Moisture Index (cont.)

Whereas the PDSI monitors long-term meteorological wet and dry spells, the CMI was **designed to evaluate short-term moisture conditions** across major crop-producing regions.

It is **based on the mean temperature and total precipitation for each week within a climate division**, as well as the CMI value from the previous week.

The CMI **responds rapidly** to changing conditions, and it is **weighted by location and time** so that maps, which commonly display the weekly CMI across the United States, can be used to compare moisture conditions at different locations.

Another characteristic of the CMI that limits its use as a long-term drought monitoring tool is that the **CMI typically begins and ends each growing season near zero**. This limitation prevents the CMI from being used to monitor moisture conditions outside the general growing season, especially in droughts that extend over several years.

National Drought Mitigation Center

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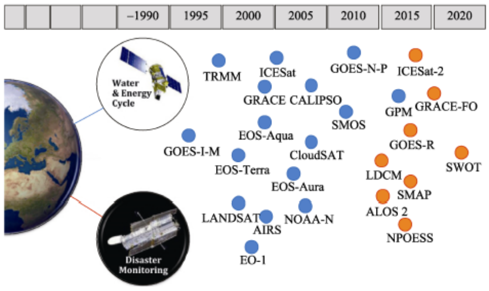
Satellite Monitoring of Drought

Many different satellites are used to monitor drought.

- **GOES, METEOSAT, INSAT, GMS** are used for prediction.
- **NOAA/AVHRR, IRS/WiFS, SPOT4/Vegetation** are used for monitoring and early warning.
- **TRMM, RESOURCESAT, MODIS** and **MERIS** need to be evaluated for monitoring.
- **LANDSAT, IRS, SPOT, Sentinel**



Remote sensing and Drought

Drought can be monitored effectively over large areas using remote sensing.

Satellite-borne remote sensing data provides a **synoptic view of Earth surface**, and therefore can be used to evaluate drought occurrence spatially.

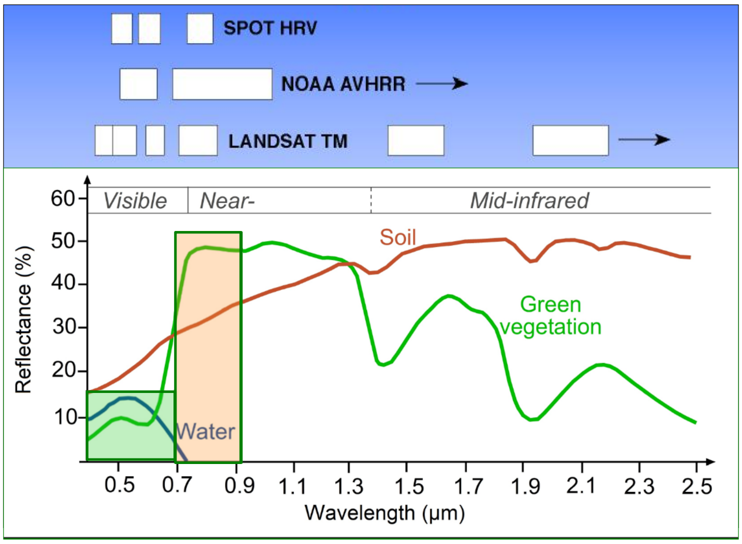
Several remotely-sensed drought indices have been developed and applied, which include duration, intensity, severity and spatial extent.

Normalized Difference Vegetation Index **(NDVI)** as a probe for vegetation health has been **one of most commonly used approaches to drought events monitoring**.

To improve the approach, **it has been advisable to combine vegetation index and temperature**. A combined NDVI and land surface temperature (LST) provides strong correlation and gives useful information to identification of agricultural drought as an early warning system.

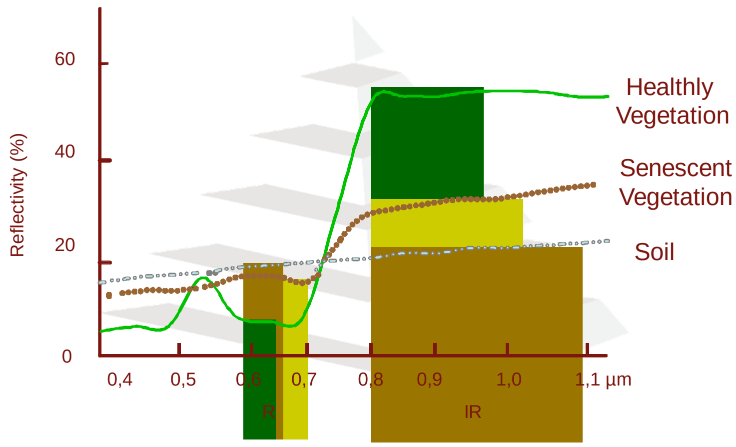
Source: Sholihah et al, 2015

Spectral Signature



Satellite Monitoring of Drought

Vegetation Index

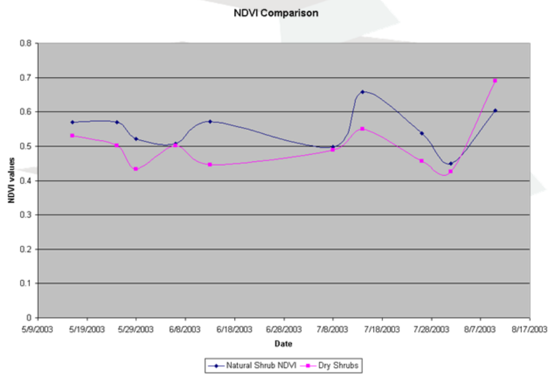


Satellite Monitoring of Drought

Normalized Difference Vegetation Index

NDVI changes with drought stresses; a drought-stressed plant will have a lower NDVI than a regular plant.

NDVI = (NIR – Red) / (NIR + Red)



Vegetation Condition Index

NDVI can be difficult to interpret when comparing different ecosystems

The Vegetation Condition Index **(VCI)** was proposed by Kogan (1990) **to separate the short-term weather signal from the ecological signal.**

$$VCI = (NDVI_{cur} - NDVI_{min}) / (NDVI_{max} - NDVI_{min})*100$$

$NDVI_{max}$ and $NDVI_{min}$ are the maximum and minimum NDVI values from the historical data

$NDVI_{cur}$ is the NDVI for the date and location under review

VCI values range from 0 to 100.

Low values indicate poor vegetation conditions, possibly related to drought.

The VCI has shown good results in drought detection tracking and mapping.

However, use of this index requires a long-term record of NDVI values.

Developed with AVHRR data.

Thermal Condition Index

The VCI has been recommended as drought tool, however, using sole VCI was not enough to describe drought analysis accurately.

TCI was developed to capture different responses of vegetation to in-situ temperature as additional information. This can be achieved by employing thermal channels for drought monitoring:

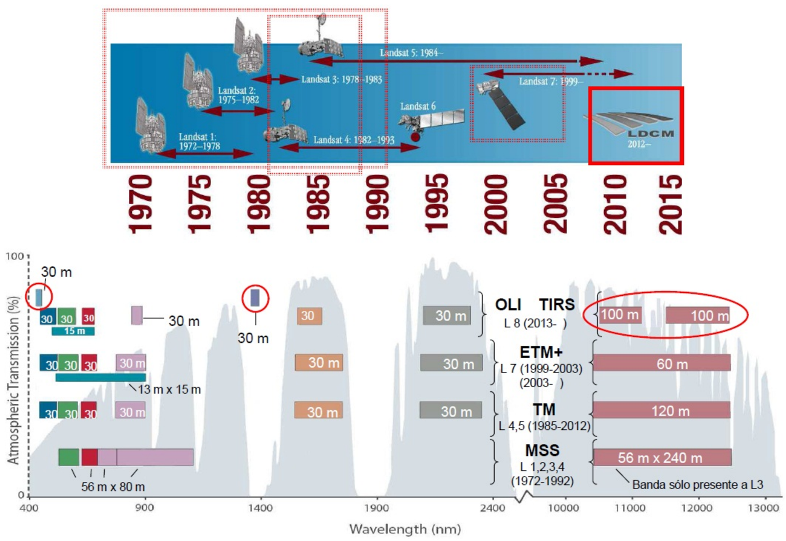
$$TCI = (LST_{max} - LST_{cur}) / (LST_{max} + LST_{min})*100$$

LST_{max} and LST_{min} are the maximum and minimum LST values from the historical data

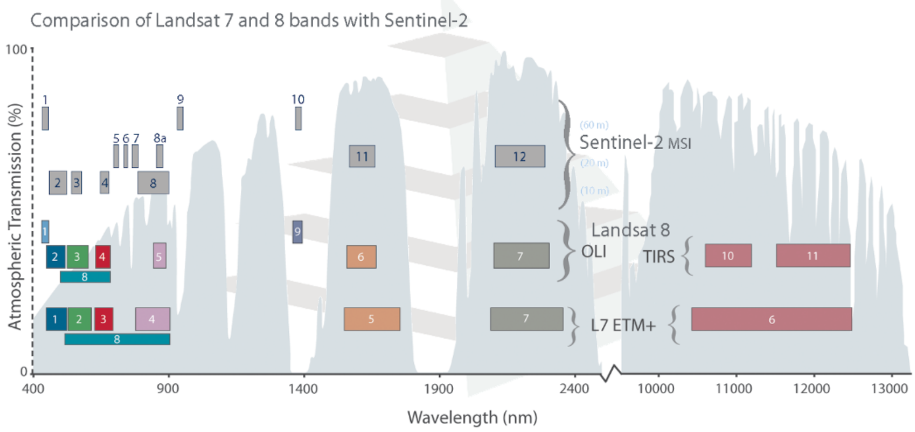
LST_{cur} is the LST for the date and location under review

TCI values range from 0 to 100.

Landsat Serie



Sentinel-2 *vs* Landsat



Vegetation Health Index

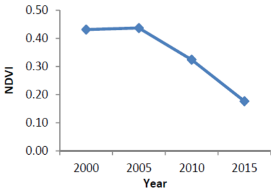
Vegetation Health Index (VHI) has demonstrated a greater capability and has presented a better suitability in detecting drought.

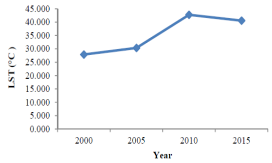
It considers both vegetation condition (VCI) and thermal condition of vegetation (TCI) within a period of observation.

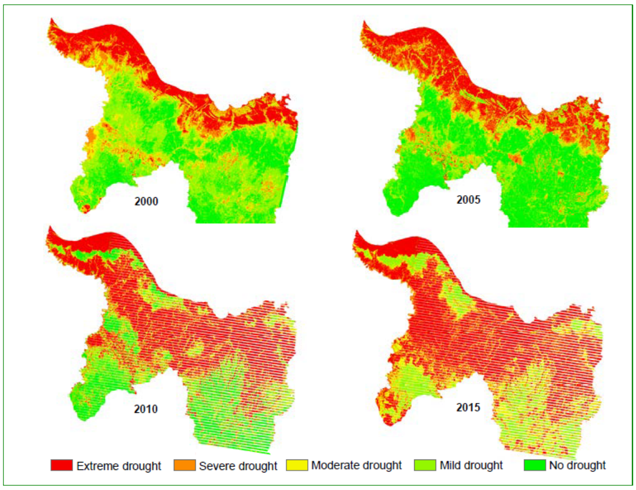
VHI = *aVCI + (1-*a*)*TCI**

Where, VHI is related to VCI and TCI by a

Vegetation Health Index







Source: Sholihah et al, 2015

Normalized Surface Drought Index

$$NDVI = \frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} + \rho_{RED}}$$

$$NDWI = \frac{\rho_{NIR} - \rho_{SWIR}}{\rho_{NIR} + \rho_{SWIR}}$$

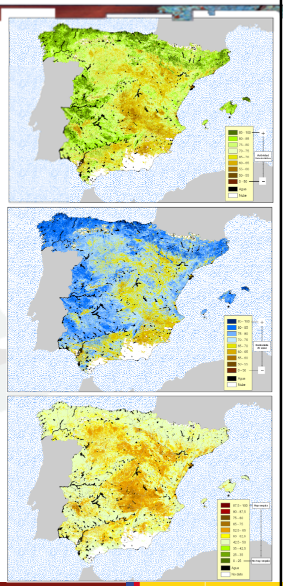
$$NDDI = \frac{NDVI - NDWI}{NDVI + MDWI}$$

MODIS Images (NDMC)

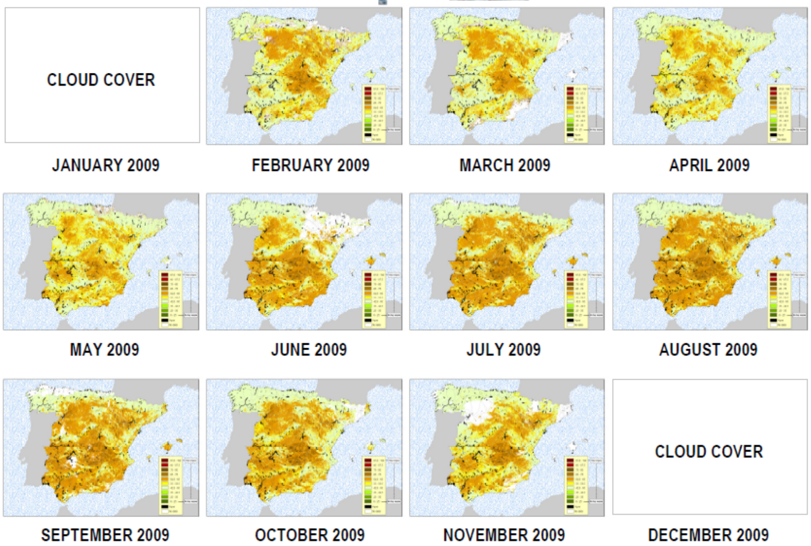
$$NDVI = \frac{MO2 - MO1}{MO2 + MO1}$$

$$NDWI = \frac{MO2 - MO7}{MO2 + MO7}$$

$$NDDI = \frac{NDVI - NDWI}{NDVI + MDWI}$$

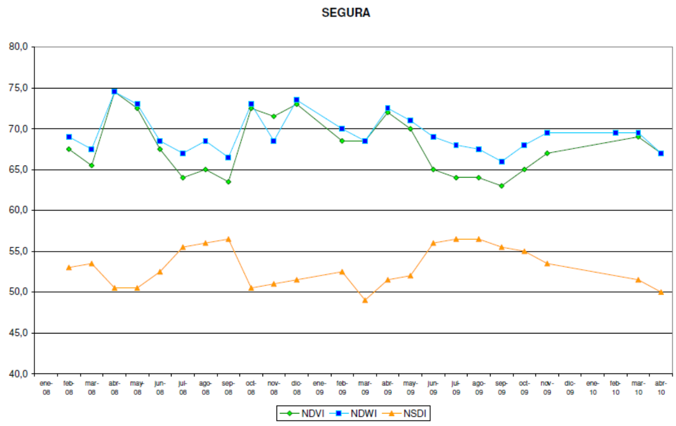


Normalized Surface Drought Index



Normalized Surface Drought Index

- **Drought.** (Monitoring at the level of Drought Management Systems of the Special Drought Plans).



October 2008 - April 2010. Drought Management System: Segura

Objectives

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What is Copernicus ?

Europe's eyes on Earth

Copernicus is the European Union's Earth Observation Programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers **information services based on satellite Earth Observation and in situ (non-space) data**.

The Programme is coordinated and managed by the European Commission. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies and Mercator Ocean.

The information services provided are **freely and openly** accessible to its users.

Copernicus Services

Atmosphere
(CAMS)

Marine Environment
(CMEMS)

Land
(CLMS)

Climate Change
(C3S)

Emergency Management
(EMS)

Security

Copernicus Emergency Management

The Copernicus Emergency Management Service (**Copernicus EMS**) provides all actors involved in the management of natural disasters, man-made emergency situations, and humanitarian crises with timely and accurate geo-spatial information derived from satellite remote sensing and completed by available in situ or open data sources.

The Copernicus EMS consists of **two components**:

- **Mapping with a worldwide coverage.**
- **Early warning with three different systems**:

The European Flood Awareness System (**EFAS**), which provides overviews on ongoing and forecasted floods in Europe up to 10 days in advance.

The European Forest Fire Information System (**EFFIS**), which provides near real-time and historical information on forest fires and forest fire regimes in the European, Middle Eastern and North African regions.

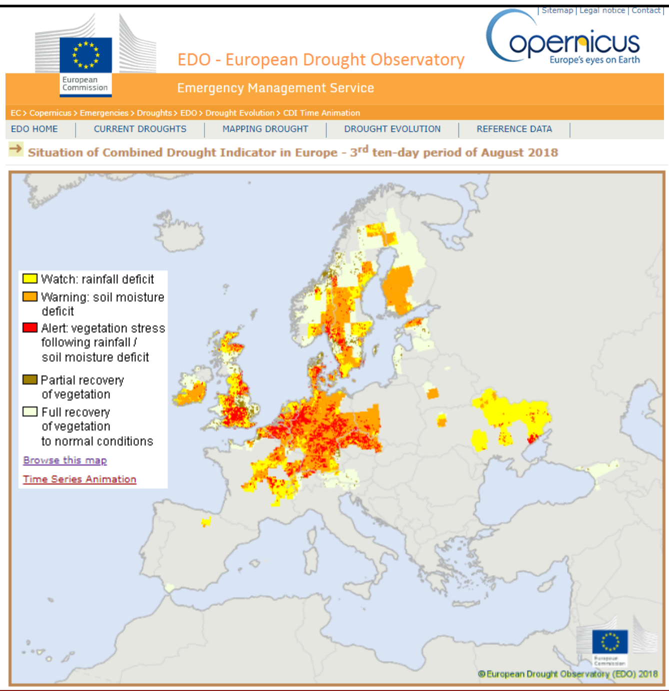
The European Drought Observatory (**EDO**), which provides drought-relevant information and early-warnings for Europe.

European Drought Observatory

The monitoring of droughts is based on the analysis of a **series of indicators**, representing different components of the hydrological cycle (e.g. precipitation, soil moisture, reservoir levels, river flow, groundwater levels) or specific impacts (e.g. vegetation water stress) that are associated with a particular type of drought.

EDO produces the following drought indicators at the European scale:

- **Standardized Precipitation Index (SPI)**
- **Standardized Snowpack Index (SSPI)**
- **Soil Moisture Anomaly (SMA)**
- **Anomaly of Vegetation Condition (FAPAR Anomaly)**
- **Low-Flow Index (LFI)**
- **Heat and Cold Wave Index (HCWI)**
- **Combined Drought Indicator (CDI)**

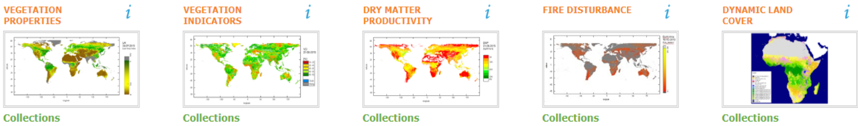


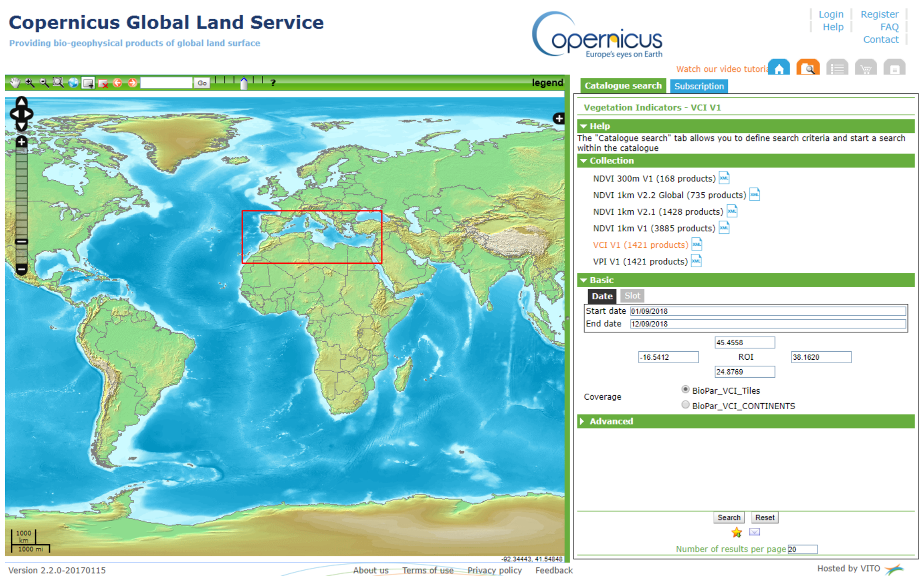
Copernicus Global Land Service

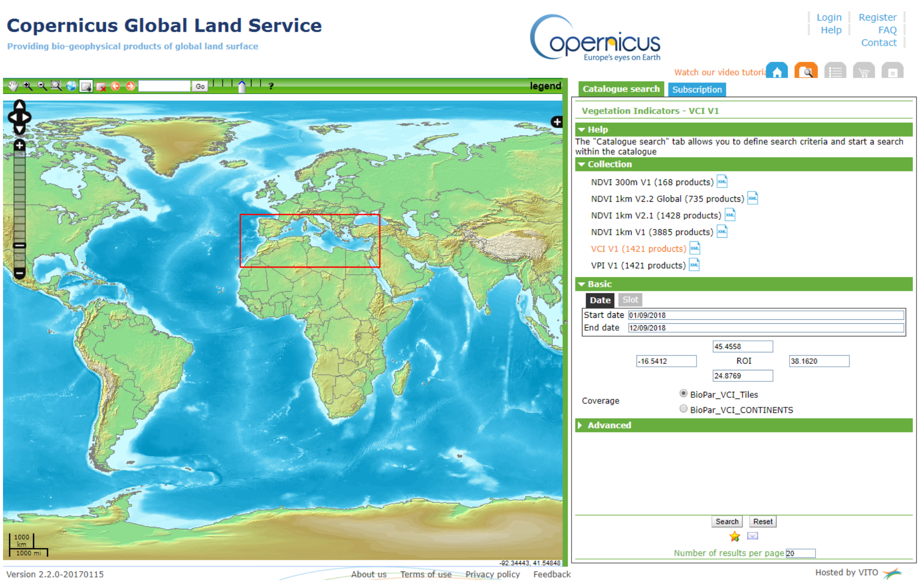
The Copernicus Global Land Service **(CGLS) is a component of the Land Monitoring Core Service** (LMCS) of Copernicus.

CGLS systematically produces a series of qualified bio-geophysical products on the status and evolution of the land surface, at global scale and at mid to low spatial resolution, complemented by the constitution of long term time series.

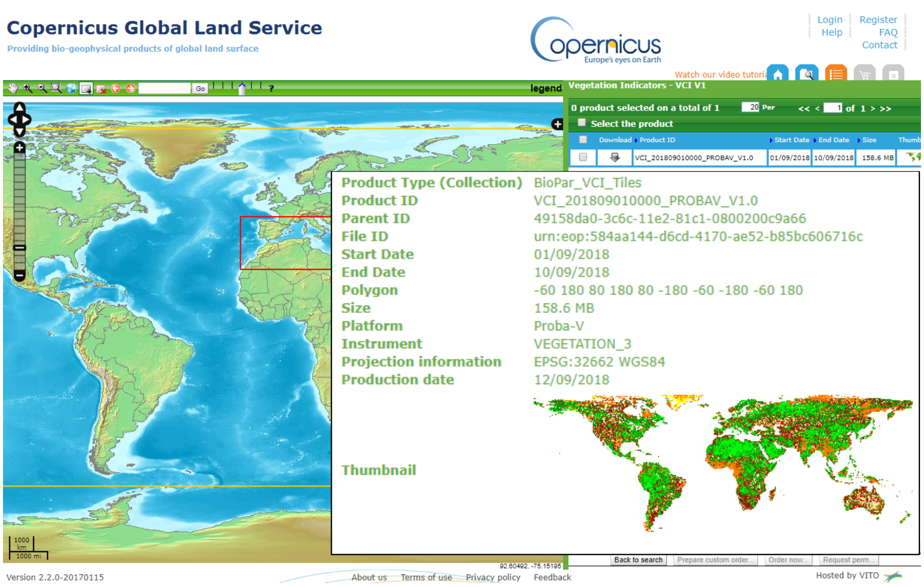
The products **are used to monitor the vegetation, the water cycle, the energy budget and the terrestrial cryosphere**.







Copernicus : Global Land Service



Copernicus

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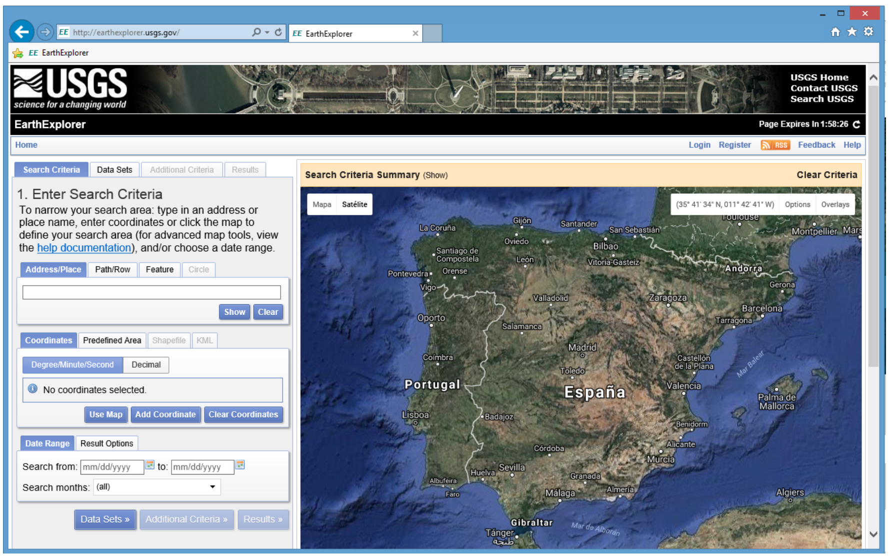
Image Acquisition

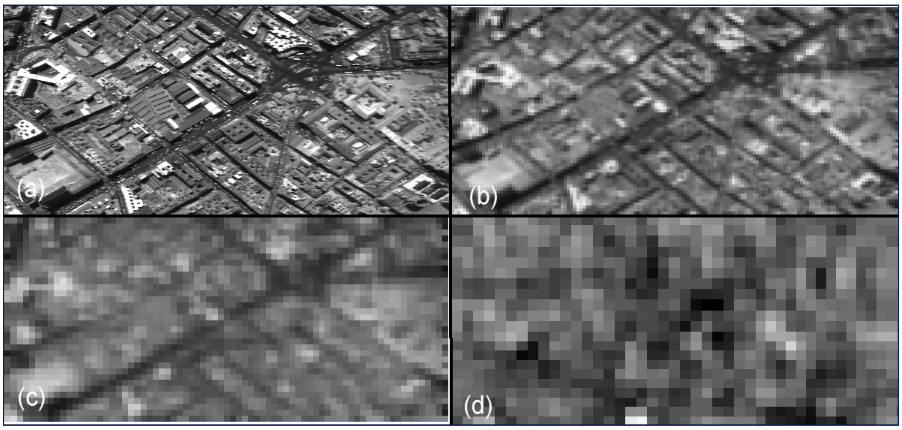


Temporal resolution

Satellites fly over the same area every short time, at the same solar time, allowing us to track the covers and processes of the earth's surface.

Aral Sea 2006-2009

Spatial resolution

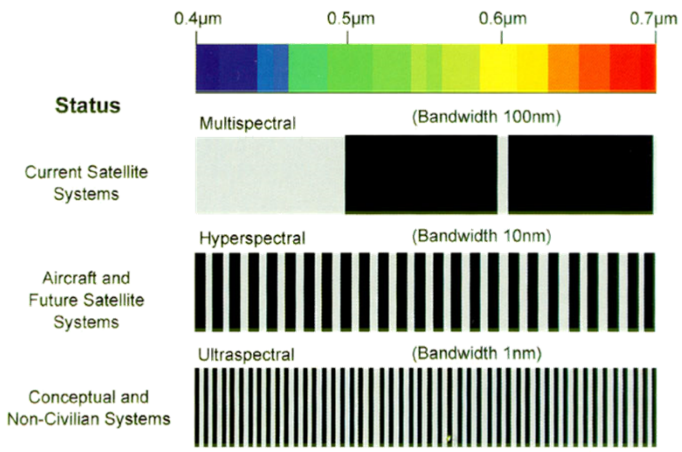


Source: Chuvieco, 2002

(a) 1 m; (b) 5 m; (c) 10 m; (d) 30 m

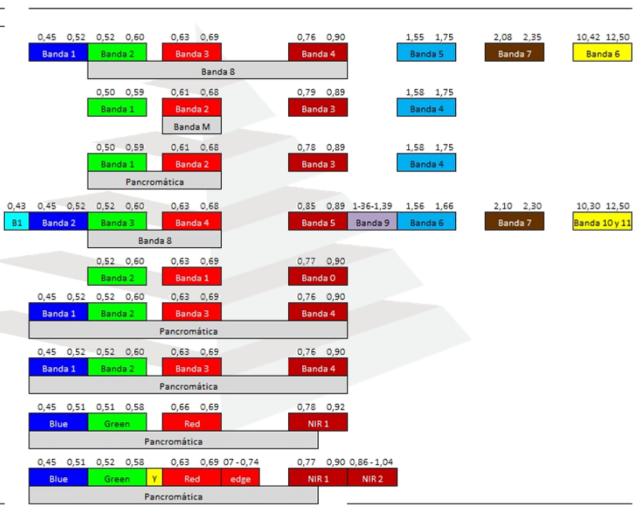
Scale = Pixel size / Maximum tolerable error

Spectral resolution



Spectral Bands

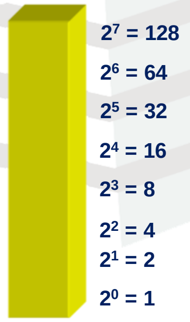
Satélite	Resolución	Año
Landsat 4-7	30 15	1984
SPOT 4	20 10	1998
SPOT 5	10; b4 (20) 2,5 ó 5	2002
Landsat 8	30 15	2013
DEIMOS-1	22	2009
IKONOS	4 1	1999
QuickBird	2,44-2,88 0,61-0,72	2001
Geoeye-1	1,65-2 0,41-0,5	2008
WordView-2	1,84-2,08 0,46-0,52	2009



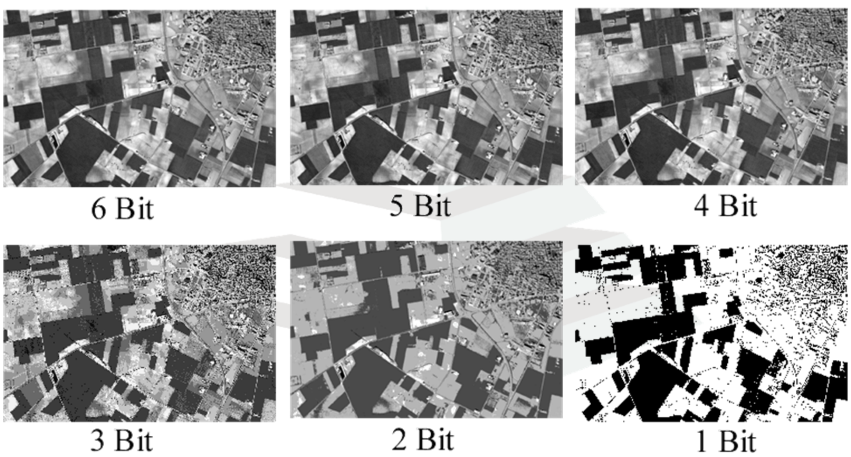
Radiometric resolution

It expresses the **ability** of a sensor, in a given spectral band, **to distinguish electromagnetic signals** of different energy.

It refers to the dynamic range, or number of possible values that each energy measure can take. With 1 byte (8 bits), the range of values goes from 0 to 255.



Radiometric resolution



SM GEODIM
MODELOS DE INFORMACIÓN DE LA TIERRA

Study case

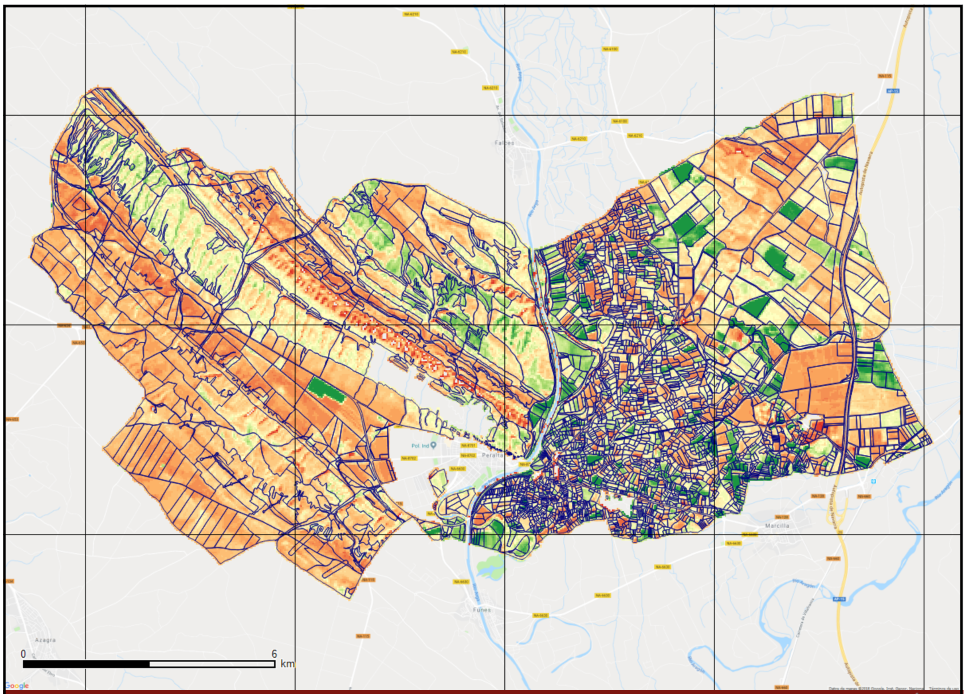
Pasture Loss Insurance in Spain

Only fools laugh at what they do not understand *(Honore de Balzac)*

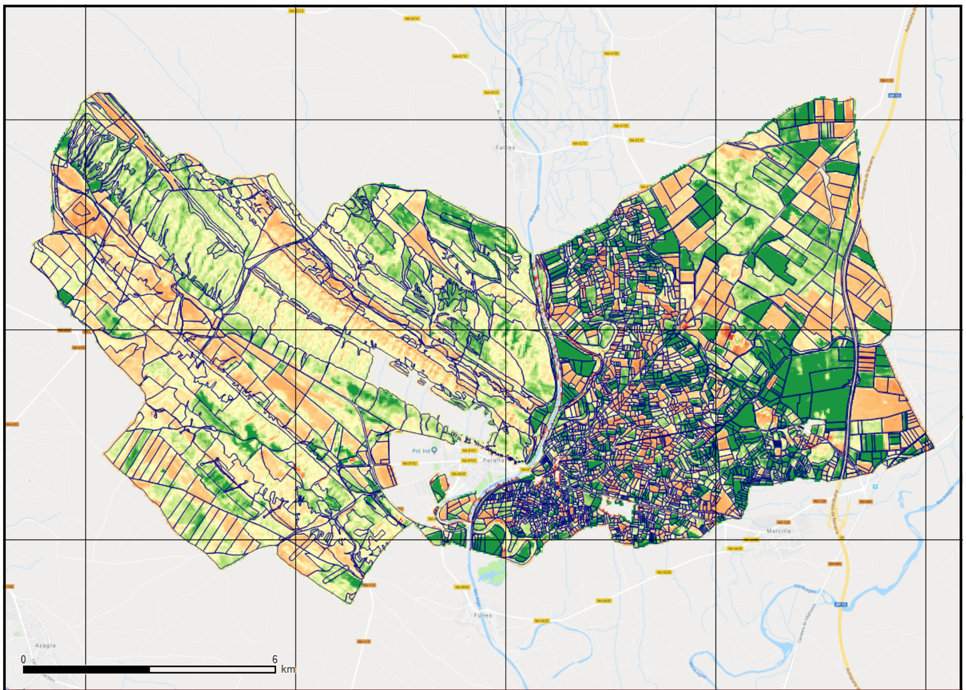
Agricultural Insurance

agroseguro is a Spanish anonymous corporation, whose purpose is the administration of Combined Agricultural Insurance.

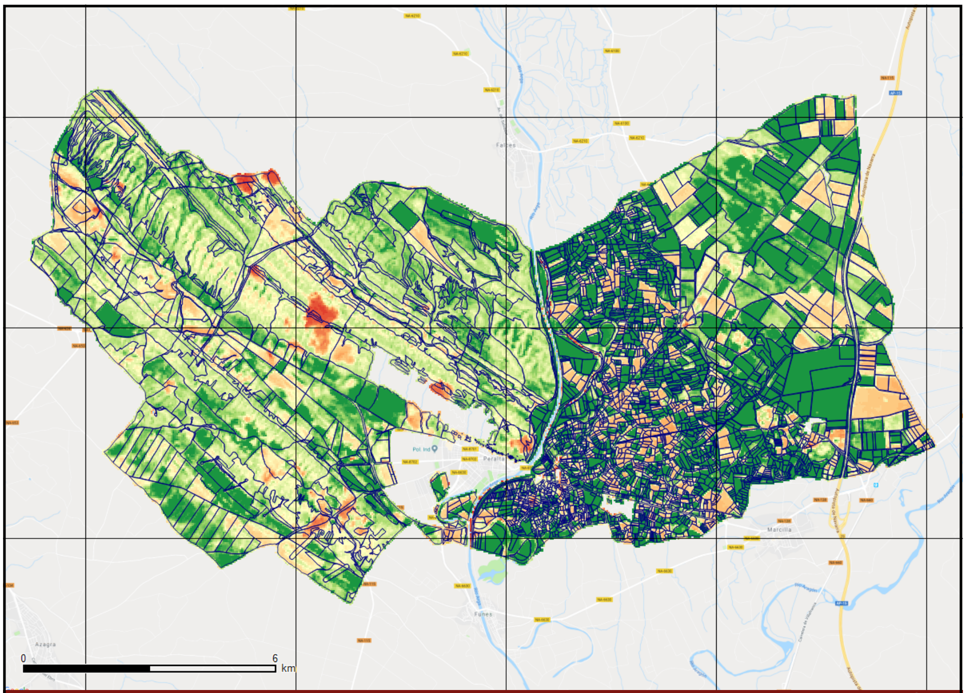
Spatial remote sensing has proven to be an operative tool in the field of agricultural insurance, being a basic data source in the **Compensation Insurance for Loss of Pastures**, where a cover has been designed for the lack of vegetation in the pastures destined to livestock feeding, calculating the NDVI of the region where the farm is located.



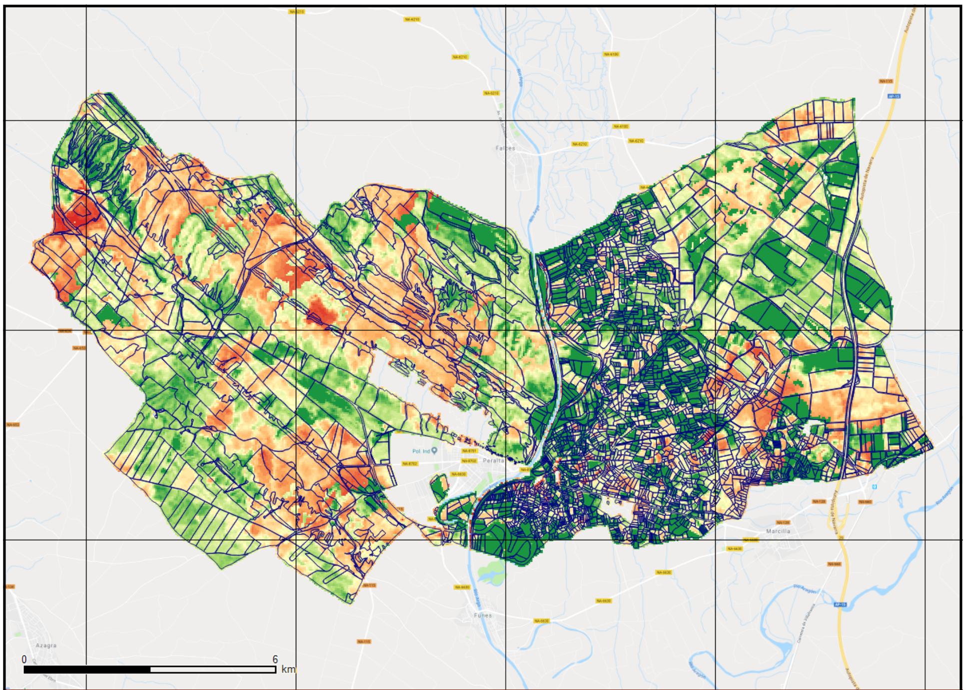
PERALTA: NDVI 1/12/2013



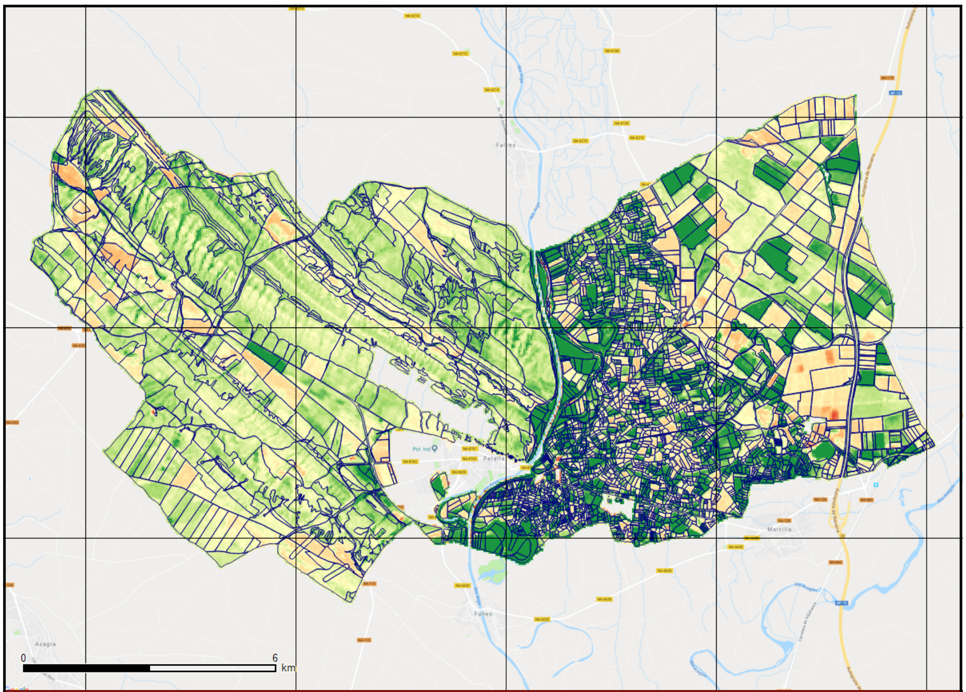
PERALTA: NDVI 7/03/2014



PERALTA: NDVI 8/04/2014



PERALTA: NDVI 26/05/2014



PERALTA: NDVI 11/06/2014

Agricultural Insurance

The operating system is simple, every ten days, by satellite, a measurement of the **vegetation index** of each region is made and **compared with the same decade of the period 2000-2014**. If the result is below a threshold determined at the average of said period, it is considered sinister.

All the data are registered in a GIS and the management is triggered automatically when the conditions established in the insurance contract are met.

www.agroseguro.es

agroseguro

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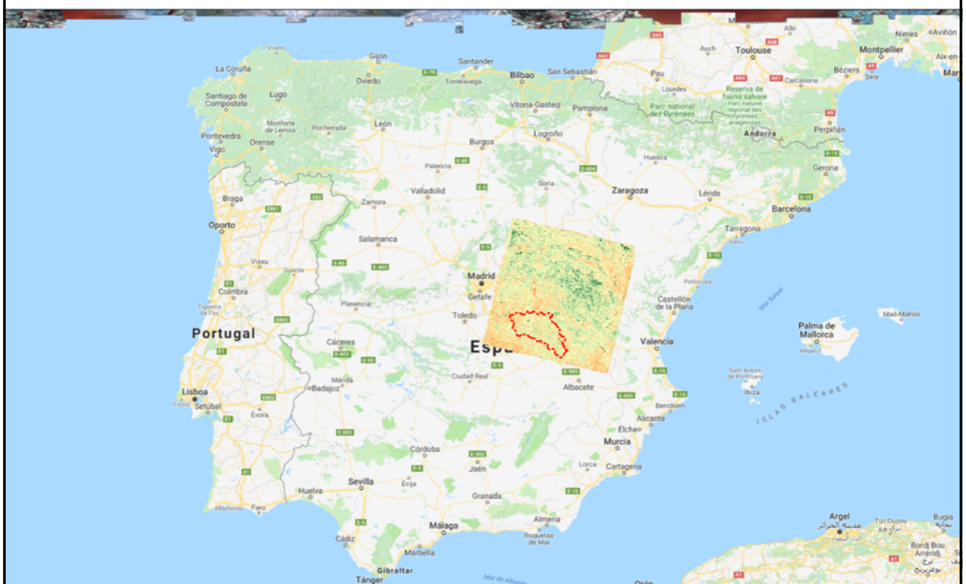
Study case

Cereal damages in La Mancha Alta (Spain)

In moments of crisis, only imagination is more important than knowledge *(Albert Einstein)*

Cereal damages in La Mancha alta (Spain)

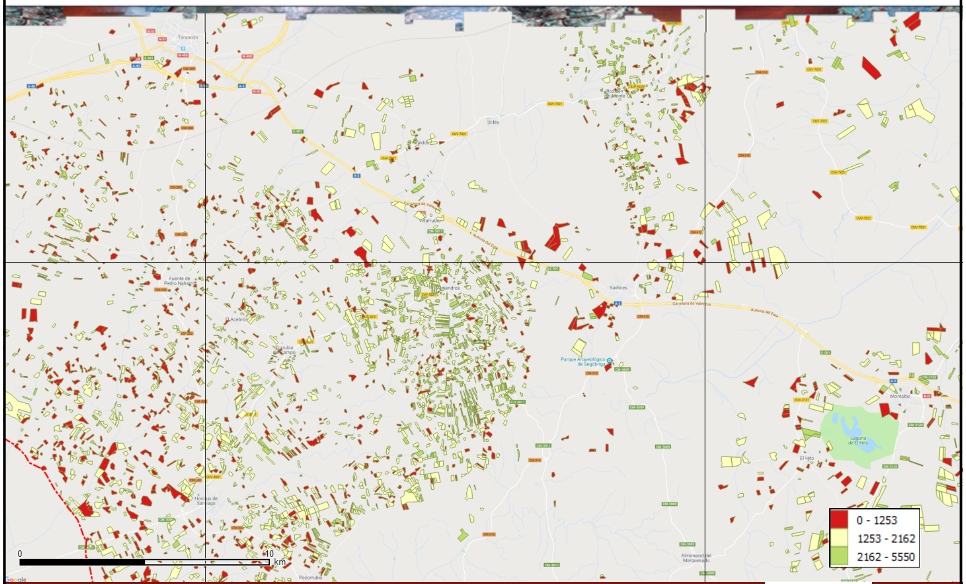
Cereal damages



Characterization of the risk of drought in cereals in the Mancha Alta (Cuenca, Spain)

agroseguro

Cereal damages



Characterization of the risk of drought in cereals in the Mancha Alta (Cuenca, Spain)

agroseguro

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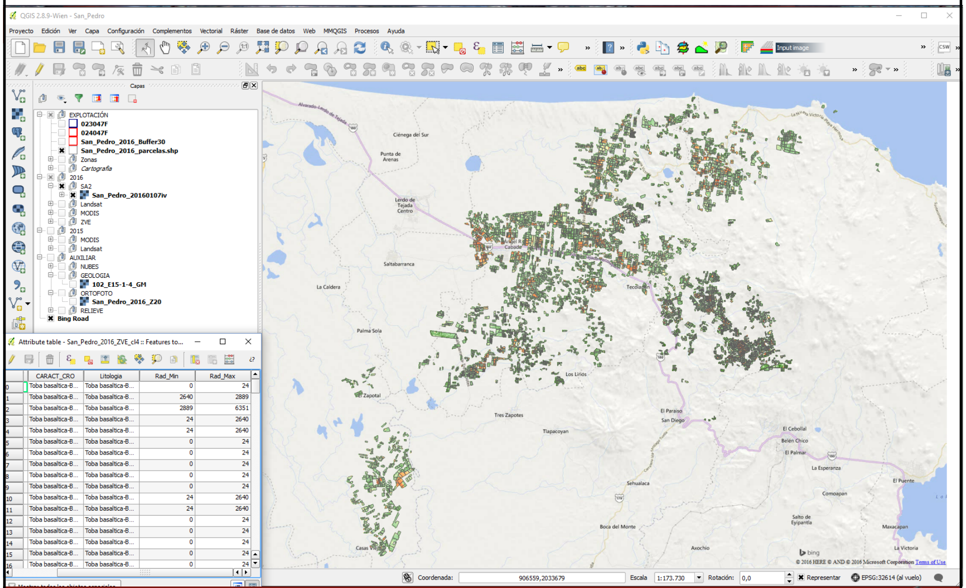
Study case

Sugarcane in Veracruz (Mexico)

If you can imagine it, you can achieve it *(Albert Einstein)*

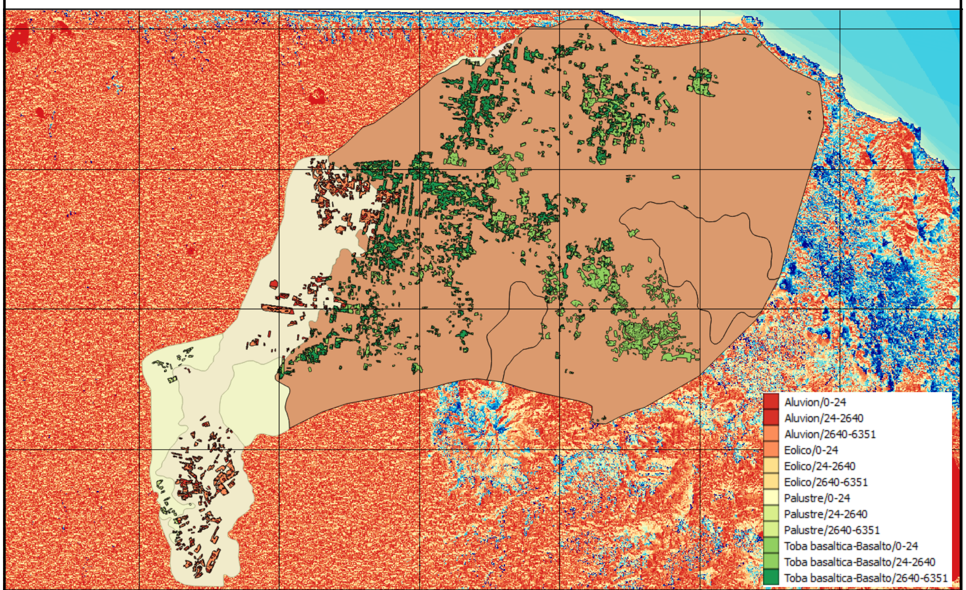
Sugarcane in Veracruz (Mexico)

GIS Implementation



Sugarcane in Veracruz (Mexico)

Zonification



Sugarcane in Veracruz (Mexico)

WorldClim Version2

WorldClim version 2 has average monthly climate data for minimum, mean, and maximum temperature and for precipitation for 1970-2000.

You can download the variables for different spatial resolutions, from 30 seconds (~1 km^2) to 10 minutes (~340 km^2). Each download is a "zip" file containing 12 GeoTiff (.tif) files, one for each month of the year (January is 1; December is 12).

variable	10 minutes	5 minutes	2.5 minutes	30 seconds
minimum temperature (°C)	tmin 10m	tmin 5m	tmin 2.5m	tmin 30s
maximum temperature (°C)	tmax 10m	tmax 5m	tmax 2.5m	tmax 30s
average temperature (°C)	tavg 10m	tavg 5m	tavg 2.5m	tavg 30s
precipitation (mm)	prec 10m	prec 5m	prec 2.5m	prec 30s
solar radiation (kJ m^{-2} day^{-1})	srad 10m	srad 5m	srad 2.5m	srad 30s
wind speed (m s^{-1})	wind 10m	wind 5m	wind 2.5m	wind 30s
water vapor pressure (kPa)	vapr 10m	vapr 5m	vapr 2.5m	vapr 30s

Below you can download the standard (19) WorldClim Bioclimatic variables for WorldClim version 2. They are the average for the years 1970-2000. Each download is a "zip" file containing 19 GeoTiff (.tif) files, one for each month of the variables.

variable	10 minutes	5 minutes	2.5 minutes	30 seconds
Bioclimatic variables	bio 10m	bio 5m	bio 2.5m	bio 30s

WorldClim.org/version2

Bioclimatic variables

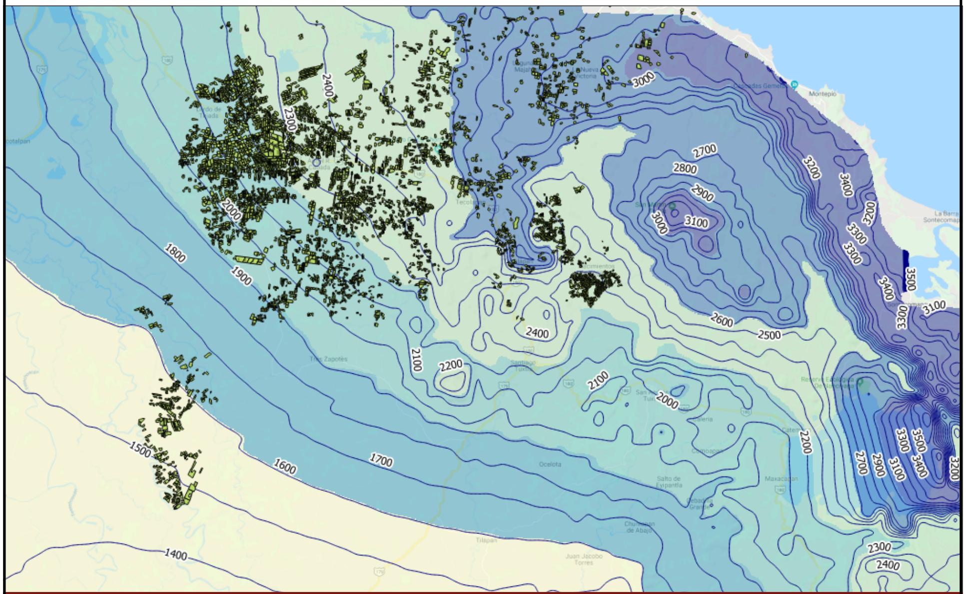
Bioclimatic variables are **derived from the monthly temperature and rainfall values** in order to generate more biologically meaningful variables.

BIO1 = Annual Mean Temperature
BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3 = Isothermality (BIO2/BIO7) (* 100)
BIO4 = Temperature Seasonality (standard deviation *100)
BIO5 = Max Temperature of Warmest Month
BIO6 = Min Temperature of Coldest Month
BIO7 = Temperature Annual Range (BIO5-BIO6)
BIO8 = Mean Temperature of Wettest Quarter
BIO9 = Mean Temperature of Driest Quarter
BIO10 = Mean Temperature of Warmest Quarter
BIO11 = Mean Temperature of Coldest Quarter
BIO12 = Annual Precipitation
BIO13 = Precipitation of Wettest Month
BIO14 = Precipitation of Driest Month
BIO15 = Precipitation Seasonality (Coefficient of Variation)
BIO16 = Precipitation of Wettest Quarter
BIO17 = Precipitation of Driest Quarter
BIO18 = Precipitation of Warmest Quarter
BIO19 = Precipitation of Coldest Quarter

A common application is **to predict species ranges with climate data** as predictors.

WorldClim.org/version2

Historical Rainfall Zonification



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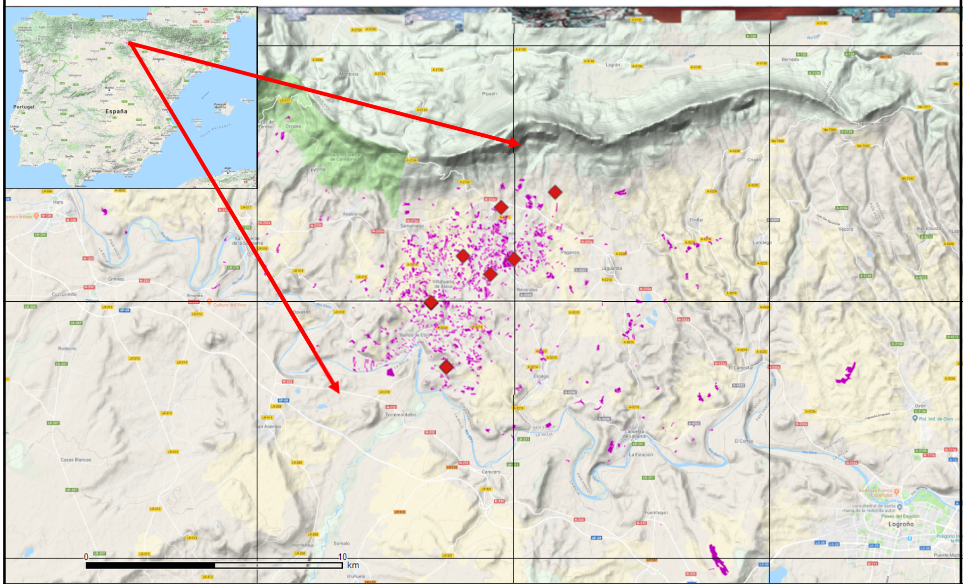
Study case

Rainfed vineyard in Rioja alta (Spain)

Everything should be made as simple as possible, but not simpler *(Albert Einstein)*

Rainfed vineyard

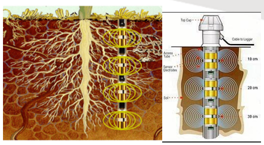


Rainfed vineyard in Rioja alta (Spain)

SMART Methodology: Temporal variability

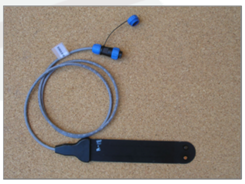
Using sensors

Climate



Soil Humidity

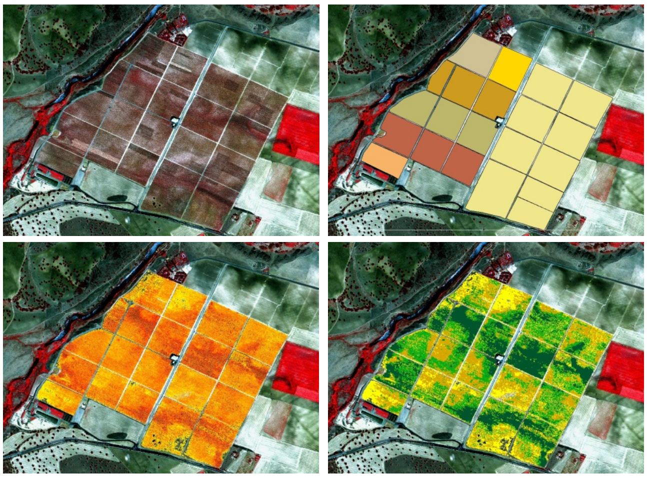
PLANTSENS Dendrometer (Patented)



Nutrition sensor (Patented)

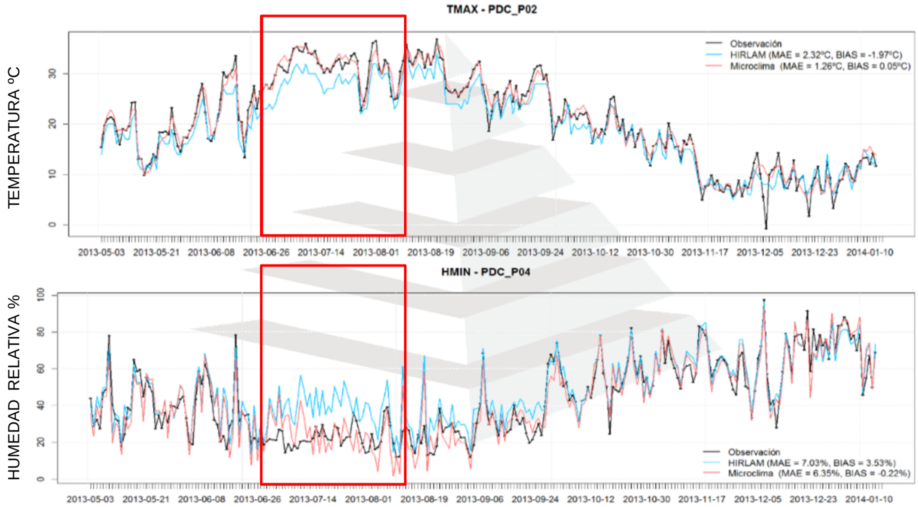
SMART Methodology: Spatial variability

Using remote sensing



SMART Agriculture

Microclimatic Forecast

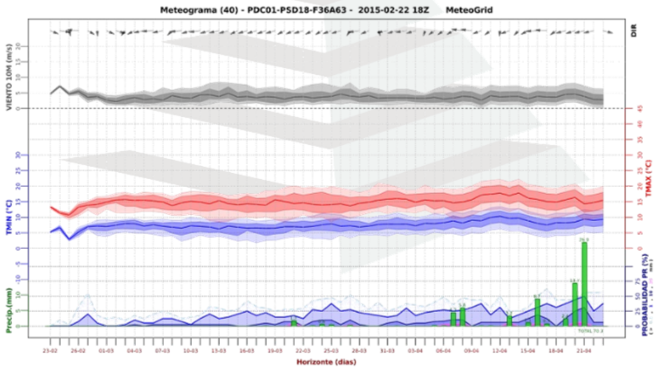


SMART Agriculture

60-days Forecast

The 60-day forecast shows the 10%, 25%, 50%, 75% and 90% percentiles of the 40 simulations for wind speed (gray), maximum temperature (red) and minimum temperature (blue). Due to the natural variability and uncertainty of the models, the long-term prediction only presents an acceptable recovery for the horizon of + 20 days. However, the predictions show a change in trends.

Predicción a 60 días



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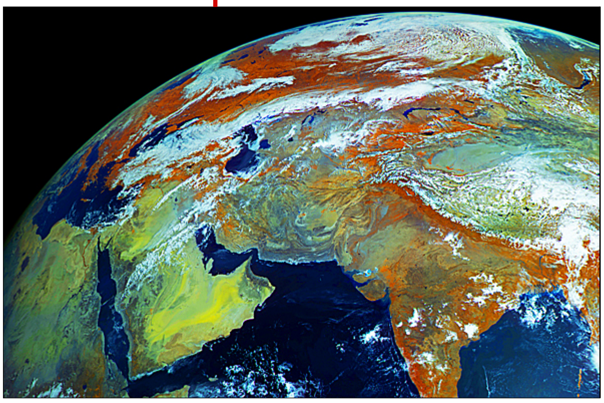
¡Gracias por su atención!



If you want to know where the wise finds the wisdom, I will tell you: In itself (Agustín de Hipona)

Tasks

- How Download QGIS software?
- How Download satellite images?
- Open Layers
- Cartographic Reference System (EPSG)
- Spectral bands
- Color composition
- Indices calculation
- Data integration
- Information Extraction

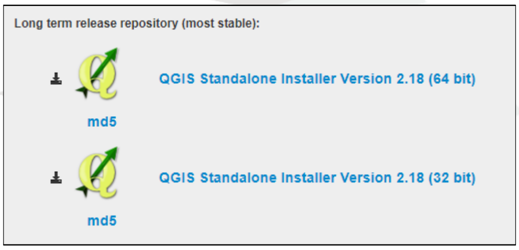
http://earthexplorer.usgs.gov

Download QGIS

QGIS is a user friendly **Open Source Geographic Information System** (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities.

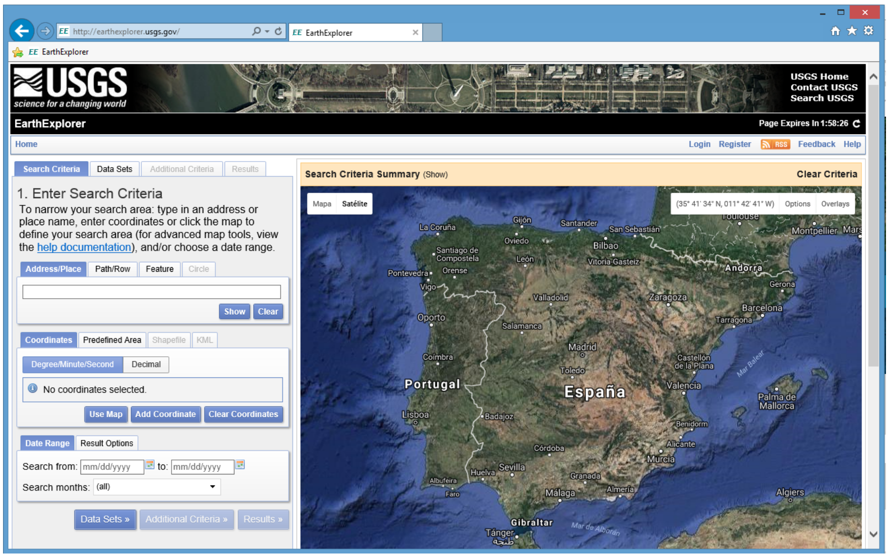
Download: https://www.qgis.org/en/site/forusers/download.html

Download Long term release!



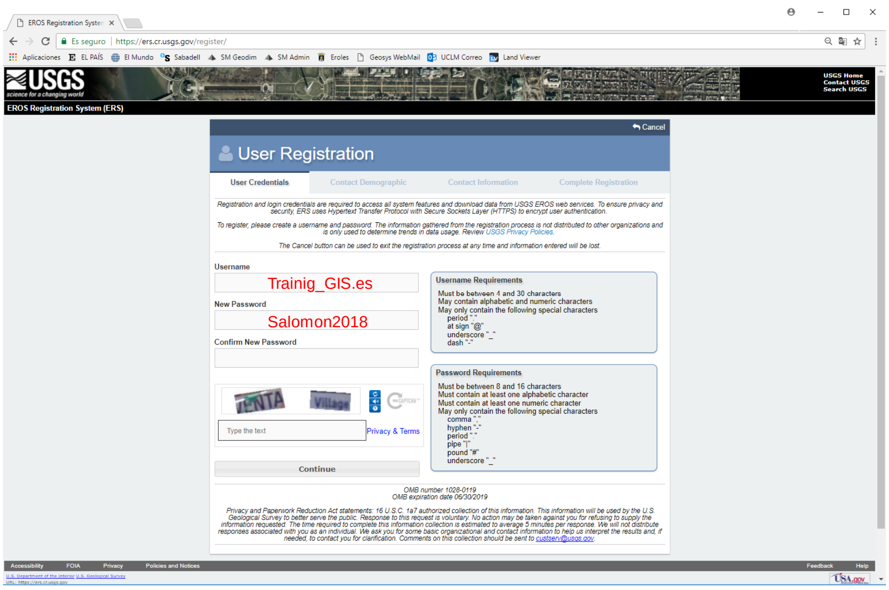
https://www.qgis.org/en/site/forusers/download.html

Image Acquisition



http://earthexplorer.usgs.gov

Image Acquisition



http://earthexplorer.usgs.gov