Customizable Drought Climate Service for supporting different end users' needs

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(IBIMET-CNR; LaMMA Consortium)

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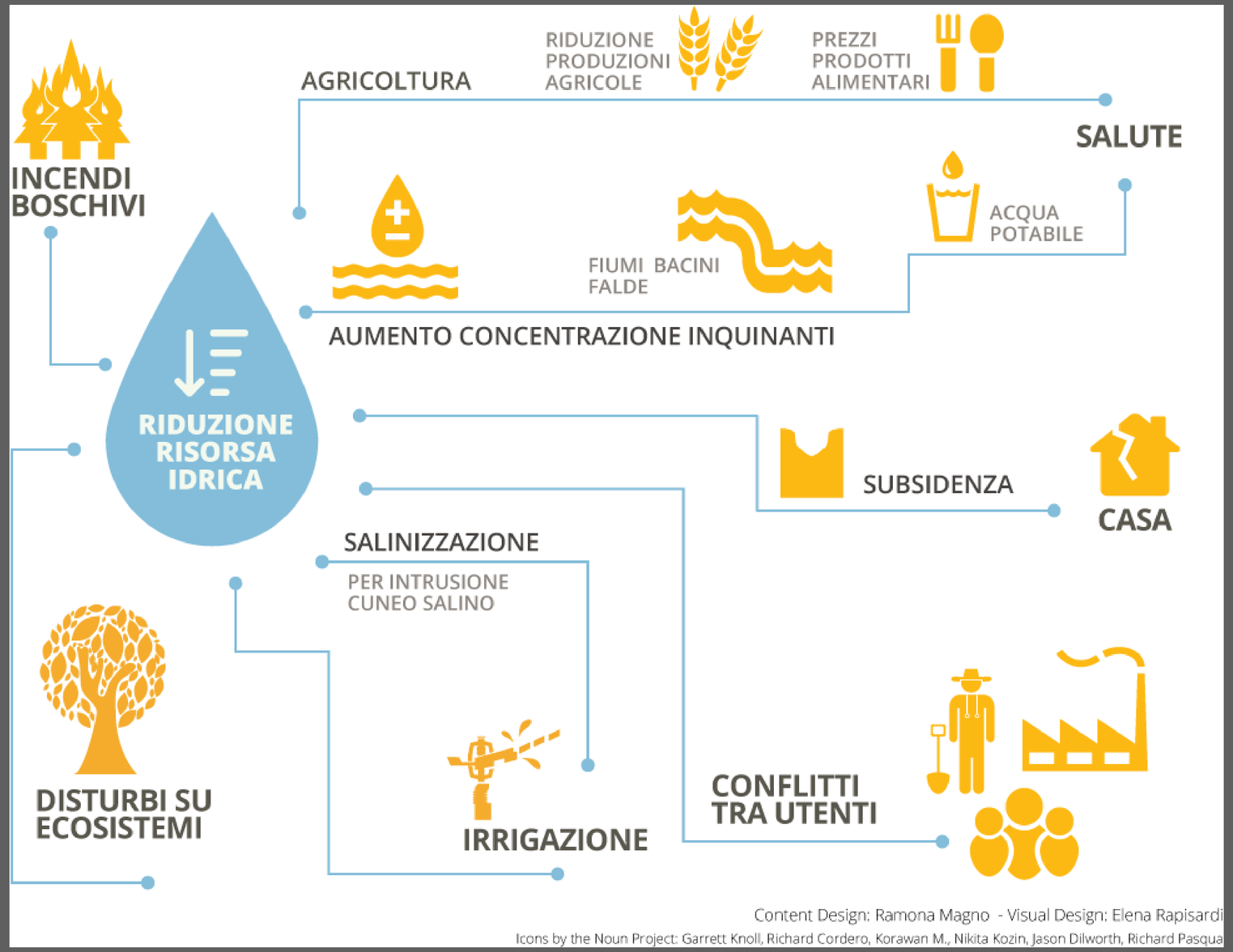


DROUGHT IMPACTS

- **2011-2012**: one of the longest dry period since 1955 in Tuscany.

  Water shortage in several areas of the region.
  Cost of 2012 drought event in Florence Province: over 50 Millions Euro of losses in crop productions and forest fires (source: Florence Province).

- **2016-2017**: over 10 Italian regions declared the water crisis.

  Cost of drought in Tuscany: 430 Millions Euro of damages estimated by Tuscany Region.

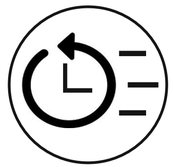
WHY

TEMPORAL GAP AND PROACTIVE SOLUTIONS

DROUGHT PREPAREDNESS

Drought development

How can we improve readiness??



Proactive solution

(Measures which enable governments, communities and individuals to respond rapidly and effectively to disaster situation)

…temporal gap …

Drought emergency management

…to support decision making process and to reduce impacts

Providing <u>simple</u> and <u>timely</u> information on current and expected drought conditions …

Implementing an integrated system of monitoring and forecasting drought status and water resource availability

COPING DROUGHT

One of the main gaps is that ***information*** on physical states and impacts is ***not optimally integrated to support different users' needs***.

To cope with and mitigate drought, is essential:

- To rely on ***formal and informal cooperation*** among national, regional and local partners that *share data and drought-related products and technologies*

- To determine drought severity and its spatial extent, ***observing current and future conditions*** (precipitation, temperature, soil moisture, vegetation health, streamflow, reservoirs levels, etc.)

- To ***share no-cost and ready-to-use data and tools*** between research institutions, government agencies, water authorities and general users ***(open-data and interoperability)***

- To ***communicate the information*** to decision makers and other stakeholders in a ***timely*** manner and ***appropriate formats***

TO WHOM

MULTI-USER OPERATIONAL SERVICE

PRIORITIES AND USER NEEDS

- Continuously updated information / Timely Dissemination
- Expandable and on-demand service
- Appropriate products / instruments supply (not simple data sharing!)

PARTICIPATORY APPROACH

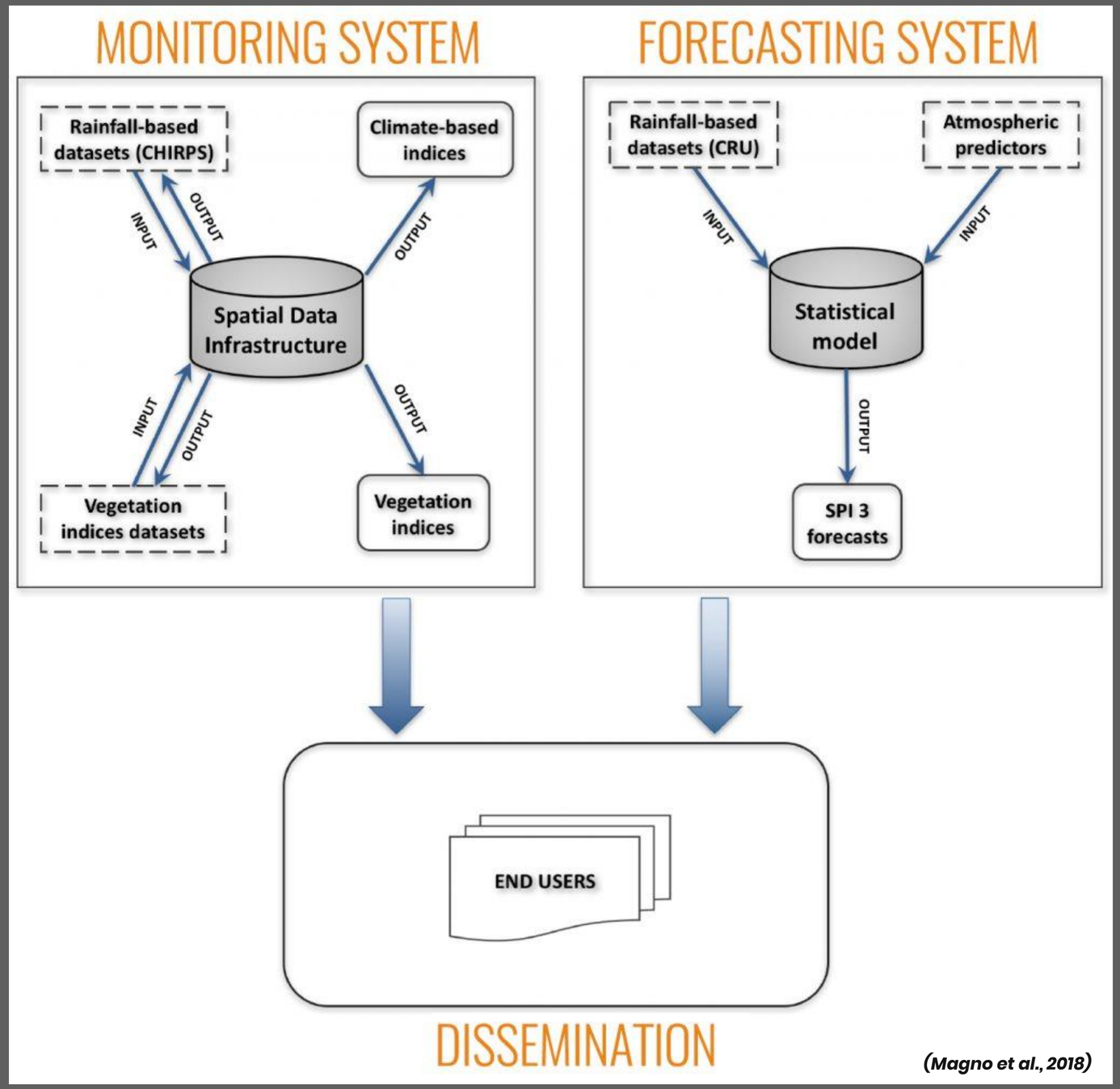
Local, regional, national and international users can ask at any time updated information more useful for their assessments or their further investigations, and even in other geographical areas covered by the available datasets.

HOW

IMPLEMENTATION OF CLIMATE SERVICE

- **Spatial Data Infrastructure**
- Open Data
- Open Source
- Interoperability
- Standardization
- Customization
- Semi-automatic / automatic updating and elaboration

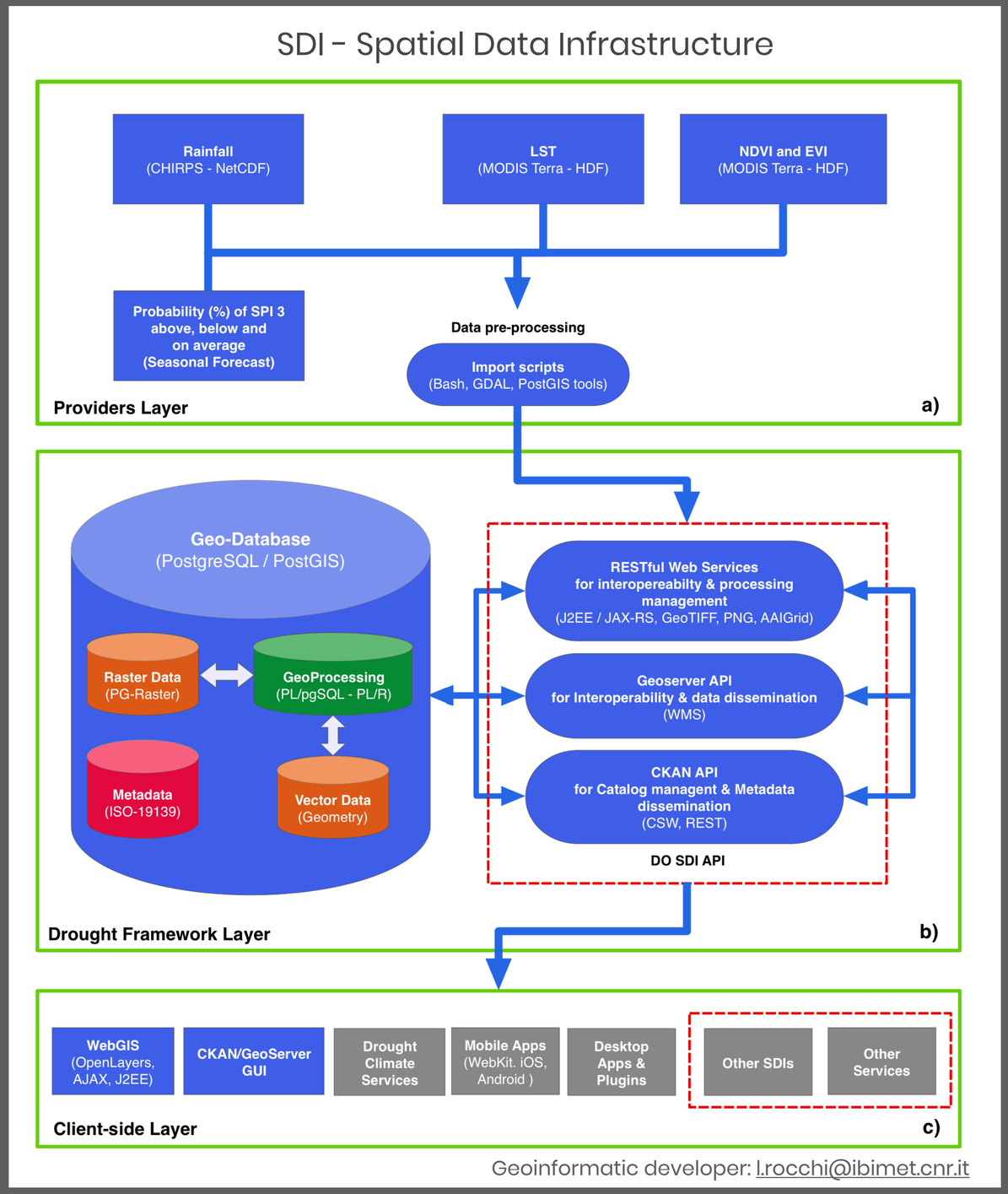
OPERATIONAL CHAIN



(Magno et al., 2018)

Components of the Drought Climate Service operational chain.

R. Magno, T. De Filippis, E. Di Giuseppe, M. Pasqui, L. Rocchi, B. Gozzini. (2018) Semi-automatic Operational Service for Drought Monitoring and Forecasting in the Tuscany Region. *Geosciences.* 8(2), 48: 1-25. doi: 10.3390/geosciences8020049



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SPATIAL DATA INFRASTRUCTURE

- The ***SDI*** built to support the DCS responds to some fundamentals ***requirements***: research data openness, interoperability, standardization, flexibility/customization, scalability, responsiveness and specific user needs.

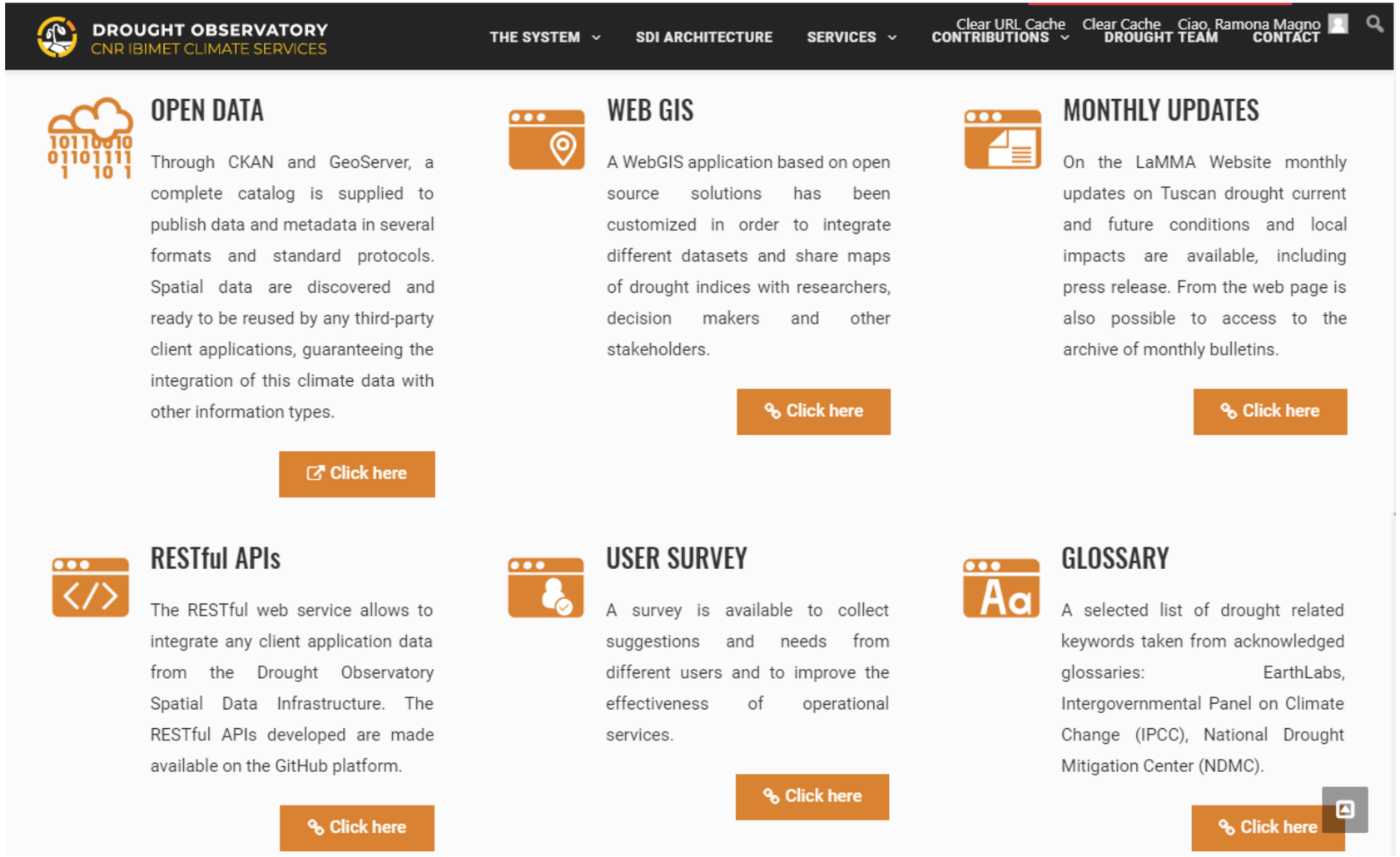
- Our user-oriented and process-based DCS SDI is focused on the ***best use of*** climate and environmental ***data*** for drought assessment and ***their translation in information***, instead of simple data sharing.

https://drought.climateservices.it/

- Open
- Interoperable
- Customizable

DROUGHT OBSERVATORY

(*Magno et al., 2018*)



- Web Services
- Standard catalog CKAN
- WebGIS Application
- Bullettins

R. Magno, T. De Filippis, E. Di Giuseppe, M. Pasqui, L. Rocchi, B. Gozzini. (2018) Semi-automatic Operational Service for Drought Monitoring and Forecasting in the Tuscany Region. *Geosciences*. 8(2), 48: 1-25. doi: 10.3390/geosciences8020049

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(*Magno et al., 2018*)

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DOWNLOADING

The downloading is possible through GET HTTP calls that get back data from the geoDB, using a URL composed by a fixed part and a variable one.

The fixed part (BASE_URL)

```
http://149.139.16.84:8080/dgws/api/download
```

The variable part is composed by three different parameters: image format, image type, period.

Image format

- *png*
- *gtiff*
- *aaigrid [coming soon]*
- *wms [coming soon]*

Image type (parameter or index)

- *tci*
- *vci*
- *vhi*
- *evhi [coming soon]*
- *spi3*
- *spi6*
- *spi12*

Period

- *year* (year of reference)
- *month* (month of reference)
- *day* (day of reference)
- *doy* (Julian day)

Syntax to download the whole image

The *day* specification is compulsory, even if we want to download monthly, weekly and two-weekly indices. The PNG images are classified, whereas the GTIFF images are saved in real.

```
BASE_URL/j_get_whole_{image_format}/{image_type}/{year}/{doy}
```

```
BASE_URL/ j_get_whole_{image_format}/{image_type}/{year}/{month}/{day}
```

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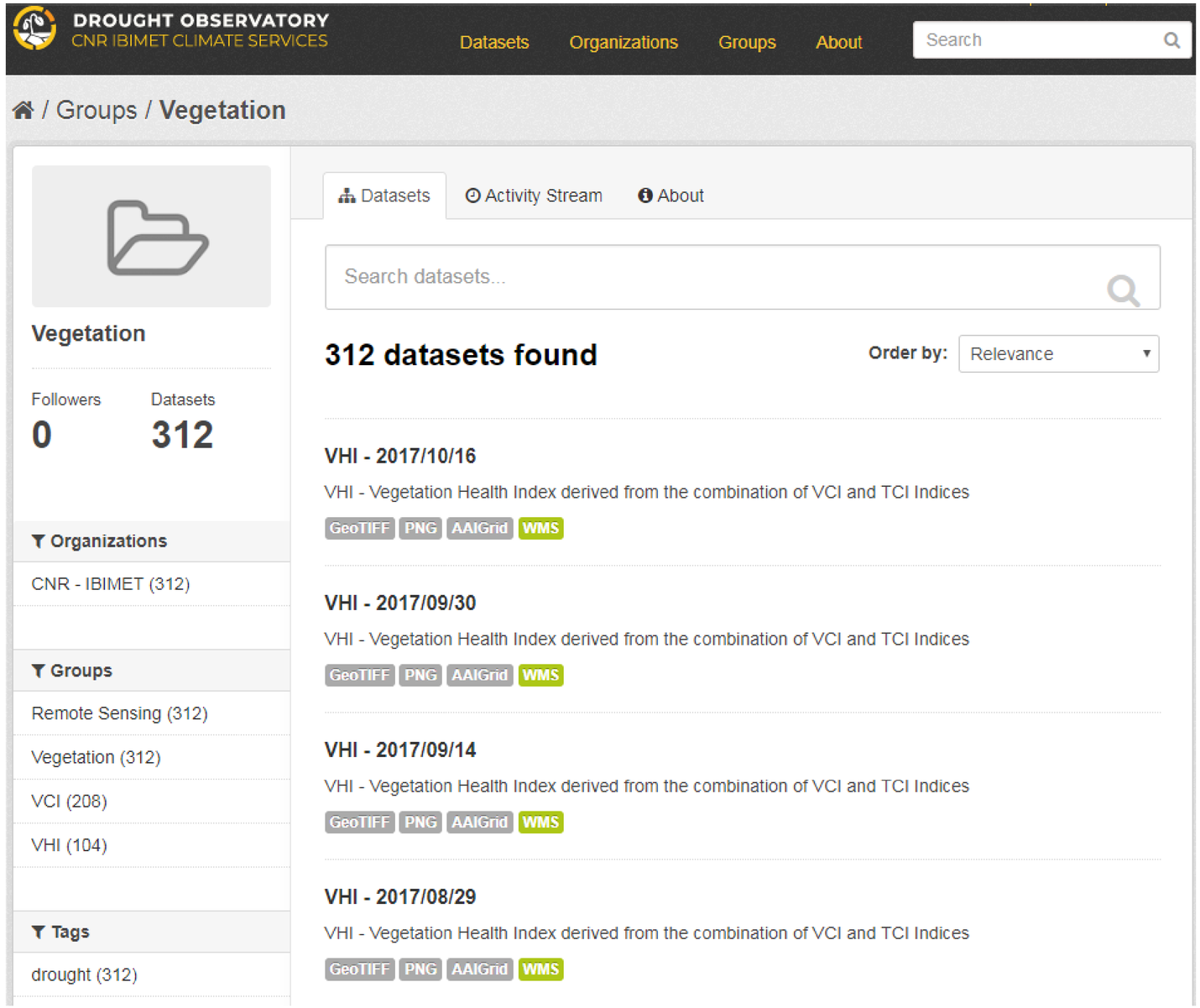
DROUGHT OBSERVATORY

(*Magno et al., 2018*)



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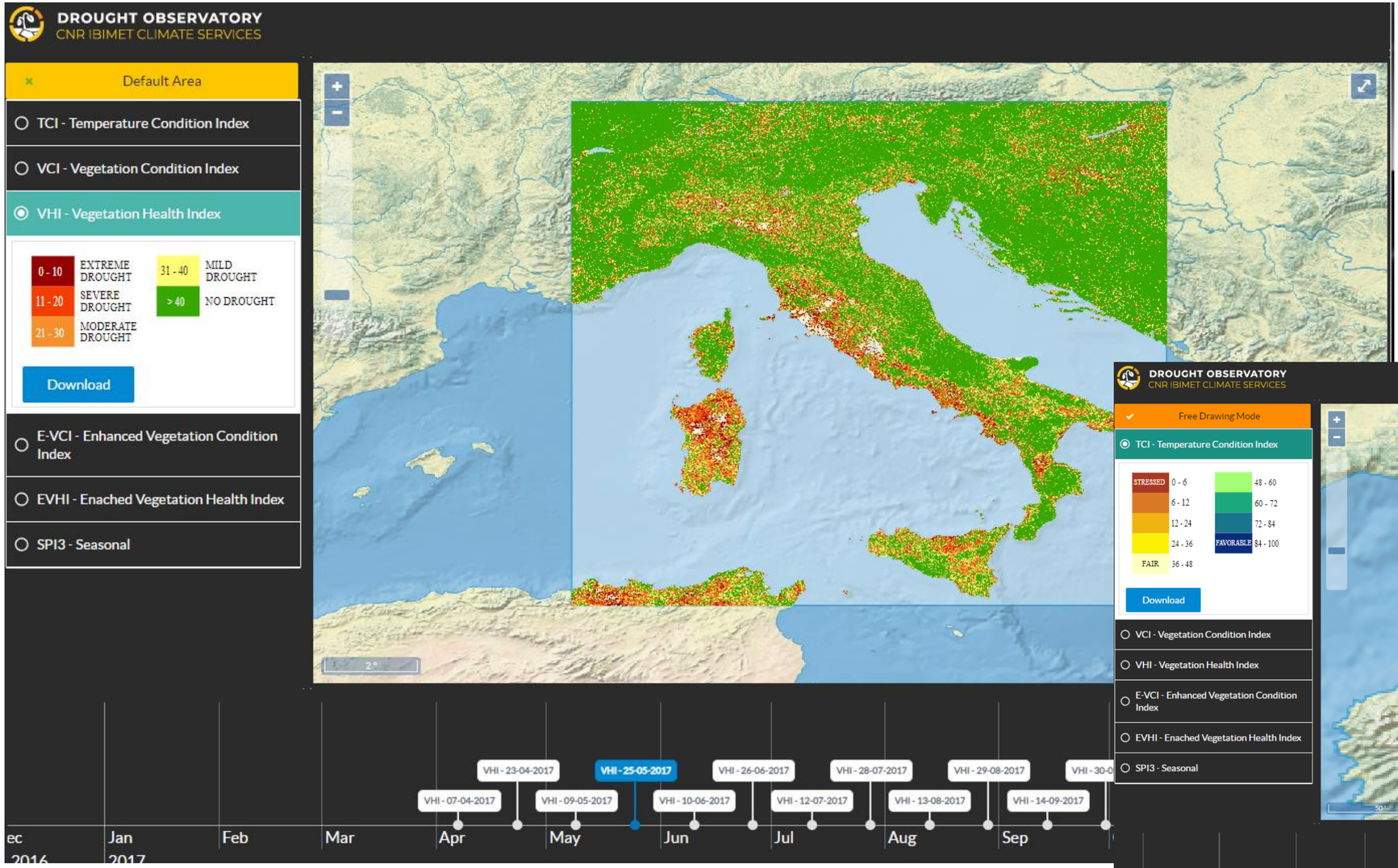

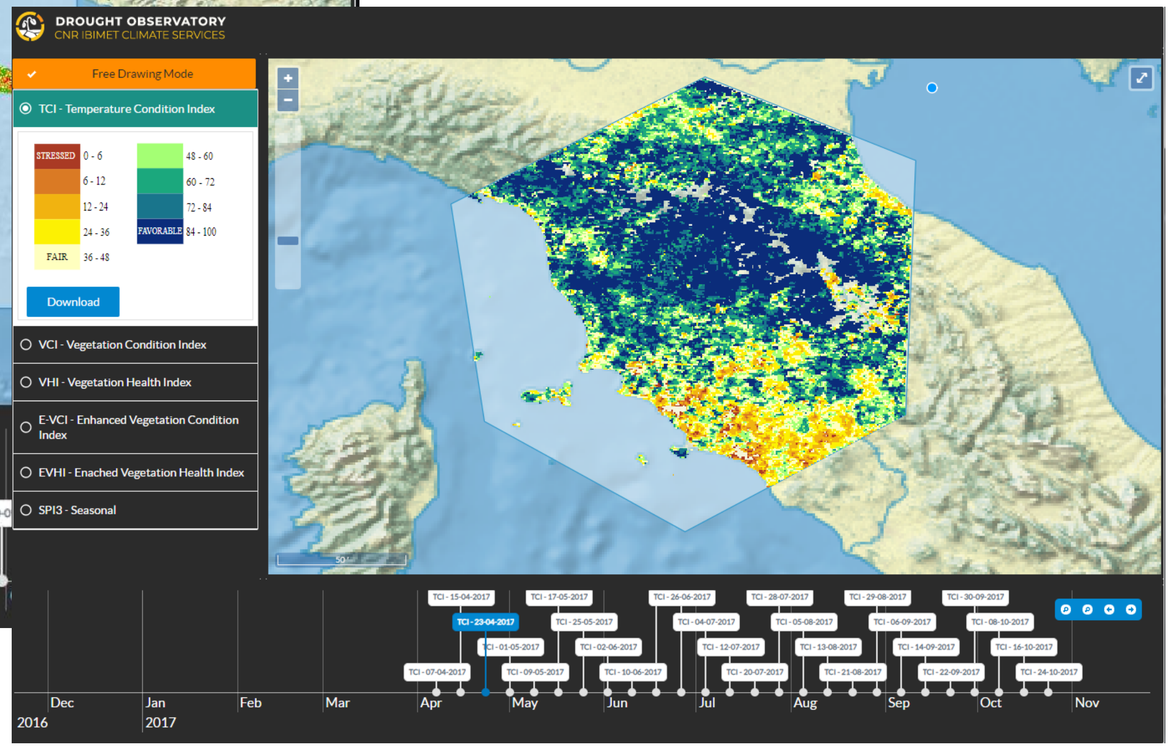

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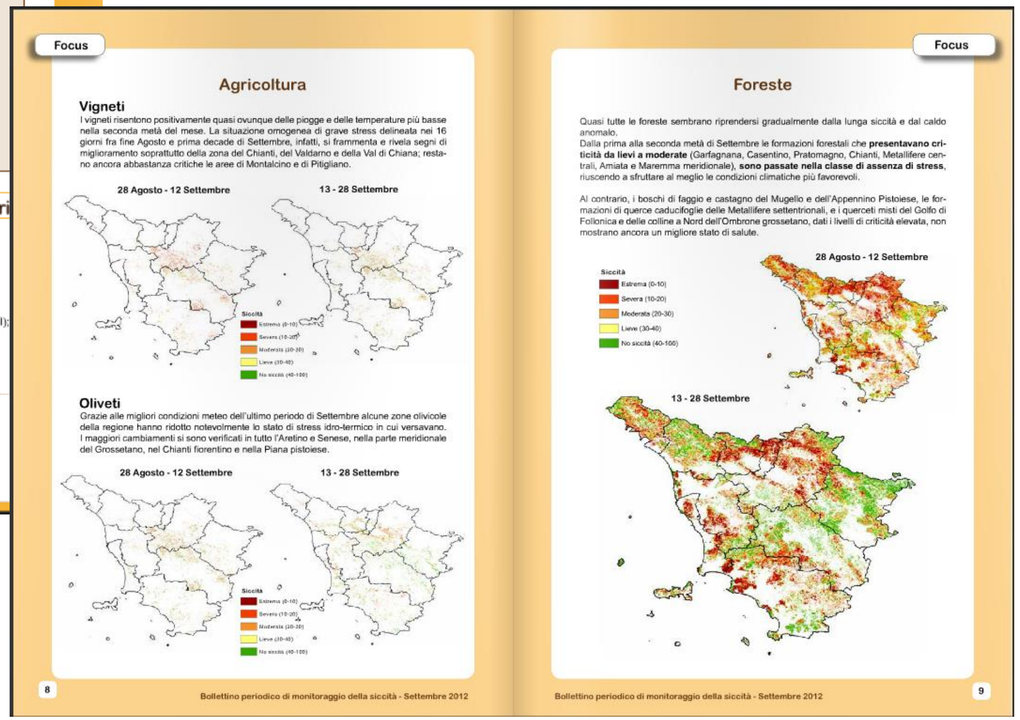
- Open
- Interoperable
- Customizable

DROUGHT OBSERVATORY

(*Magno et al., 2018*)

Previous month recap and forecasts of next months.

Analysis of forests and main crops condition (spring/summer).



On-line visualization and downloadable version

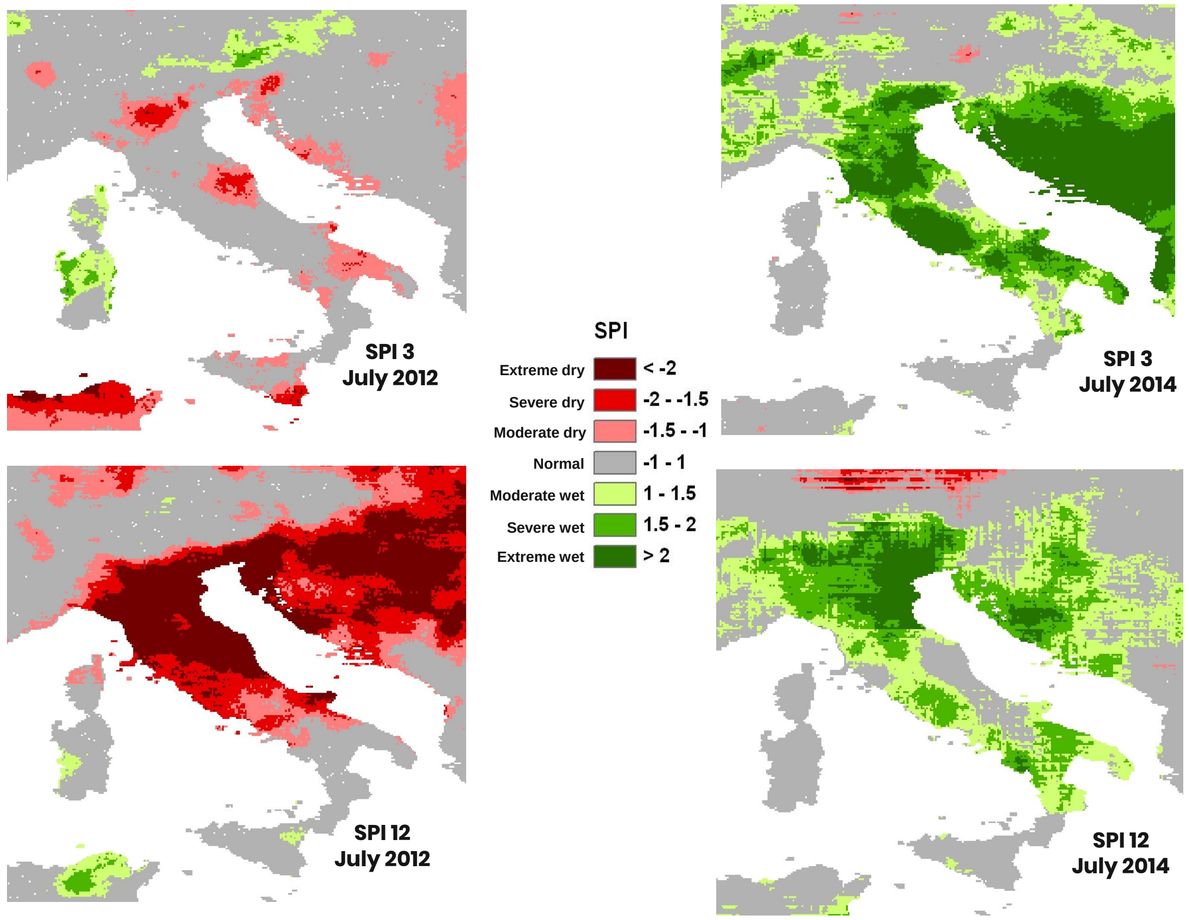
- Bullettins

https://issuu.com/consorziolamma

WHAT

MONITORING AND FORECASTING

- Remote sensing
- Precipitation & Vegetation
- Multiple indices
- Near-real time computation
- Long and continuous time series of main parameters



MONITORING

RAINFALL-BASED INDICES

SPI – Standardized precipitation Index

Monthly dataset;

Multi-temporal index (3,6, 12 months);

Long and up-to-date rainfall time series;

Standardized.

CHIRPS (*Climate Hazards Group InfraRed Precipitation with Stations*) (Funk et al., 2014)

From daily to annual data; resolution 0.05° ; from 50N to 50S; available from January 1981.

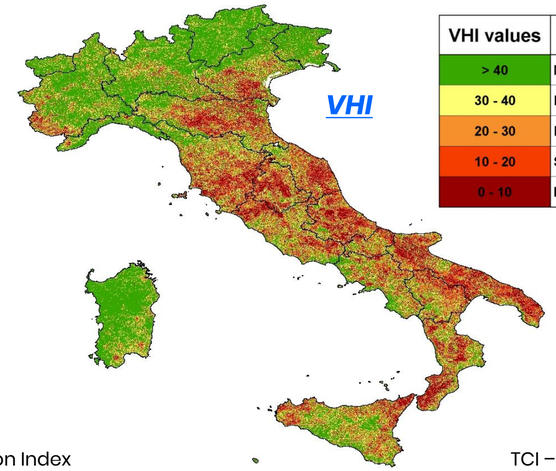
Three main types of information :
(1) global 0.05° precipitation climatologies (datasets: GHCN, GSOD, GTS, national, regional)
(2) time-varying grids of satellite-based precipitation estimates,
(3) in situ precipitation observations.

MONITORING

REMOTE SENSING INDICES

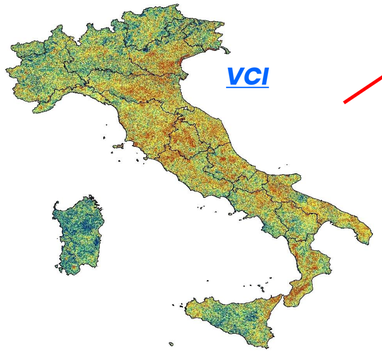
VHI – Vegetation Health Index

$$VHI = a * VCI + b * TCI$$



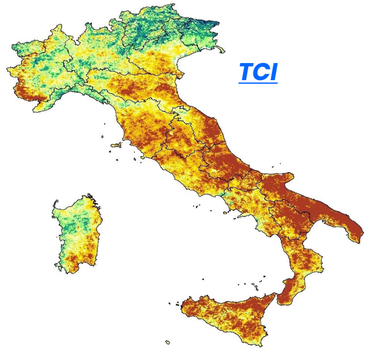
VHI values	Classes
> 40	No drought
30 - 40	Mild drought
20 - 30	Moderate drought
10 - 20	Severe drought
0 - 10	Extreme drought

VCI – Vegetation Condition Index



0 - 5.99	Stress conditions
6 – 11.99	
12 – 23.99	
24 – 35.99	
36 – 47.99	Normal conditions
48 – 59.99	
60 – 71.99	Favourable conditions
72 – 83.99	
84 – 100	

TCI – Temperature Condition Index



$$VCI_i = ((NDVI_i - NDVI_{min}) / (NDVI_{max} - NDVI_{min})) * 100$$

(Kogan, 1995)

Terra MODIS 16-day smoothed EVI & NDVI products,
250m resolution (MOD13Q1)

$$TCI_i = ((LST_{max} - LST_i) / (LST_{max} - LST_{min})) * 100$$

(Kogan, 1995)

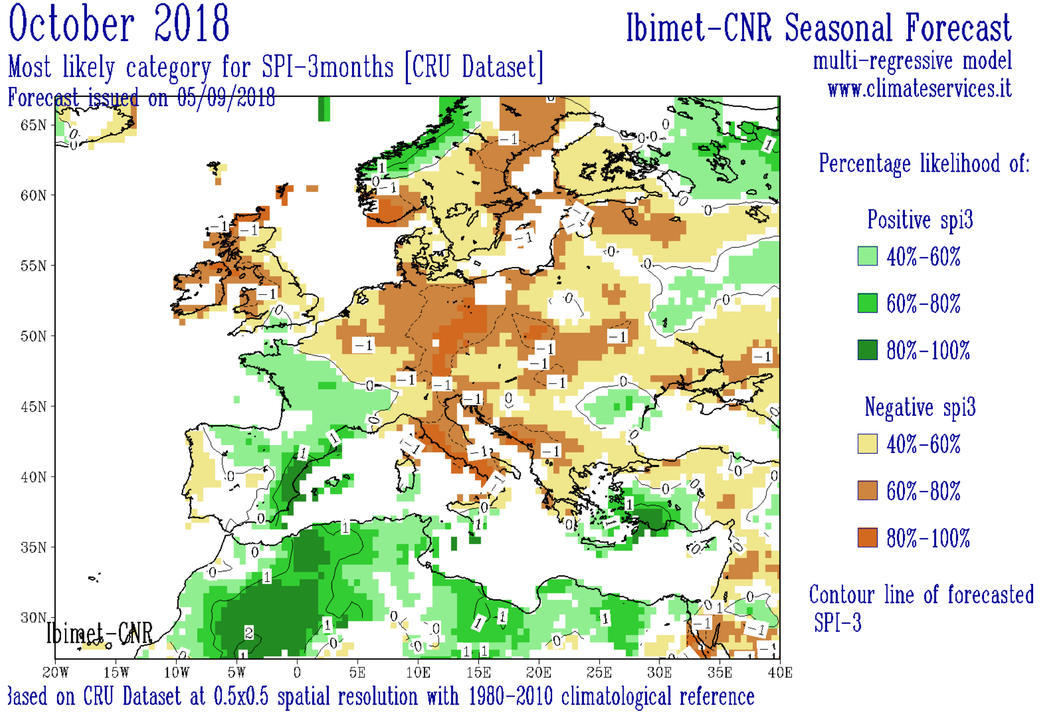
Terra MODIS 8-day smoothed LST images,
1 km resolution (MOD11A2)

✓ Frequent and detailed spatial information

✗ Application in periods with less cloud cover

VHI – Vegetation Health Index

Combination of two indices (TCI and VCI) that monitor temperature and moisture impacts on vegetation.



Authors: m.pasqui@ibimet.cnr.it e.di.giuseppe@ibimet.cnr.it

SEASONAL FORECASTS

- First phase (***selection of predictors***): double step procedure to select the best MR model in terms of predictive performance, i.e. which are the large scale atmospheric drivers (and their lags) to use as predictors for SPI3.
- Second phase (***estimation of parameters***): estimate the value of MR parameters that reproduce the linear relation between SPI3 and each driver selected at 1).
- Third phase (***extrapolation***): use the parameter estimates obtained at 2) to predict future SPI3 anomaly.

CRU (*Climatic Research Unit – University of Est Anglia*) (Harris & Jones, 2017)

CRU TS v. 4.00: monthly long data series (1901-2015) of several parameters (min and max temperature, precipitation, etc.); 0.5° spatial resolution.

SPI - 3 months forecast (***Magno et al., 2018***)

Empirical physically-based approach (Multivariate Regression Model) to predict meteorological drought using the SPI 3 index.

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NEXT STEPS

NEW INDICES, NEW IMPROVEMENTS

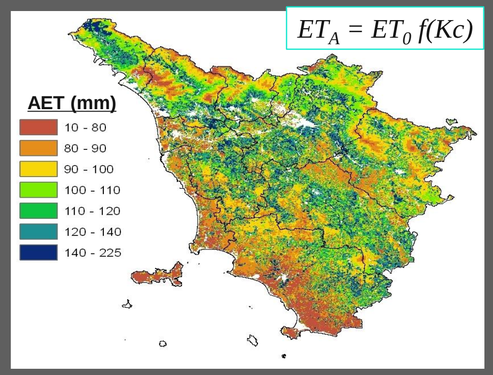
- AET – Actual Evapotranspiration
- Soil Moisture

Soil moisture

AET – Actual Evapotranspiration

Separation of Evaporation and Transpiration processes.

Inclusion of short term water stress (Cws & AW).

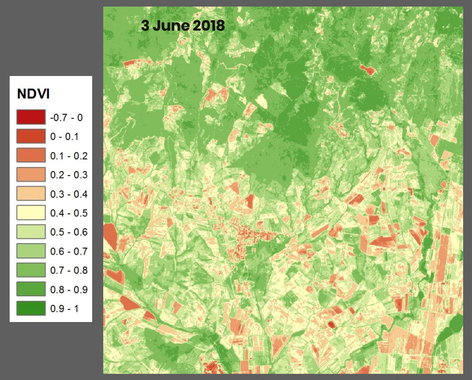


$$AET = ET_0\ (FVC*Kc_{Veg}*Cws + (1-FVC)*Kc_{soil}*AW)$$

(Chiesi et al., 2013; Maselli et al., 2014)

Downscaling for on-demand analysis at local level

Implementation of new indices based on high resolution satellite data



Sentinel 2 (10m resolution)

NEW INFORMATION

Ongoing collaborations for sharing information at different levels and for specific needs (from precision agriculture to regional/national drought monitoring).

Help us to improve the Drought Observatory for Climate Services:

https://drought.climateservices.it/survey/

Get Connected

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