Technical sheet

Policy
Europe: *RDP 2014- 2020. Priority N. 4, promoting resource efficiency and supporting the shift toward a low-carbon and climate resilient economy in the agriculture, food and forestry sectors. https://ec.europa.eu/sfc/en/2014/quickguides/PRGEAFRDP#-priority-1-5858*
Italy: *Azioni del programma Rete Rurale Nazionale. Azione 4.2.1 Servizi per la diffusione della innovazione. C:/Users/Admin/Downloads/Allegato_azioni_RRN_Rev_Dic_2016..pdf; Law n. 4/2011 National Integrated Production Quality System; National guidelines for integrated crop production / phytosanitary defense and weed control (DM n.4890 of 08.05.2014)*
Campania Region: *Integrated Production Regulations of the Campania Region (Decree n. 29 of 29.02.2019); Technical Rules for Defense Plant Health And Integrated Weeding ff Crops (Decree n. 27 of 19/03/2019)*

First draft

TOOL AGROCLIMATIC SERVICES – *Territorial Scale: Regional*

WHY
Agriculture management and planning require knowledge of both past and forecasted weather data. The space-time variability of weather data affects both the feasibility of some on-farm agronomic practices (such as tillage, fertilization) and crop growth dynamics and yield. Past and future climatic scenarios can be exploited in order to plan on-farm operations and resource provision as well as to reduce crop vulnerability to climatic uncertainties. Short and medium term weather forecasts may be exploited for the real-time scheduling of agronomic applications (e.g. irrigation and fertilisation scheduling) in order to optimize resource consumption and prevent losses due to weather anomalies. These farm management strategies are also fundamental for reducing the environmental impact of agriculture and increasing farm revenues.
FOR WHOM
The “Agroclimatic Services” tool can be used by both single farms and farm associations/consortia that manage agricultural activities affected by weather conditions. The tool is also of interest for stakeholders (e.g. environmental protection authorities, water catchment authorities, landscape planners) who are responsible for regional and local planning of the use of land and other environmental resources.

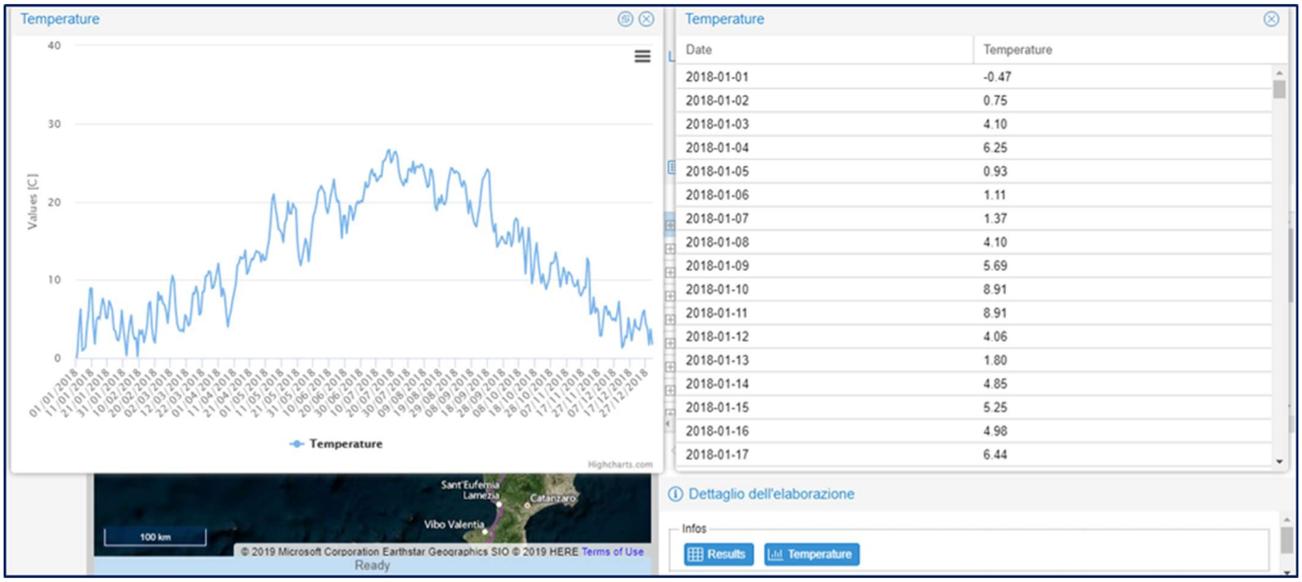
HOW – if you want to *select your Region Of Interest (ROI)*[i]
The tool can provide data for any site within the Campania Region, Marchfeld and Zala County. The user can select the Region of Interest (ROI) and retrieve the data of interest through a very simple procedure:
Operational procedure

- Click on the "Draw (Polygon)" button on the top bar and draw the ROI boundary;
- Assign a name to the selected ROI[ii];
- Click on the "Save" button to keep the ROI available in the system for further queries.

TOOL AGROCLIMATIC SERVICES

HOW – if you are interested in retrieving “CLIMATE - RECENT AND FORECAST CLIMATE TIME SERIES”

Operational procedure
By selecting the "Recent and forecast climate time series" icon from the Toolbox, the user can retrieve mean values of daily time series of rainfall, temperature, wind speed and relative humidity for any time interval from four months before the current date up to 5 days ahead. These time series are retrieved from the limited ensemble prediction system COMO-LEPS[iii].
The data can be analyzed in the "Results" section. Results are individually displayed by selecting the operation of interest in the "Elaboration detail" section. The data are not point data (which cannot be delivered) but mean values obtained after a zonal statistic over the ROI. The data can be displayed in a table and plotted on a graph (figure in the next page: temperature). Table and graphs can be downloaded into different file extensions.
What for
The tool can be exploited for the sustainable management of resources and planning at farm level. For example, an analysis of rainfall temporal patterns, coupled with the type of soil and terrain attributes, can be used for assessing soil hydrological conditions and, thus, irrigation planning. Temperature data can be used to predict plant phenology. The same data can be used to plan agricultural land use when combined with soil maps.



TOOL AGROCLIMATIC SERVICES

HOW – if you are interested in retrieving "CLIMATE – HISTORICAL TIME SERIES"

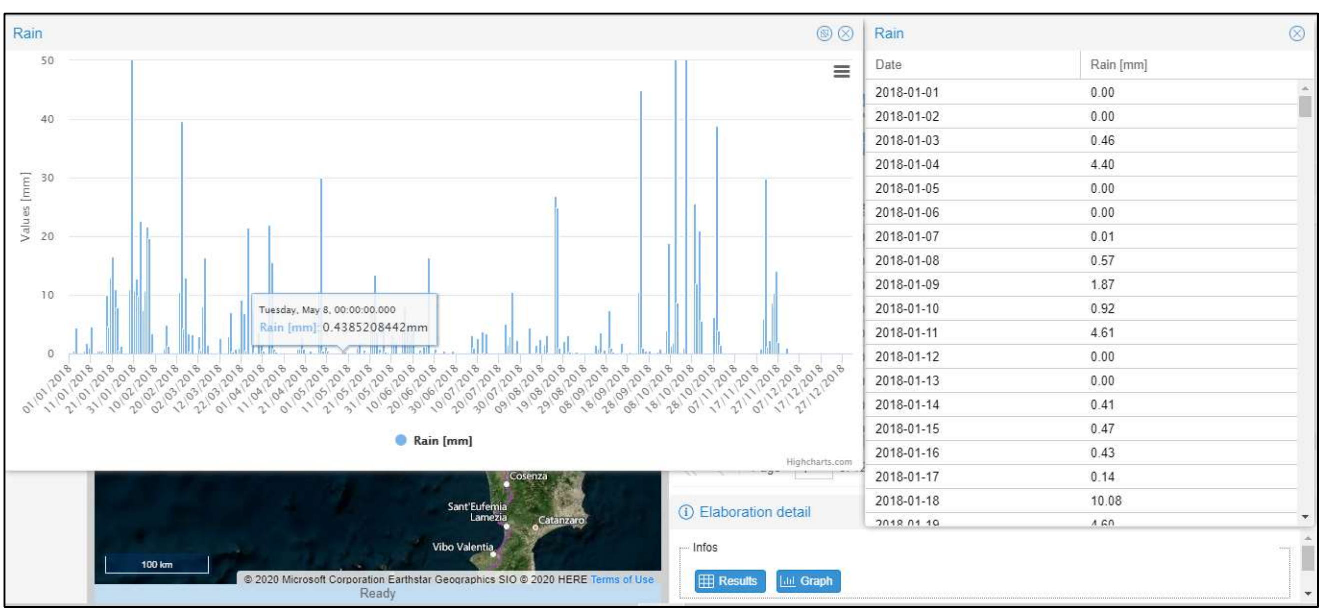
Operational procedure

By selecting the "Historical time series" icon from the Toolbox, the user can retrieve mean values of daily time series of rainfall, temperature, wind speed and relative humidity for any time interval from 01/01/1981 to four months before the current date. These time series belong to the climate reanalysis database ERA5-Land[iv].

The data can be analyzed in the "Results" section. Results are individually displayed by selecting the operation of interest in the "Elaboration detail" section. The data are not point data (which cannot be delivered) but mean values obtained after a zonal statistic over the ROI. The data can be displayed in a table and plotted on a graph (figure in the next page: temperature). Table and graphs can be downloaded into different file extensions.

What for

The tool can be exploited for the sustainable management of resources and planning at farm level but also at regional/national level. For example, past weather data can be used for assessing irrigation water volumes and, thus, planning structural and investments funds for improving agricultural water management. Then, past weather data can be used as input of a great variety of environmental models. Moreover, these data may represent a reliable source of comparison for evaluating different climate future scenarios and change.



LIMITATIONS

Both reanalysis data and weather forecasts are obtained by assimilating land surface observations into very complex and advanced physically-based models. However, the quality of the numerical weather reconstructions and previsions is subjected to these limitations: (i) model resolutions cannot resolve the small scale spatial variability of weather conditions, especially in areas with complex terrain features (hills, mountains); (ii) weather data are subject to the uncertainties generated by the NWP model simplifications of atmospheric physics and by assumptions and errors made on model parameters, initial and boundary conditions. These latter circumstances are amplified by the chaotic nature of the atmospheric processes.

Moreover, reliability and performance of NWP outputs may not be uniform over a large area, such as Europe, because of both the above-mentioned heterogeneous terrain features and the fact that meteorological service providers tend to optimize the algorithms and model parameters for specific areas of interest.

However, the NWP models and reanalysis dataset are frequently updated by meteorological service providers to overcome these limitations so that the system has to be flexible enough to adapt and deal with the most advanced meteorological data. In general terms, there is a large bulk of scientific literature that address the above limitations (for further info write to landsupport@unina.it).

FUTURE DEVELOPMENT

The following developments are foreseen: (i) integration of NWP model data (both reanalysis and real-time weather forecasts) with ground measurements provided by the ground-based weather stations in selected regions of Italy (Campania Region, URCOFI database), Austria (Marchfeld) and Hungary (Zala Country) to reduce model errors and uncertainties by means of statistical post-processing techniques [Pelosi et al., 2017]; (ii) inclusion of performance statistics related to the different sources of NWP model data with respect to the reference ground observations in the above-mentioned selected regions of Italy, Austria and Hungary.

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[i] Special care is required when user draws/select the Region of Interest. In fact LANDSUPPORT is a multi-scale decision support system. Each of the 15 available tools is designed for a specific application and for a specific scale. Furthermore, the databases using specific standards required for that specific scale. The users of LANDSUPPORT web platform must therefore be well aware of the limitation embedded in the different maps that they require for their specific application. The users must be expert on their specific problem and must understand if the input data offered by the platform are suitable for their problem. In light of the above, the system provides very reliable results only if used appropriately.

[ii] It is also possible to draw a ROI with numerous polygons. In this case, it is possible to assign different values (eg numbers) to each of the drawn polygons.

[iii] Data sources (and benefits). Real-time numerical weather prediction (NWP) models are employed to provide the best assessment of the weather over the last four months up to the current date and for weather forecasting up to 5 days ahead.

Current and forecast weather data are based on the limited area ensemble prediction system, COSMO-LEPS with a spatial resolution of 7 km.

Forecast performances of NWP models have considerably improved in the 21st century [Bauer et al., 2015]. Regional NWP models, such as COSMO-LEPS, give reliable outputs, with finer spatial resolution than the global circulation models, and represent a great source of data for hydrological and agricultural science applications [among others: Pelosi et al., 2016; Chirico et al., 2018]. Moreover, ensemble prediction systems make it possible to treat explicitly uncertainties associated with the forecasts. The development of the operational limited area ensemble prediction system (LEPS) was mainly driven by the need to support decision makers with forecasts of high-impact weather events and, particularly, precipitation fields at a higher level of resolution and reliability than could be achieved with single deterministic regional forecasts. One of the first examples was the limited area ensemble prediction system, developed by the Consortium for small-scale modelling (COSMO-LEPS), which is implemented by the Regional Hydro-Meteo-Climate Service of Emilia-Romagna (ARPA–SIMC) and is operationally used by several countries in Europe [Montani et al., 2011; Marsigli et al., 2014].

Here we clarify that this tool does not provide original COSMO-LEPS data (those can be required interacting with Arpae-Emilia Romagna SIMC Struttura Idro-Meteo-Clima). Our tool allows only either (i) the visualization of output of models using COSMO-LEPS data or the visualization of COSMO-LEPS processed (e.g. zonal statistics) data (for more information visit the website http://www.cosmo-model.org/content/tasks/operational/leps/).

[iv] Data sources (and benefits). Reanalysis models provide the best weather reconstruction for up to four months before the current date. Reanalysis data are based on the outputs of ERA5-Land with a spatial resolution of 9 km [ERA5-Land on line documentation; Pelosi et al., 2020].

The choice of reanalysis data as proxy of past weather data in place of ground-based meteorological observations depends on the following considerations: (i) having access to observed weather data is difficult due to data policy and management, especially in a wide, heterogeneous context such as Europe, (ii) in such a context, the unevenness of the observational network may also represent a source of enhanced errors and uncertainties in areas with an insufficient network density; (iii) the climate data variable estimations obtained by statistical spatial interpolation of sparse meteorological ground stations are often affected by great uncertainty, (iv) on the other hand, the reanalysis models seek to combine optimally information included in observations from several data streams (even satellite data) and models that obey known physical laws exactly.

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