

HPC and open climate data for climate-proofing water and natural resources management

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The Highlander (HIGH performance computing to support smart LAND sERvices) project, funded by Connecting European Facility, processed data for generating climate forecasts and reducing the risks associated with climate change, for a smarter and sustainable management of natural resources and the territory.

New datasets for the reconstruction of recent past climate were developed by CMCC by dynamically downscaling ERA5 reanalysis, originally available at ≈ 31 km horizontal resolution, to ≈ 2.2 km resolution, covering the whole Italy so to provide a very detailed and comprehensive dataset of climatological condition for 30 years (01/1989-12/2020).

A similar effort is ongoing to downscale at 2.2km climate data from a global climate models, still over Italy, from 1989 to 2050 so to evaluate climate variations expected in the future using the IPCC scenario RCP8.5 with respect to a the recent historical period (1989-2020).

Moreover, ECMWF developed the post-processing output of statistical downscaled sub-seasonal forecasts over Italy using the ecPoint technique, delivering probabilistic forecasts at point-scale of global 24-hour precipitation and minimum, maximum and mean temperatures in 24h for weeks three and four of the forecast (days 16-30). This product allows to obtain more reliable climatological representations than the raw model output - e.g. numbers of dry days, numbers of very wet days and amounts of rainfall on the very wet days, facilitating agricultural planning.

The very high resolution climate and forecast runs have been performed on the GALILEO and GALILEO100 supercomputers of CINECA, that allowed to obtain them respectively in 3 and approximatively 5 months (estimated) using dedicated nodes (from 30 to 60), corresponding to 1000 - 2160 cores, and employing more than 12M core hours. To date, climate datasets produced in HIGHLANDER are at unprecedented spatio-temporal resolution to reconstruct climate in the last decades and projecting climate at least in the next 30 years for Italy. Enlarging such experiments to Europe is valuable and will need larger resources that can be obtained only through PRACE/EuroHPC.

Similar datasets serve downstream services for decision support system. Some examples concern:

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- **Soil erosion**, which reduces soil thickness and fertility or causes physical damages to agricultural fields. The climate dataset produced in HIGHLANDER fed 12 algorithms to calculate rainfall erosivity within the empirical Revised Universal Soil Loss Equation
- **Human and animal wellbeing**, function of combined air conditions making the working or living environment more or less suitable and comfortable. The climate dataset produced in HIGHLANDER is used to feed 4 indicators based on temperature, relative humidity and wind regimes.
- **Crop water requirement sub-seasonal forecasts** conceived to support irrigation consortia that need support in their decision-making to increase water use efficiency. This service produces every week subseasonal forecasts (+1 month) of water irrigation demand for specific areas during the season ranging from April to September.

All the datasets and climate services produced are accessible through the HIGHLANDER portal, which can contribute to the Destination Earth initiative to ensure the timely development of “replicas” on climate trends, variability and extreme events, and related impacts.

DOMAINS:

Climate Change, Agriculture, Water Resources, Health, Soil