IDROCLIMA: A CLIMATOLOGIC MAPPING OF SOIL WATER CONTENT FOR TRENTINO

IDROCLIMA: UNA MAPPATURA CLIMATOLOGICA DEL CONTENUTO IDRICO DEI SUOLI IN TRENTINO

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Abstract
Project IdroClima (co-funded by the Climate change Fund of the Autonomous province of Trento) had the aim of studying the high-resolution (500 m) water content of Trentino soils. The water budget model GEOtop was applied to a 23-year period (1990-2012), corresponding to the hourly coverage of meteorological data. GEOtop accepts a thorough meteorological input, including several atmospheric variables. Pedology was described with a uniform soil, with 7 layers, owing to the lack of gridded information. Soil use has been input according to the CORINE Land Cover classes. A qualitative validation of the model was done with pre-existent probe measurements (2006-2008). The possible processing of results are multiple: the main results are analyzed and discussed in this work.

Keywords
water soil content, GEOtop, Trentino, climate
Parole chiave
contenuto idrico dei suoli, GEOtop, Trentino, clima

Introduction
Water cycle among atmosphere, soil and vegetation cover is affected by the ongoing climate change. The assessment of soil water content can be obtained by resolving two budget equations: mass conservation and energy conservation. The project aims at the creation of a database that will be included in a space-time storage and processing platform, envisaging climatologic purposes.

Methods
The simulations were carried out with the hydrological model "GEOtop" (Endrizzi *et al.*, 2011, 2013), with a resolution of 500 m, for the period 1990-2012. GEOtop is a physically-based model which analyses the hydrological cycle with an integrated approach on a basin. The model accepts as input the topographical features (DTM), which are processed to calculate useful indices for the balance, such as slope, aspect, shading, sky view factor. The hydrological features of soil, detailed on a number of vertical layers, are included in the model input to simulate water infiltration and runoff. The model accepts a number of physical quantities as input: temperature, precipitation, solar radiation, relative humidity, wind velocity and direction. Hourly data from 126 stations were supplied by Meteotrentino and Fondazione E. Mach.
All grids in the space domain correspond to pedological and soil use classes. Given the unavailability of pedological information, all soil types were unified to a uniform class (sandy clay loam), from which the hydrological quantities were calculated by the van Genuchten - Mualem parameterization. Corine Land Cover classes were used for soil use.

Results and Discussion
To verify simulations, a likelihood of results was sought from the comparison with data measured with a capacitive probe in the period 2007-2008 at three points (Fig. 1). Dynamics at 1 m depth are clearly negligible. For space reasons, mapped results are given here at one depth (0.23 m) and for one summer month. Values can be conveniently referred to the map mean, in order to show the relative value at each grid.

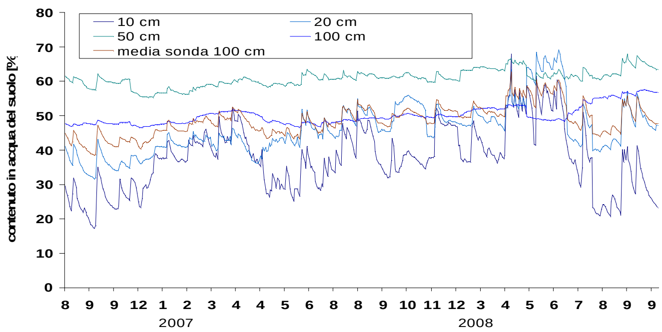

Fig. 1 – Water content at different depths. Capacitive probe, Mezzolombardo
Fig. 1 – Contenuto idrico a diverse profondità, sonda capacitiva, Mezzolombardo

A mean humidity regime is reached and typically maintained during summer. The resulting pattern is strongly determined by orography, but also by rainfall regime. The latter features determine the larger part of the soil water balance variability in a watershed.
From the central part of summer mean humidity values tend to stabilize, highlighting both mountain, more humid, areas, and the areas more prone to scarce water availability.

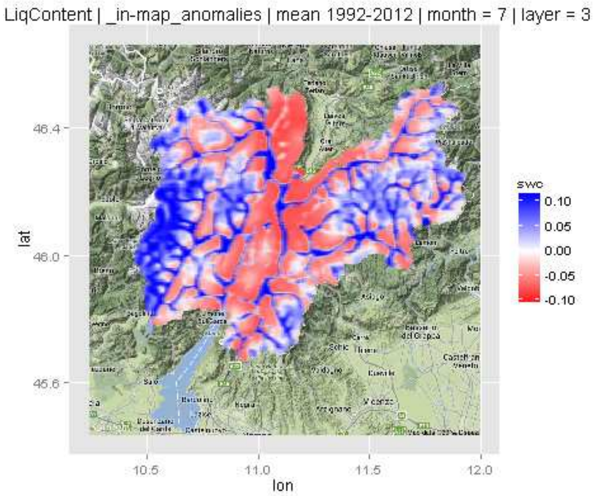

Fig. 2 – Mean soil water content, August, anomalies with respect to the map mean
Fig. 2 - Contenuto medio di acqua nel suolo, agosto, anomalie rispetto al valore medio di mappa

In Fig. 2, well evident are the water flow lines (valley bottom), where the model simulates the drainage of infiltrated water. Some patterns are shown which cannot be directly ascribed to soil height and/or to land morphology.

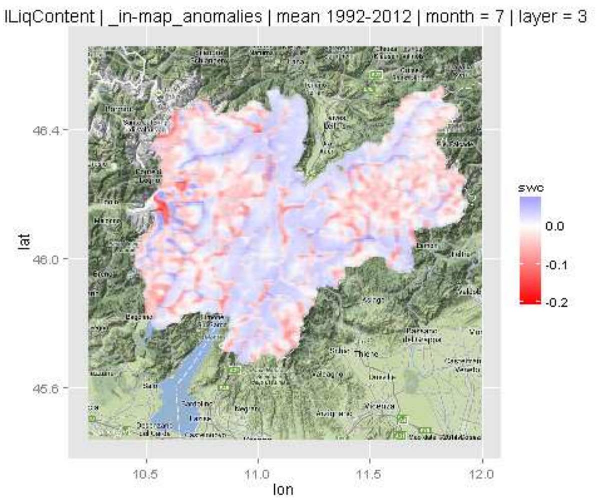

Fig. 3 – Difference between minimum and mean monthly values in soil water content, July, anomalies with respect to the map mean
Fig. 3 - Differenza tra valori minimi e medi mensili del contenuto d'acqua, luglio, anomalie rispetto al valore medio di mappa

In Fig. 3 the differences are shown between monthly minimum and mean in the same period. The most negative figures show the areas most prone to a lowering of water content with respect to the mean values of the period. Particularly, in summer months this map shows the bigger potential exposure to drought episodes.

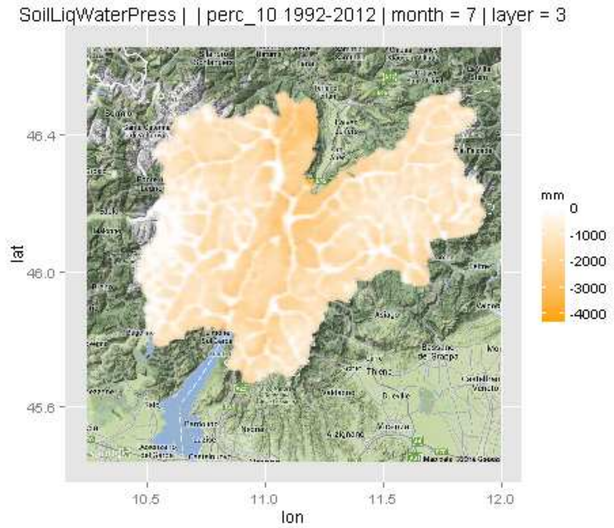

Fig. 4 – Water suction, July, 10th quantile.
Fig. 4 – Carico di pressione, luglio, 10° percentile

Another quantity - water suction - can be usefully mapped to assess more thoroughly the soil content analysis. Fig 4 shows the 10th quantile (an index of critical conditions) in summer.

Conclusions

The model GEOtop was used to simulate soil water content in Trentino, under theoretical conditions of natural rain supply (without irrigation), in a period long enough to assign a climatological value to the simulation. Simulations were carried out with the use of all the available meteorological quantities in hourly series. Soil use data were input according to the classes given by OpenData Trentino and CORINE Land Use. Results point out the climatic soil water pattern in the region, with the caveat that mean, natural climate conditions, typical for every season, are strongly determined by soil characteristics, in terms of depth and retention curves. In the present implementation, the latter were set as constant all over the domain, waiting for the availability of relevant information.

References

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