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Land surface evapotranspiration modelling at the regional scale

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Climate change has relevant implications for the environment, water resources and human life in general. The observed increment of mean air temperature, in addition to a more frequent occurrence of extreme events such as droughts, may have a severe effect on the hydrological cycle. Besides climate change, land use changes are assumed to be another relevant component of global change in terms of impacts on terrestrial ecosystems: socio-economic changes have led to conversions between meadows and pastures and in most cases to a complete abandonment of grasslands.

Water is subject to different physical processes among which evapotranspiration (ET) is one of the most significant. In fact, ET plays a key role in estimating crop growth, water demand and irrigation water management, so estimating values of ET can be crucial for water resource planning, irrigation requirement and agricultural production. Potential evapotranspiration (PET) is the amount of evaporation that occurs when a sufficient water source is available. It can be estimated just knowing temperatures (mean, maximum and minimum) and solar radiation. Actual evapotranspiration (AET) is instead the real quantity of water which is consumed by soil and vegetation; it is obtained as a fraction of PET.

The aim of this work was to apply a simplified hydrological model to calculate AET for the province of Turin (Italy) in order to assess the water content and estimate the groundwater recharge at a regional scale. The soil is seen as a bucket (FAO56 model, Allen et al., 1998) made of different layers, which interact with water and vegetation. The water balance is given by precipitations (both rain and snow) and dew as positive inputs, while AET, runoff and drainage represent the rate of water escaping from soil. The difference between inputs and outputs is the water stock.

Model data inputs are: soil characteristics (percentage of clay, silt, sand, rocks and organic matter); soil depth; the wilting point (i.e. the minimal point of soil moisture that plant requires not to wilt); the field capacity (i.e. the maximum amount of water content that a soil can held); the available water content (AWC), obtained as the difference between field capacity and wilting point. Furthermore, the model considers 15 different ID of land use, with a resolution of 250 m.

The model was then tested by a direct comparison with experimental data. First, the modelled water content from the surface down to 65 cm of soil depth was compared to the measured one with a Time Domain Reflectometry (TDR) in Grugliasco (TO), a non-irrigated flat permanent meadow, for years 2006-2008. Here, the soil is sandy with a slope of about 1%. Then, considering three corn farms located in the Cuneo district, the goodness of modelled irrigations was verified. The soil texture of the three farms, analysed according to the USDA criteria, is loam or silty-loam. In particular, we compared the number of irrigations done by the farmers with the ones given by the model, which irrigates as soon as the plant reaches an imposed level of water stress. We also compared the irrigation turn given by the model with the farmers' one. Then we compared the modelled water content with the one measured before and after the irrigation. We observed that the modelled irrigation occurred when the measured water content was close to the modelled wilting point. In both test cases, the model seems to reflect quite well the real behaviour of water content.