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ESTIMATION OF EVAPOTRANSPIRATION FOR BASILICATA REGION WITH A PENNMAN-MONTEITH METHOD

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KEYWORDS

Basilicata

Pennman-Monteith equation

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ABSTRACT

Estimation of reference evapotranspiration rate is a very significant parameter in agriculture science. It indicates the water consumption of the plant. So, it plays an important role in irrigation scheduling as well as plant growth modeling. In most cases, reference evapotranspiration has been computed by the Penman-Monteith equation (PM) as recommended by the FAO and applied over different climates over the globe. Information on ET_c and crop coefficients (K_c) is useful for normal irrigation planning and management purposes, for the development of basic irrigation schedules, and for most hydrologic water balance studies. Therefore, according to the importance of ET_c for agriculture planning and management purposes, this study was conducted in order to estimate the rate of evapotranspiration with a Penman-Monteith method for Basilicata region. The results of this experiment showed that, ET_c calculated with Penman equation for arable land was 3.90 (mm/d) while it was reported 2.95 (mm/d) for Vineyard area and 3.07 (mm/d) for Pasture polfit. Result of study revealed that sample areas which were close to the lake Pertusillo, rates of ET on average higher than other areas.

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1 Introduction

Evapotranspiration is the largest hydrological flux in the summer months under plains. The ability of estimating the magnitude of this flux will, therefore, go a long way toward computing the water balance and planning the use of available water resources (Peacock & Hess, 2004). It is, however, the most difficult flux to quantify (Peacock & Hess, 2004). Evapotranspiration (ET) is a fundamental component of the water cycle and profoundly important for the energy cycle. An understanding of ET is crucial for myriad scientific and management issues, including hydrology (Buytaert et al., 2006; Senay et al., 2009), hydroinformatics (Va'zquez & Hampel, 2014), water resources management (Kisi & Cengiz, 2013), agricultural management (Yoder et al., 2005a), crop simulation models (Ababaei, 2014), climatology (Midgley et al., 2002), ecohydrology (D'Odorico et al., 2010), and even biodiversity (Fisher et al., 2011; Córdova et al., 2015). Evapotranspiration process is the combination of two separate processes commonly known as Evaporation and Transpiration. In this process water is lost on the one hand from the top soil or water surface by evaporation and on the other hand from the crop plant tissues through transpiration by stomatal dynamics (Allen et al., 1996). Estimates of evapotranspiration provide an outlook of soil water balance in association with the amount of precipitation. Such estimates are of immense importance for calculation of water demand of the field crops and irrigation scheduling (Rasul, 1992). It also determines the nature of agro-climate a region has, agro-climatic potential of that region and suitability of crops or varieties, which can be grown successfully with the best economic returns (Mashru & Dwivedi, 2016).

A reference evapotranspiration rate is a very significant parameter in agriculture science. It indicates the water consumption of the plant. So, it plays an important role in irrigation scheduling as well as plant growth modeling (Yoder et al., 2005b). In most cases, reference evapotranspiration has been computed by the Penman-Monteith equation (PM) as recommended by the FAO and applied over different climates over the globe (Penman, 1948; Allen et al.,

1998, Garcia et al., 2004). Crop production, however, demands not only efficient use of nutrients but also efficient and economic utilization of water, especially when it is applied artificially. Crop evapotranspiration (ET_c) is a principal factor of crop productivity in humid and sub-humid tropics. In these regions, when soil water is available, ET_c can reach or even exceed 10 mm day^{-1} under low atmospheric humidity and high wind velocity conditions (Fasinmirin & Olufayo, 2009). Information on ET_c and crop coefficients (K_c) is useful for normal irrigation planning and management purposes, for the development of basic irrigation schedules, and for most hydrologic water balance studies (Tyagi et al., 2000; Suleiman et al., 2007). The objective of this study, therefore, is estimation of evapotranspiration for Basilicata region with a Penman-Monteith method.

2 Materials and Methods

This study was conducted in Basilicata region of Italy; this is the most mountainous region of the south of Italy (Figure 1). The region is divided in to two provinces, Potenza and Matera. The territory of the region Basilicata is characterized by an extensive river network, where some of the bigger waterways are Bradano, the Cavone, the Agri and the Sinni. Mountain area is represented by 8.356 km^2 while, for the remaining parts, 45% is hilly, and 8% is made up of plains. The test area is a part of the Agri Valley. The Agri Valley is a sub region of Basilicata in the south of Italy between the mountains and Sirino Volturino. This area covers $1,417.53 \text{ KM}^2$ and it also has 52,422 inhabitants; its altitude ranges from 0 to 1,559 m a.s.l., then an average altitude of 746 meters a.s.l.

During study following regions based on the land cover were studied: Hedges, Pasture, Small Ponds, Orchard, Vineyard and Arable area. The territory of the Agri Valley is also rich in forests. From vegetation point of view, the strip with the lower altitude has evergreen oak and thermophilic woods with oak, hornbeam, and flowering ash. In the higher strips there is widespread beech woods mixed with oaks and holly, white pine, lobelia or maple.

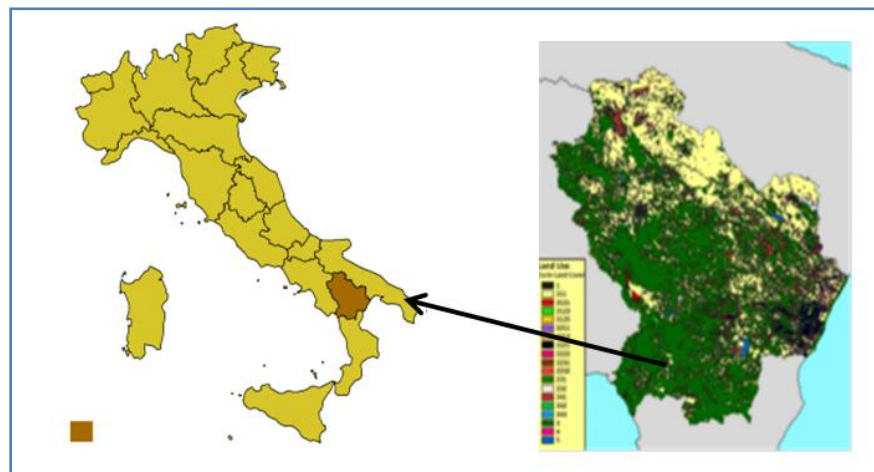


Figure 1 Italy, and Basilicata region showed in dark green

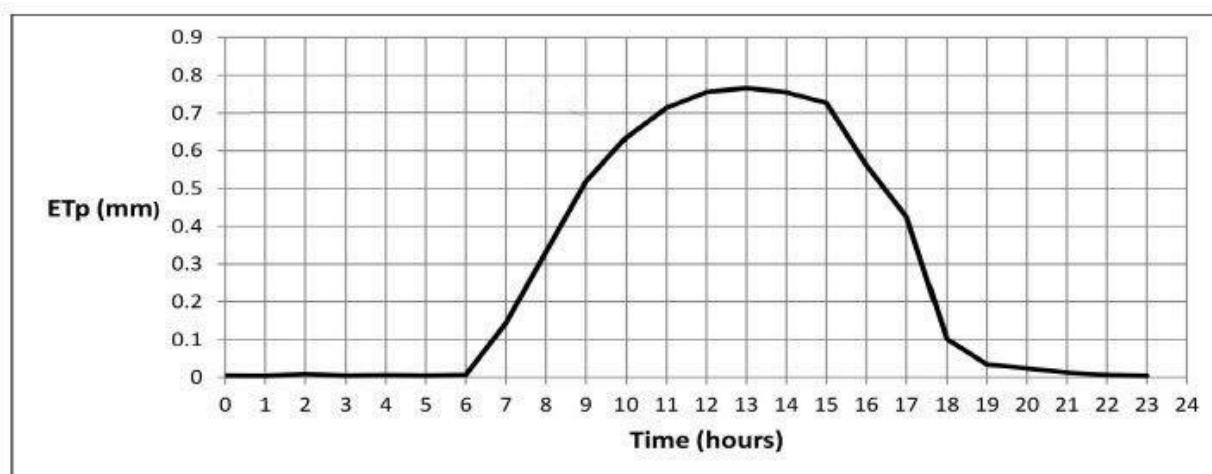


Figure 2 Daily ET_p (mm/day) of Agri Valley area

The remaining fire wood of Laurenzana is one of the most important forests of its kind in southern Europe. Due to the heterogeneity of the test area three discrete vegetation regions viz arables, vineyards and pastures and deciduous forest were selected based on the land cover.

The Penman-Monteith equation is the standard FAO method to determine reference crop water ET (ET_p) (Allen et al., 1998) and makes use of meteorological data. The estimation of ET was based on the FAO Penman-Monteith methodology which was calculated as:

$$ET_c = ET_p \times K_c$$

Where ET_c is the crop ET under standard condition, it will be between 1 to 9 mm/day from cool to warm average temperature and ET_p is the potential evapotranspiration and K_c is the coefficient factor for a well watered crop in optimal agronomic condition. Figure 2 shows ET_p as the result of the Penman-Monteith equation based on Villa d'Agri meteorological station data. ET_p calculated using the Penman-Monteith equation in this figure was based on the weather data retrieved from the Agenzia Regionale per la Protezione dell'Ambiente (ARPA) Basilicata's meteorological station of Villa d'Agri, the nearest to the test area.

3 Results and Discussion

Determination of the actual crop evapotranspiration (ET_c) during the growing period is important for accurate irrigation scheduling in arid and semi-arid regions. Development of a crop coefficient (K_c) can enhance ET_c estimations with relation to specific crop phenological development (Kenjabaev et al., 2014). Results of this experiment showed that, value of ET_c calculated with Penman equation for arable land was 3.90 (mm/d), while this was 2.95 (mm/d) for Vineyard area and 3.07 (mm/d) for Pasture polfit (Table 1).

Results of study suggested that sample areas which were close to the lake Pertusillo, rates of ET on average higher than other areas. This is due to the higher water content in the soils surrounding the lake and consequently the greater availability of water for ET.

Estimation of Etc is an important parameter for the estimation of water requirement and in this calculation is the distance from the lake (Chanthai & Wonprasaid, 2016). In Table 1 crop ET (ET_c) estimated by the Penman-Monteith. It has been chosen K_c for the arable area in the Basilicata of (0.60). K_c is the crop coefficient which is affected by several factors such as crop types, crop stages and cultural practices.

Table 1 Values of ET_c (mm/d) for arable, vineyard pasture of test area

Area	ET _p (mm/d)	K _c	ET _c (mm/d)
Arable area near the lake	6.55	0.60	3.90
Arable area far from the lake	6.55	0.60	3.90
Arable area average distance the lake	6.55	0.60	3.90
Vineyard area near the lake	6.55	0.45	2.95
Vineyard area far from the lake	6.55	0.45	2.95
Pasture polfit far from the lake	6.55	0.47	3.07

The Kc coefficient is different in the vineyard (0.45) and pasture (0.47). Results of Milella & Dettori (1987) and Dettori (1987) also determined the crop water requirements in a young orchard of Oli mana olive plants in Sardinia, concluding that the optimum Kc was 0.5 from May to September and 0.55 in April and October.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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