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Evapotranspiration Models: Short Review

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Mini Review

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Abstract

The evapotranspiration (ET) is a combination of evaporation and transpiration. Where the water is lost from the soil surface and from the crop canopy. The evaporation (E) and transpiration (T) occur instantaneously with no distinguishing between theme. During bare soil stage the E is the dominant process while the T is the effective one when the crop coverage is 100%. The ET is affected with weather conditions, crop features, management and environmental features. The ET methods varied based on the complexity of the model. The air temperature (Ta) is the most critical driving factor which has been used in all ET estimation models. Solar radiation (Ra) intensity and period have been involved in most models. Relative humidity (RH) and wind speed (U) are important parameters affecting on vapor pressure deficit (VPD). The VPD gradient is the most limiting factor affecting the ET rate. Remote sensing is a promising technology. It is prepared to be instead of traditional technologies in the future. The NDVI is a good physical indicator for earth's land cover classes. The surface temperature results are related to the substance's potential energy. Scientists still search out to find a way of using remote sensing as a stand-alone technology. A short review on ET models and its new trends are the main target of this work.

Keywords: Evapotranspiration; Estimation; Irrigation; Temperature; Pressure

Abbreviations: ET: Evapotranspiration; Ta: Air Temperature; Ra: Solar Radiation; RH: Relative Humidity; U: Wind Speed; VPD: Vapor Pressure Deficit.

Background

The weather parameters affecting ET are radiation, air temperature, humidity and wind speed. The crop type, resistance to transpiration, crop height, crop roughness, reflection, ground cover and crop rooting characteristics driving the ET rates. Besides the soil salinity, poor land fertility, limited application of fertilizers, the presence of hard or impenetrable soil horizons, the absence of control of diseases and pests and poor soil management may limit the crop development and reduce the ET [1].

The level of ET calculation is built on the target of application so it is very important to differentiate between ETo, ETr, ETc and ETa. The estimating reference evapotranspiration for short canopies (ETo) and tall canopies (ETr) has different canopy resistance and aerodynamic resistance which calculated as a function of wind speed that is specific to the height of the reference surface [2,3]. The ETc is the crop evapotranspiration under standard conditions while ETa is the crop evapotranspiration under non-standard conditions [1].

The importance of ET estimation for water rationalization and irrigation water management is clear in arid and semi-arid regions. In the western USA, during 1890's the water saving from losses became a vital where the applied water was significantly more than the consumptive-use rate [4]. After that date, numerous scientists started to formulate the quantity of agricultural water needs or consumption. They tried to simulate the physical procedures of water consumption from the soil surfaces and the plant canopies which termed ET [5].

The ETa is the physical quantity of Plant-water-consumption throughout its life; the phonological phases from cultivation to Senescence. The weather parameters, crop characteristics and water availability are driving factors of the ETa [1]. The ETa calculation depends on many parameters.

$$ETa = ETc \times Ks \quad (1)$$
$$ETc = ETo \times Kc \quad (2)$$

Where: Kc is crop-coefficient and Ks is water-stress-coefficient.

The information of soil water availability at large scale is essential for irrigation water management. Recently, the satellite and airborne have been used to estimate ET at regional and global scale, beside the ground based remotely sensed data which used at farm level. The active and passive remote sensing data is highly effective to calculate soil water availability [5-8].

The crop-coefficient (Kc) curves may be observed and settled based on remotely sensed data [9-11].

The millimeters (mm, distance unit) per day (time unit) is the most common expression of ET rate (mm/day). This unit could be customized to be suitable in farming applications, i.e., one hectare equals 10000 m^2 and 1 mm is equal to 0.001 m, which means 10 m^3 of water per hectare [1].

ET Models

Location, elevation and Julian day play an important role in *ET* calculations under different locations conditions. In developing world countries, the availability of data is scarce, and ground meteorological data is very few beside of the ability of stations maintenance is not adequate the responsibly [11]. The need to using new technologies grows day after day. The early satellite age was the beginning of the development of global scale models through using satellite images to calculate ETa and manage Crop water consumption [5]. Coupling of remote sensing data with ground data was used in agricultural water management from many decades.

Triangle and crop water stress index (CWSI) methods were used and developed in the 1970's and the 1980's respectively. In 1990's and beginning of 2000's the SEBAL [12], and SEBS [13] models represent a new step in the way of evapotranspiration development models. In last decade, METRIC [14], ETlook [15], and ET watch [16] models were developed to fill the gaps of SEBAL and SEBS model. Researchers around the world still try to modify these models to improve the results.

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