Estimation of actual evapotranspiration

S.1. Regional scale: Lake Victoria drainage basin
An empirical model between observed temperature and calculated potential evapotranspiration ($ET_p$) based on Langbein (1949) was used, where $T$ is average annual temperature and $ET_p$ is potential evaporation:

$$ET_p = 325 + 21T + 0.9T^2.$$  \hspace{1cm} (S1)

The actual evapotranspiration was then estimated using an empirical relation (Turc 1954) as:

$$ET_a = \frac{P}{\sqrt{0.9 + \left(\frac{P^2}{ET_p^2}\right)}}$$  \hspace{1cm} (S2)

where $ET_a$ is the annual estimate of actual evapotranspiration.

S.2. Local scale: Orongo village
Due to lack of local temperature observations, observed pan evapotranspiration ($E_{pan}$) was used in combination with the method described in Allen et al (1998) to estimate local actual evapotranspiration. First the pan coefficient ($K_{pan}$) was determined using representative literature values of monthly relative humidity and wind speed (Ochumba and Johnson 1996). Reference evapotranspiration ($E_{To}$) was then calculated as:

$$E_{To} = K_{pan}E_{pan}$$  \hspace{1cm} (S3)

where $E_{To}$ is the reference evapotranspiration over a hypothetical surface consisting of green short grass. This reference evapotranspiration was converted to a crop evapotranspiration using a crop coefficient ($K_c$) for each day of a year. The crop coverage of an average plot for the Orongo village was estimated based on a survey of local farmers. The results from this survey show that maize covers approximately 64% of agricultural plots. The rest is covered by various crop (e.g. millet, beans, sweet potato, cassava and sukuma) of which millet constitutes the single majority with 18%. $K_c$ was determined for each crop based on this average plot composition in the main agriculture area of the Orongo village and FAO literature values (Allen et al 1998). The $K_c$ value was set to 1 after harvest which is the equivalent of using mulch after harvest.

The actual evapotranspiration was assumed to be equal to crop evapotranspiration and thus calculated with a daily time-step:

$$ET_a = ET_c = ET_o \sum_{i=1}^{n} K_{ci} \frac{A_i}{A_{tot}}$$  \hspace{1cm} (S4)

where $A_i$ is the area of each crop, $K_{ci}$ is the associated crop coefficient and $A_{tot}$ is the total cultivated area for an average farmer.
References
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