Evaporation Component of ET Estimated from Daily Lysimeter Measurement at Kimberly, Idaho.

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The following sets of figures show estimates of the evaporation component of ET as a function of the transpiration component. The evaporation and transpiration components have been normalized into an evaporation coefficient, K_e, and estimated transpiration coefficient by dividing by reference ET. Because the lysimeter measurements do not separate E from T, transpiration was estimated as $T = K_{cb}\, ET_{ref}$, so that the transpiration component, $K_t = K_{cb}$, where K_{cb} is the basal coefficient representing ET from a nearly dry soil surface. The K_{cb} was estimated using a K_{cb} curve constructed to undergird the lower boundary of the measured ET data, as illustrated in Allen et al, 2000[1].

The T that is estimated as $K_{cb}\, ET_{ref}$ overstates T by 5 to 15% of ET_{ref} because the K_{cb} curve includes some diffusive evaporation from the surface soil layer.

The K_e component was estimated as:

$$K_e = \frac{ET_{lysimeter} - K_{cb} ET_{ref}}{ET_{ref}}$$

Two methods were used to estimate K_{cb} and ET_{ref}: the method of FAO-56 where the straight-line segment method was used to describe K_{cb} and ET_{ref} was represented by grass reference ET_o by the FAO-56 PM method; and the method of Wright (1982)[2] where a curvilinear K_{cb} curve was fitted to lysimeter data by Wright and where ET_{ref} was represented by an alfalfa reference ET_r by the 1982 Kimberly Penman method (Wright, 1982).

Results are shown in the following figures. The lysimeter and estimated ET data are plotted and described in Allen et al., (2000). The lysimeter system and data collection are described in detail in Wright (1982). As expected, due to constraints on available energy, maximum values for the evaporation coefficient, K_e, following wetting events decrease with increasing transpiration coefficient. The decreasing trend in the upper bound for K_e is most notable for the 1976 sweet corn crop at Kimberly and is least notable for the 1974 snap bean crop. The two K_c and ET_{ref} systems produced similar estimates for K_e. Values estimated for K_e that are negative provide an indication of the relative error and uncertainty associated with the estimates of T (i.e., K_{cb} and ET_{ref}) and to a lesser extent in lysimeter measurements.

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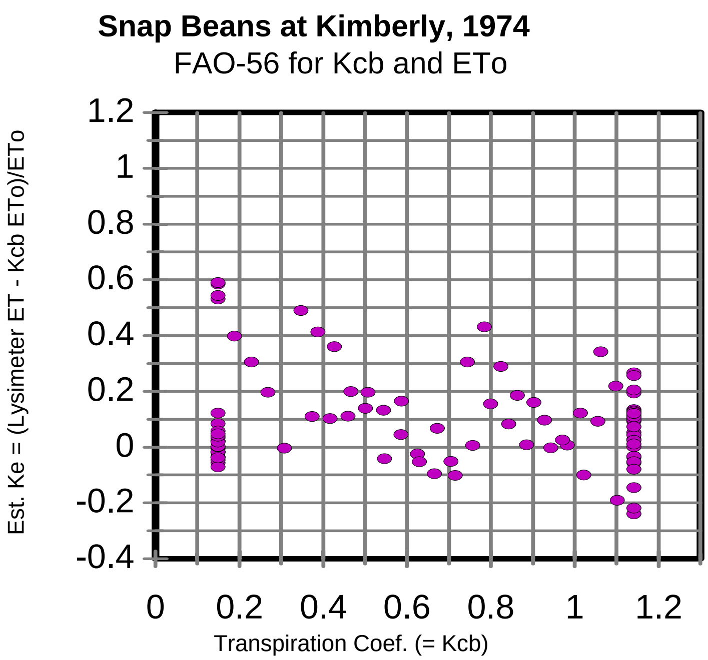
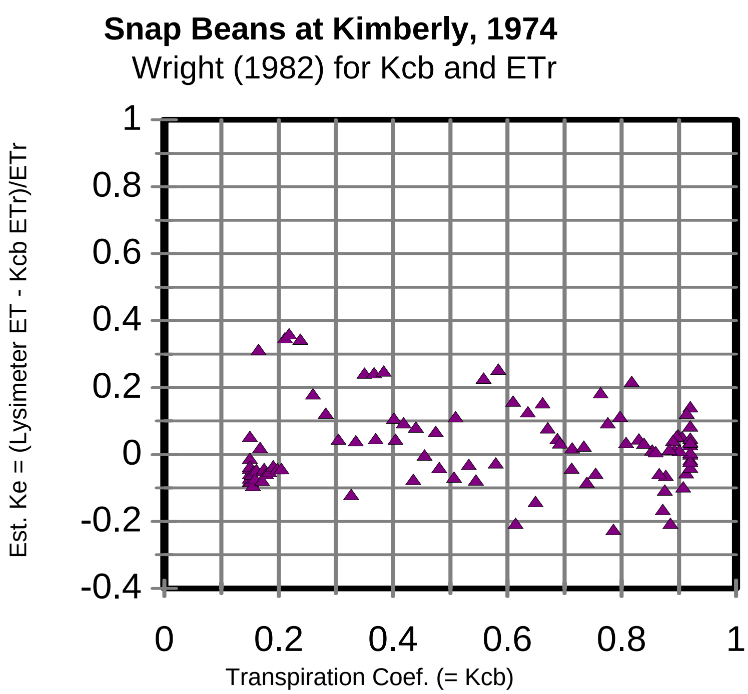
[1] Allen, R.G., M. Smith, L.S. Pereira, D. Raes, and J.L. Wright. 2000. Revised FAO procedures for calculating evapotranspiration – Irrigation and Drainage Paper No. 56 with testing in Idaho. ASCE Watershed Management Conference, 2000. Ft. Collins, CO, 6/20/2000 – 6/24/2000. 10 p. (proc. on CD)

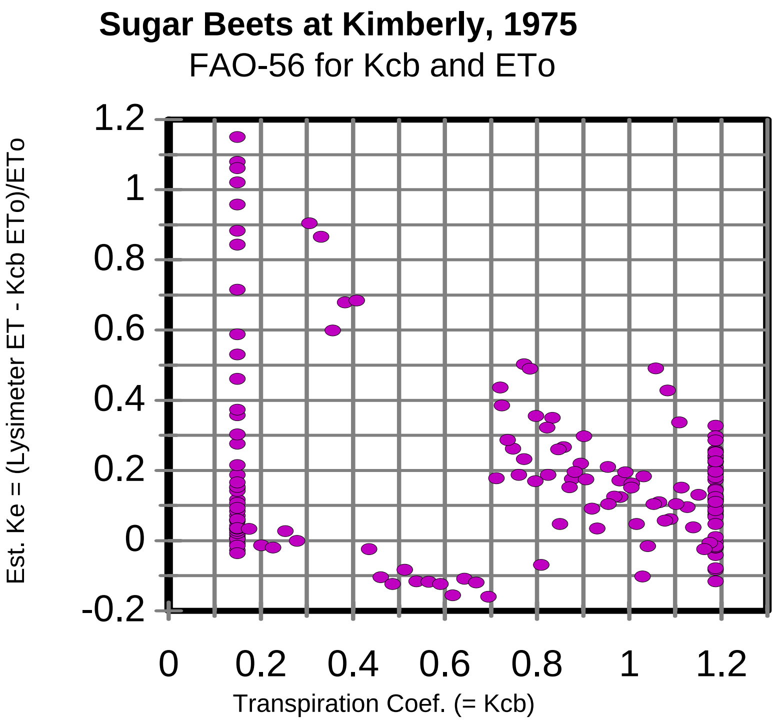
[2] Wright, J.L. 1982. New Evapotranspiration Crop Coefficients. Journal of Irrigation and Drainage Division, ASCE, 108:57-74.

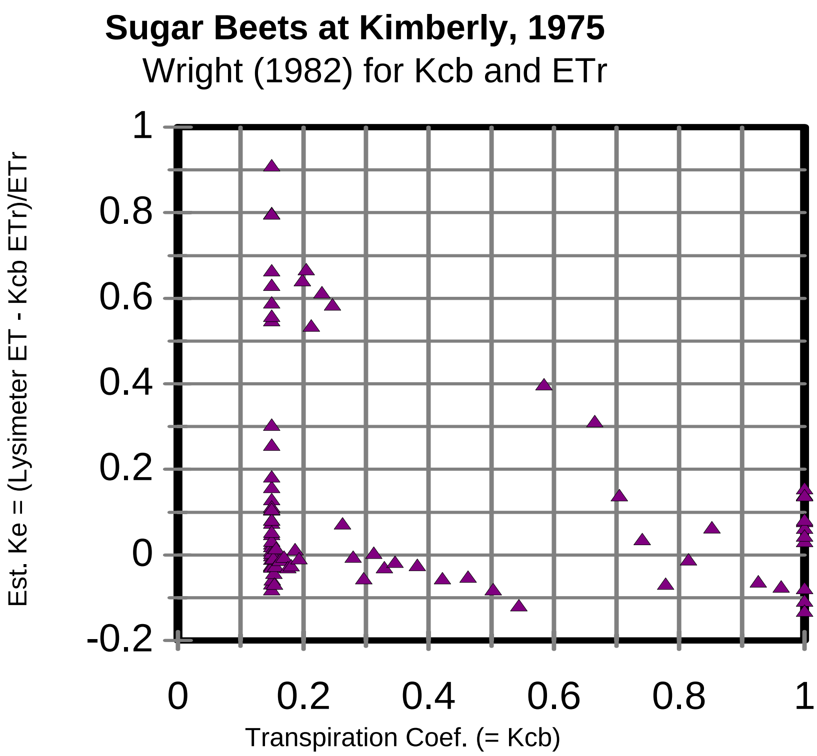
The large number of points plotted for K_{cb} = 0.15 are due to the use of 0.15 as a lower bound for K_{cb} for both sets of K_c curves. The lower bound for estimated K_e represents K_e under conditions of a dry soil surface with varying amounts of vegetation present. Vegetation amount is proportional to the K_{cb}. The upper bound for estimated K_e represents K_e for a wet soil surface.

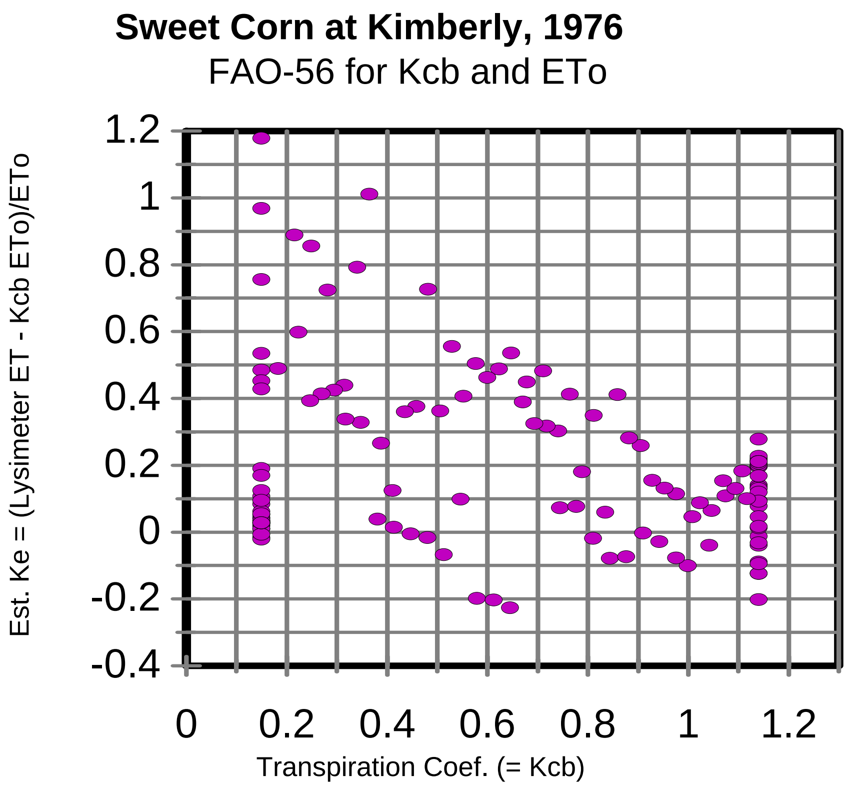
One can conclude from this analysis that the relative amount of evaporation will decrease given an increase in transpiration for the same frequency and amount of surface wetting. One caution, however, is that this analysis does not show the impact of extended drying during periods of high transpiration (i.e., high vegetation cover), so that K_e is sustained above the lower threshold value for a longer time as compared to when transpiration is low (see discussions in Chapter 7 of FAO-56). In otherwords, evaporation "spikes" are broadened and shortened during periods of high transpiration, so that evaporation events tend to extend over a longer period of time per event (see illustrations in Allen et al., 2000). The integrated area within the spike (above the basal K_{cb} curve) represents evaporation. This behavior will tend to reduce change in total evaporation per wetting event with increasing transpiration. However, it is not expected to eliminate the differences.

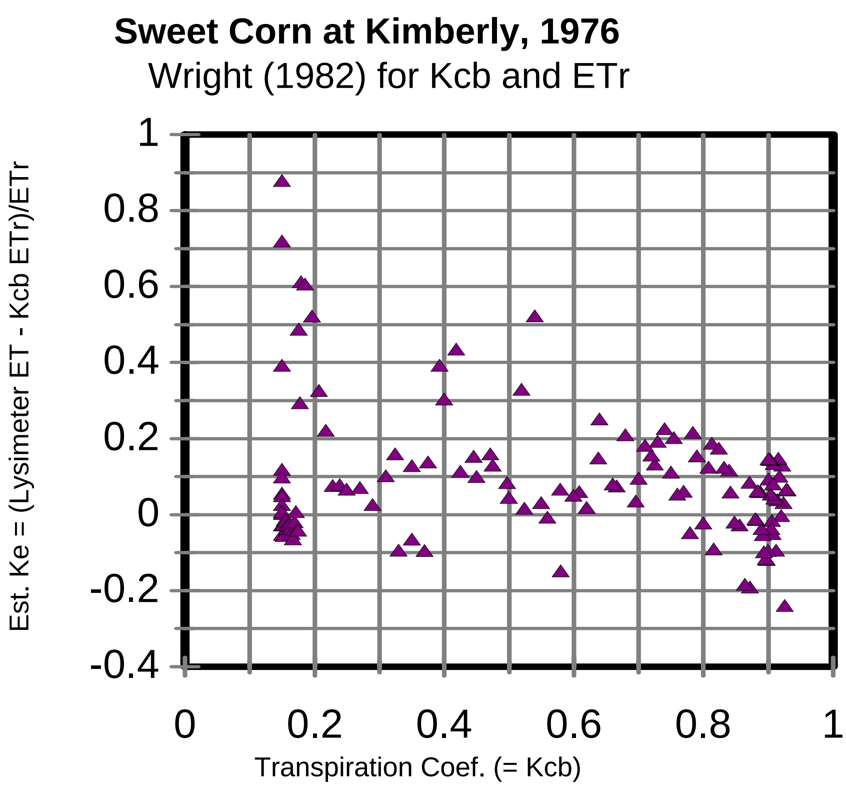

Snap Beans at Kimberly, 1974
FAO-56 for Kcb and ETo
Est. Ke = (Lysimeter ET - Kcb ETo)/ETo
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.2
0.4
0.6
0.8
1
1.2
Transpiration Coef. (= Kcb)


Snap Beans at Kimberly, 1974
Wright (1982) for Kcb and ETr
Est. Ke = (Lysimeter ET - Kcb ETr)/ETr
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.2
0.4
0.6
0.8
1
Transpiration Coef. (= Kcb)


Sugar Beets at Kimberly, 1975
FAO-56 for Kcb and ETo
Est. Ke = (Lysimeter ET - Kcb ETo)/ETo
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
Transpiration Coef. (= Kcb)


Sugar Beets at Kimberly, 1975
Wright (1982) for Kcb and ETr
Est. Ke = (Lysimeter ET - Kcb ETr)/ETr
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1
Transpiration Coef. (= Kcb)


Sweet Corn at Kimberly, 1976
FAO-56 for Kcb and ETo
Est. Ke = (Lysimeter ET - Kcb ETo)/ETo
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.2
0.4
0.6
0.8
1
1.2
Transpiration Coef. (= Kcb)


Sweet Corn at Kimberly, 1976
Wright (1982) for Kcb and ETr
Est. Ke = (Lysimeter ET - Kcb ETr)/ETr
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.2
0.4
0.6
0.8
1
Transpiration Coef. (= Kcb)