CALIBRATION FOR HISTORICAL CROP ET ESTIMATES

Introduction and Issues

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Why Calibration?

- Most historical consumptive use analyses based on long evaluation period
- Long periods of record available at many NOAA Coop Observer network (max/min/precip) stations
- Simple temperature-based methods
- Limited period of record at electronic weather stations (20 years or less)
Why Calibration?

- Published studies have generally shown the simpler temperature-based ET estimation methods are inaccurate, especially in arid and semi-arid climates.
- Local calibration/verification is strongly recommended to obtain more accurate historical crop ET estimates.
Approach

- Compute calibration coefficients for some specific time interval during growing season (e.g., 10-days, monthly)

\[
\text{Calibration coeff.} = \frac{\text{Measured Crop ET}}{\text{Crop ET by method being calibrated}}
\]

- In the absence of measured ET (i.e., lysimeter), use crop ET based on ASCE Std Ref-ET Eqn
Measured Crop ET

- **Lysimetry**

- **ASCE Std Reference ET**
Approach

- Compute average calibration coefficient values for overlapping period of record
  - Monthly time step
- Minimum 5-7 years of overlapping record
Modified Blaney-Criddle Method (TR-21)

\[ u = k_c \left( k_t \right) \left( t \times p \right) / 100 \]

- \( u \) = monthly consumptive use (inches)
- \( k_t \) = climatic coefficient
  \[ = 0.173 \times t - 0.314 \]
- \( k_c \) = crop growth stage coefficient
- \( t \) = mean monthly air temperature (°F)
- \( p \) = monthly percentage of annual daylight hours
Modified Blaney-Criddle Method

- Data required—mean monthly temperature
- 100’s of max/min/precip stations in Colorado
- Developed for irrigation planning
- $k_t \left( t \times p \right) / 100$ not representative of the impact of meteorological elements
Extraterrestrial Radiation & Percent of Daylight as a Percentage of Maximum
Crop factor, $k_c$, is not a crop coefficient in the same sense as the reference ET-crop coefficient approach.

- Contains a meteorological component
  - location bias
  - values not geographically transferable (ASCE Manual 70, 1990; USDA-NRCS, 1993)

- Ignore $k_c$ and calibrate just the factor: $k_t \frac{(t \times p)}{100}$
ET_0 = 0.0023 \left( T_{\text{max}} - T_{\text{min}} \right)^{0.5} \left( T_{\text{mean}} + 17.8 \right) R_a

ET_0 = \text{grass reference ET (mm/day)}
T_{\text{max}} = \text{maximum daily air temperature (°C)}
T_{\text{min}} = \text{minimum daily air temperature (°C)}
T_{\text{mean}} = \text{mean daily air temperature}
\quad = \frac{T_{\text{max}} + T_{\text{min}}}{2}
R_a = \text{extraterrestrial radiation (mm/day)}
R_a (\text{mm/day}) = \frac{R_a (\text{MJ/m}^2/\text{day})}{2.45}
1985 Hargreaves Method

- Originally developed in 1975
  - solar radiation and temperature data inputs
- Updated in 1982 and 1985
  - solar radiation estimated from extraterrestrial radiation, $R_A$
- Grass reference ET
- May be used to compute daily estimates, but more accurate over longer time steps: 10-days, monthly
1985 Hargreaves Method

- Simple, easy to use
- Data required—maximum and minimum air temperature
- Better predictive accuracy in arid climates than modified Blaney-Criddle
  - Max-min temperature difference
  - Extra-terrestrial radiation
- Underpredicts in windy or high advection conditions—requires local calibration
1985 Hargreaves Method

- Grass reference ET method
- Directly calibrate:

\[
K = \frac{\text{ASCE std ref } ET_r}{\text{Hargreaves } ET_o}
\]

- Use alfalfa reference crop coefficients

\[
ET_c = K_{cr} (K * ET_o)
\]
Calibration
Precautions/Limitations

- Extent of areal representation?
- Weather station pairing
  - Compute calibration coefficients by pairing each NOAA station of interest with electronic weather station
  - Site bias at the NOAA site may not be properly captured
  - Bigger problem with SCS BC than 1985 Hargreaves
Coefficients for one EWS-NOAA station pair generally not applicable at other NOAA stations when conditions at the NOAA sites are dissimilar.