



METHOD IN BRIEF: Evapotranspiration by urban lawns and trees in Los Angeles

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BACKGROUND

We outline below a first-of-its-kind method for calculating evapotranspiration of lawns and trees in a city. To date, in Los Angeles, we have made continuous ET measurements on 108 trees of 14 species in 2007-2009 and 11 lawns in 2008-2011, before the recent drought. Based on these measurements, we developed empirical equations that estimate ET based on weather and landscape parameters.

LAWNS

Required data

Fractional tree canopy cover above grass ($0 < A_{TCC}/A_{veg} < 1$)

Daily potential evapotranspiration (ET_0 , mm/d; download from www.cimis.water.ca.gov).

Calculation of the microclimate coefficient:

Microclimate coefficient ($0 < k_{mc} < 1$) is estimated as

$$k_{mc} = a - b \frac{A_{TCC}}{A_{veg}}, \text{ where } a = 0.90 \pm 0.09 \text{ and } b = 0.35 \pm 0.13.$$

Calculation of ET

$$ET_{Grass} = k_{mc} ET_0.$$

TREES

Required data

Planting densities of each tree species (d_i , trees/ha)

Diameter of tree trunks at 1.4 m above ground, average for each species (DBH , cm)

Solar irradiance (I_0 , $W m^{-2}$; download from www.cimis.water.ca.gov).

Air temperature (T , °C; download from www.cimis.water.ca.gov).

Water vapor pressure (p , Pa; download from www.cimis.water.ca.gov).

Calculation of parameters

1) Vapor pressure deficit of the air (D , kPa) is calculated as

$$D = 0.611 \exp\left(\frac{17.502T}{T + 240.97}\right) - p$$

2) Average sapwood area of each species ($A_{S(i)}$, cm^2) is estimated as:

$$A_S = -20.56 + 0.94DBH + 0.54DBH^2 - 0.005DBH^3, \text{ for species with } DBH \geq 8.7 \text{ cm,}$$

$$A_S = \pi \left(\frac{DBH}{2}\right)^2 \text{ for species with } DBH < 8.7 \text{ cm.}$$

Calculation of ET

1) For flowering trees (each species): $E_{fl(i)} = 1.2 \times 10^{-6} d_i A_{S(i)} (5.5 + 2.3 \ln D + 0.02 I_0)$ during growing season. For deciduous trees, $E \approx 0$ when trees are leafless.

2) For coniferous trees (each species): $E_{con(i)} = 4.0 \times 10^{-7} d_i A_{S(i)} (5.5 + 2.3 \ln D + 0.02 I_0)$,

3) For palm trees (all species): $E_{palms} \approx 0.017 \frac{d_{palms}}{100}$ or $0.004 \frac{d_{palms}}{100} \leq E_{palms} \leq 0.03 \frac{d_{palms}}{100}$

4) Total for all trees: $E_{Trees} = \sum E_{fl(i)} + \sum E_{con(i)} + E_{palms}$.

LAWNS + TREES TOGETHER

Required data

Total vegetated area, assumed to be similar with the cumulative area of irrigated lawns (A_{veg} , ha)

Land area of a city that includes all vegetated and impervious areas, as well as bare soil (A_{LA} , ha)

Calculation of ET

On cumulative vegetated area: $ET_{veg} = ET_{Grass} + ET_{Trees}$

On total land area: $ET_{land} = ET_{veg} \frac{A_{veg}}{A_{land}}$, assuming that ET from non-vegetated surfaces is negligible compared to ET from irrigated vegetation.

PROJECT DETAILS

Funding: This research was funded by the National Science Foundation (NSF) IOS 1147057 and EAR 1204442.

Citation: Litvak E., Manago K., Hogue T. S. and Pataki D. E., 2017: Evapotranspiration of urban landscapes in Los Angeles, California at the municipal scale. *Water Resources Research*, 53, DOI: 10.1002/2016WR020254.

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