AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE

10.1002/2016WR020254

Key Points:

- Evapotranspiration from irrigated landscapes in Los Angeles was close to reference evapotranspiration
- Turfgrass was responsible for 70% of evapotranspiration from vegetated areas
- Evapotranspiration from total land area (vegetated and nonvegetated) was linearly correlated with median household income

Supporting Information:

- Supporting Information S1
- Table S1

Correspondence to:
E. Litvak,
elitvak@uci.edu

Citation:
Litvak, E., K. F. Manago, T. S. Hogue, and D. E. Pataki (2017), Evapotranspiration of urban landscapes in Los Angeles, California at the municipal scale, *Water Resour. Res.*, *53*, 4236–4252, doi:10.1002/2016WR020254.

Received 9 DEC 2016
Accepted 27 APR 2017
Published online 24 MAY 2017

Evapotranspiration of urban landscapes in Los Angeles, California at the municipal scale

E. Litvak[1], K. F. Manago[2], T. S. Hogue[2], and D. E. Pataki[1]

[1]Department of Biology, University of Utah, Salt Lake City, Utah, USA, [2]Civil and Environmental Engineering Department, Colorado School of Mines, Illinois, Colorado, USA

Abstract Evapotranspiration (*ET*), an essential process in biosphere-atmosphere interactions, is highly uncertain in cities that maintain cultivated and irrigated landscapes. We estimated *ET* of irrigated landscapes in Los Angeles by combining empirical models of turfgrass *ET* and tree transpiration derived from in situ measurements with previously developed remotely sensed estimates of vegetation cover and ground-based vegetation surveys. We modeled irrigated landscapes as a two-component system comprised of trees and turfgrass to assess annual and spatial patterns of *ET*. Annual *ET* from vegetated landscapes (ET_{veg}) was 1110 ± 53 mm/yr and *ET* from the whole city (vegetated and nonvegetated areas, ET_{land}) was three times smaller, reflecting the fractional vegetation cover. With the exception of May and June, monthly ET_{land} was significantly higher than predicted by the North American Land Data Assimilation System. ET_{veg} was close to potential *ET*, indicating abundant irrigation inputs. Monthly averaged ET_{veg} varied from 1.5 ± 0.1 mm/d (December) to 4.3 ± 0.2 mm/d (June). Turfgrass was responsible for ~70% of ET_{veg}. For trees, angiosperm species (71% of all trees) contributed over 90% to total tree transpiration, while coniferous and palm species made very small contributions. ET_{land} was linearly correlated with median household income across the city, confirming the importance of social factors in determining spatial distribution of urban vegetation. These estimates have important implications for constraining the municipal water budget of Los Angeles and improving regional-scale hydrologic models, as well as for developing water-saving practices. The methodology used in this study is also transferable to other semiarid regions for quantification of urban landscape *ET*.

1. Introduction

Urban evapotranspiration (*ET*) is an essential component of water and energy budgets of vegetated cities, yet it is still highly uncertain [*Pittenger and Shaw*, 2007, 2010; *Pataki et al.*, 2011a; *Shields and Tague*, 2012; *Sun et al.*, 2012; *Nouri et al.*, 2013]. Heterogeneous urban land cover is a patchwork of vegetation and built structures, which results in complex patterns of *ET* [*Grimmond et al.*, 1996; *Grimmond and Oke*, 1999; *Offerle et al.*, 2006; *Anderson and Vivoni*, 2016]. In addition, there is a paucity of in situ measurements of *ET* in virtually all types of urban land cover [*Boegh et al.*, 2009; *Hart et al.*, 2009; *Pittenger and Shaw*, 2010; *Pataki et al.*, 2011b; *Nouri et al.*, 2013]. In dry regions, urban *ET* may be much larger than the surrounding natural ecosystem and therefore plays a significant role in local hydrologic fluxes [*Grimmond and Oke*, 1999]. Measuring and modeling *ET* is particularly challenging in urban regions with diverse and nonnative plant composition [*Pataki et al.*, 2011b; *Peters et al.*, 2011].

The city of Los Angeles has more than 6 million trees, most of which are nonnative and originate from mesic environments in multiple geographic regions and continents [*Dwyer et al.*, 2000; *Clarke et al.*, 2013; *Pataki et al.*, 2013]. In natural environments, *ET* in southern California is primarily controlled by groundwater availability and the amount and timing of precipitation events [*Duell*, 1991; *de Vries and Simmers*, 2002; *Hamlet et al.*, 2007; *Goulden et al.*, 2012]. In irrigated urban areas with diverse plant composition such as Los Angeles, surface soil moisture may be nonlimiting, such that *ET* is largely controlled by stomatal responses of landscape plants to environmental conditions in the presence of advection [*Grimmond and Oke*, 1999]. The combination of moist, irrigated soil and dry air often exposes cultivated plants to conditions beyond the range of their natural habitats, resulting in a variety of transpiration patterns [*Litvak et al.*, 2011, 2012; *Pataki et al.*, 2011b]. For example, the majority of trees in Los Angeles are imported from mesic temperate and tropical regions, which are more humid than the local environment [*Nowak et al.*, 2010; *Avolio et al.*,