AWRA 2012 SUMMER SPECIALTY CONFERENCE
Riparian Ecosystems IV: Advancing Science, Economics and Policy
Denver, Colorado
June 27 – 29, 2012

COMPARATIVE WATER USE BY RIPARIAN FOREST, GRASS, AND CROPS IN THE GREAT PLAINS

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ABSTRACT: In arid regions, riparian vegetation consumes water that could otherwise support critical in-stream flows and irrigation. Reducing evapotranspiration (ET) by riparian vegetation is a strategy that has been employed in the southwestern U.S. for mitigating water shortages, meeting consumptive water rights, and achieving mandated in-stream flows (Davenport et al. 1982; Wilcox et al. 2007).

In the arid Great Plains, water demands are also challenging river managers. Throughout this agricultural region, riparian buffers have been, and continue to be, installed for the purposes of improving water quality and wildlife habitat, but the consequences for water supply are not known. Whether, and by how much, riparian buffers impact water supply will depend on how much ET changes in response to converting riparian cropland to perennial buffer vegetation. The objectives of this study were to estimate annual ET for cropping systems commonly practiced in the central Great Plains, and, to compare crop ET with estimated values for different kinds of riparian buffer vegetation.

Annual ET was estimated using the Penman-Montieth dual crop coefficient model published in FAO Irrigation and Drainage Paper No. 56 (Allen et al. 1998). The reference vegetation was grass in a 17 m-wide strip. Modeled scenarios included forest, grass, and common cropping systems with and without irrigation, for different water table depths and soil types in three climate regions. Climate regions were represented by a 30-year average weather year in western (Sidney), central (Lexington), and eastern (Lincoln) Nebraska. Annual rainfall averages from 425 mm in the western region to 695 mm in the eastern region. Modeled estimates of ET accounted for vegetation differences in crop coefficient, growth stages, mature height, root depth, and crop residue. Adjustments were made for clothesline and oasis effects which can be pronounced in riparian zones in arid regions. Adjustments were also made for soil water depletion, capillary rise from groundwater, and for overland runoff from adjacent uplands.

Estimates of annual ET ranged from 251 to 1343 mm across all scenarios. The lowest values were obtained for crop-fallow rotations over deep water table which had ET values that were less than annual precipitation. Also on these sites, all non-fallow, non-irrigated vegetation types had ET values that were similar to annual precipitation. The highest ET values were obtained for vegetation having access to ground water and/or irrigation in the order of trees > alfalfa > grass > annual crops, and, ET values for tall trees with a high crop coefficient (i.e., phreatophyte) were 1.4 to 1.6 times greater than for row crops. Annual ET for vegetation having access to groundwater or irrigation was only 5-18% higher in western Nebraska than in eastern Nebraska because drier climate conditions in the west are partially offset by a shorter growing season.

The impact of riparian buffer installation on water supply in the Great Plains will depend strongly on the crop and buffer systems being converted and on the site conditions, especially water table depth. In general, buffer installation in riparian areas having shallow water table will increase consumptive water use whereas installation over a deep water table will decrease consumptive use, especially if the crop had been irrigated. These results provide initial insight into potential water supply impacts of different riparian management options in the central Great Plains.

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