Irrigated agriculture and ecology in the arikaree river basin: finding a sustainable future

Linda Vandamme and Ramchand Oad
Department of Civil Engineering, Colorado State University.

Abstract. The Arikaree River, a tributary to the Republican River, is located in Yuma County on the eastern high plains of Colorado and is sustained by springs and seeps from the regional Ogallala Aquifer. The river traverses a short-grass prairie underlain by Tertiary sediments eroded off the Rocky Mountains, which make up the regional aquifer (Fausch, et. al. 2006). The river provides a unique oasis for much of the wildlife in the riparian zone, including white-tailed deer, coyote, beaver, several species of turtles, eagles, heron, and wild-turkey. The Arikaree is also home to many fish species, and is the last stronghold in Colorado for the state-threatened brassy minnow. The Nature Conservancy purchased the Fox Ranch, through which the Arikaree River flows, to conserve and study the area. The Fox Ranch now serves as the primary site for our study. The Fox Ranch is surrounded by cropland, a majority of which is irrigated (ca. 60%; Fardal 2003), and most of this is supplied by center-pivot systems. Farmers in Yuma County extract almost 300,000 acre-feet of groundwater annually, one of the largest regional groundwater withdrawals in Colorado (Fausch, et. al. 2006). Because this groundwater supply is linked to the Arikaree river, concerns have been raised about the role of center-pivot irrigation in reducing or eliminating the habitat of the brassy minnow, especially during drought (Fausch, et. al. 2006).

On-going research has shown a strong correlation between groundwater pumping and stream flow declines. However, vegetation growth, evapotranspiration, and senescence in the watershed also likely follow the same temporal pattern as irrigation water use, so the relationship between cause and effect is unclear. In the Arikaree River valley, the landscape is dominated by stands of cottonwood. Plains cottonwoods (Populus deltoides) and willows (Salix exigua) have been identified as the two major plant users of water (Solek, 1996). These phreatophytes have a major influence on water levels in the river. Griffin and Oad (2004) found diurnal fluctuations in stream gage measurements during the growing season. Wachob (2006) confirmed the influence of the phreatophytes on stream stage and estimated the seasonal rate and timing of phreatophyte evapotranspiration. Wachob (2006) identified two reaches in the 'wet' segment of the study site that have similar topography and soils but one has phreatophytes while the other area has almost none. The phreatophyte vegetation was surveyed and 15 piezometers were installed, eight with data loggers, to measure water level changes over the year and evaluate the differences between the vegetated and non-vegetated areas. Evapotranspiration (ET) of the phreatophytes was estimated using the specific yield and the water table fluctuation method (White 1932; Healy and Cook 2002). While these methods produced reasonable results, it is believed that remote sensing measurement techniques could be used to better estimate values of ET. Generally, remote sensing combines regional satellite data with localized ET measurements to calculate regional ET.