

## PHREATOPHYTES

### Key Points

- Phreatophytes are a good indicator of high groundwater levels, as their occurrence is governed by the presence of groundwater within their maximal rooting depth.
- We replicated a previous study by Groeneveld and Prescott who developed estimations of phreatophyte ET from groundwater in the S. Platte basin for the baseline year of 2001. We extended this methodology forward to 2010 and back to 1990 to evaluate the expansion of phreatophytes up to the current period.
- Phreatophytes continue to increase in the basin, resulting in large quantities of non-beneficial consumptive use, perhaps as much as 250,000 AF/yr. We found a 35% increase in phreatophyte ET over the 20-year period from 1990 to 2010.
- We were unable to link expanded phreatophyte ET to changed groundwater management in the basin as the data do not show an increase in phreatophyte ET in areas outside the river floodplain, but instead indicated a densification of phreatophytes within the same areas of the floodplain.
- The analysis of phreatophyte ET was conducted for the HB1278 study by Dr. Ahmed Eldeiry of Colorado State University.

HB1278 stated that the analysis of groundwater conditions in the basin should include an evaluation of the relationship between high groundwater levels and nonbeneficial consumptive use by phreatophytes. Phreatophytes are trees and other deep-rooted perennial vegetation types that derive some part of their ET demand from groundwater. They are typically a good indicator of high groundwater levels, as their occurrence is governed by the presence of groundwater within its maximal rooting depth. South Platte DSS Task Memo 65 by David Groeneveld and Michael Prescott dated January 30, 2007 developed estimations of phreatophyte ET from groundwater in the S. Platte basin for the baseline year of 2001. The method used Landsat data and a derivation of the Normalized Difference Vegetation Index (NDVI). Total annual phreatophyte ET estimated for their study area, which included the tributaries to the S. Platte, was approximately 255,000 AF per year within the riparian zones along the river and the tributaries in basin. The total annual phreatophyte ET estimated by Groeneveld for the riparian corridor along Water Districts 2, 1, and 64 was 123,686 AF for the year 2001.

By far, the largest proportion of phreatophyte ET occurs during the growing season along the mainstem of the S. Platte in the floodplain. Groeneveld's ET estimations were based on annual totals and included reaches not considered in the HB1278 study, specifically the mountain front to the Henderson gage, the Cache la Poudre basin, and portions of the tributaries including the Beaver, Badger, Bijou, Sand Creek, Box Elder Creek, First and Second Creek, and portions of Cherry Creek (Figure 50). Pixels within Landsat imaging have an area of 0.2 acres, so

Groeneveld's ET estimations were derived on this scale. A single Landsat image may be used because the presence of a high water table confers a reasonably steady state condition of water availability, and thus phreatophyte vegetation is generally not water limited. Given that the phreatophytic vegetation in the S. Platte is predominantly deciduous trees, most of the plant transpiration occurs during the growing season from May 1 to September 30. Additionally, given the topography and amount of run-on that occurs in the floodplain, Groeneveld reasonably considered all of the precipitation that occurred during the growing season to be effective, thus his calculation for phreatophyte ET from groundwater was essentially reference ET – total precipitation.

We replicated Groeneveld's 2001 results independently and then extended a slightly corrected method that used 30-year average precipitation and reference ET back to 1990 and forward to 2010 using the stretched normalized difference vegetation index (NDVI\*) developed from Landsat 5 satellite images and the weather station data (reference ET and precipitation) in order to estimate the annual and seasonal phreatophyte ET from groundwater in the mainstem of the S. Platte. Landsat 5 satellite images with a 30 meter resolution were acquired for the years: 1990, 2001, and 2010. The resolution of the Landsat 5 images makes it difficult to differentiate between the annual and perennial vegetation; therefore, aerial photos with high resolution were also collected (Figure 51). Color aerial photos were acquired for the years 2005 and 2011 from the National Agricultural Imagery Program (NAIP) with one meter resolution. Weather station data were collected from 81 weather stations scattered over the S. Platte to develop a thirty year average (1980-2010) of both annual and seasonal ET and precipitation (Table 22 and Figure 52). The seasonal (May 1 through Sept 30) and the annual weather data were used with the NDVI\* to estimate the annual and perennial phreatophyte ET in a raster map formats. The result of this work shows increases in phreatophyte ET from groundwater from 1990 to 2010 from 115,438 AF annually in 1990 to 156,601 AF annually in 2010, a 35% increase over the 20-year period. Because the riparian corridor is constrained by development and agricultural fields for most of the river through Districts 2, 1, and 64, the majority of the increase in ET is due to increased density of the canopy within the existing riparian corridor. Due to the constrained area of phreatophyte growth, we were unable to draw any relationship between changes in high water areas and phreatophytes.