# Riparian Evapotranspiration (ET) Estimates on the Middle Rio Grande Using Remote Sensing

Final Student Research Report

**Submitted to:**

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## Introduction

Riparian evapotranspiration (ET) along rivers in the western United States has become a major hydrological as well as political issue. In the arid southwestern region of the United States, where water supplies are limited, water salvage by a reduction of ET from riparian vegetation may increase the availability of the resource for other uses including irrigation, residential, and commercial applications (Shafroth et al., 2005). Concerns about the spread of invasive plants have also led Congress to take actions and fund projects to control and eradicate non-native riparian trees (Friedman et al., 2005).

Saltcedar (*Tamarix ramosissima*) is a non-indigenous plant which was introduced to the United States from the Mediterranean area as an ornamental plant. Later, it was used mainly for soil erosion control (Stromberg et al., 2005). This plant is now an important component of riparian vegetation found along the Rio Grande River. It has been reported that saltcedar increases evapotranspiration (ET) and soil salinity in riparian areas in the West of the United States (Blossey, 1999). Controlling the spread of saltcedar may also restore native riparian vegetation; increase the flow of water, and improve wildlife habitats (Shafroth et al., 2005). The distribution and prevalence of saltcedar over other types of riparian vegetation is influenced by elevation, soil type, water availability, and topographic conditions (Taylor and McDaniel, 2004). Methods for eradication and control of saltcedar include mechanical removal, herbicide application, burning, and biological eradication by means of herbivore insects.

## Objectives

The primary objective of this research was to perform in-situ measurements of evapotranspiration (ET) and to collect ET data from flux towers located at Bosque del Apache National Wildlife Refuge (Fig. 1). The information was used to develop regional maps of ET for the Middle Rio Grande Region using remote sensing technology. The results can be used to evaluate and quantify the hydrologic impact of saltcedar eradication as well as providing a better estimate of the water budget for the Middle Rio Grande Region.

## Project description

Quantification of water consumption by riparian vegetation is important for water rights management, water allocation, planning, and regulation. There is urgent need for an accurate method to estimate evapotranspiration (ET) of the regional riparian zone of the Middle Rio Grande in an effort to balance water budget, evaluate the impact of saltcedar eradication, and to better manage the River. The State of New Mexico has spent millions of dollars in recent years to eradicate riparian vegetation without being able to accurately quantify the change in regional ET. Many studies have focused on measuring ET of individual riparian vegetation, mainly saltcedar and native cottonwood. However, the riparian vegetation along the Middle Rio Grande varies in density and species, due to spatial variations in climate, soil type, and depth to groundwater. Due to this inconsistency, the ET also varies from one location to another.

It is evident, that in order to get more accuracy in measurements, a lot of sampling points are needed, thus making the process very expensive and complicated. An alternative solution, which is also cost-effective, is to estimate evapotranspiration (ET) by using remote sensing technology. Remote sensing combines regional satellite data with in-situ measurements through flux towers to calculate regional ET. Remote sensing of ET is currently being used in many countries, including Egypt, India, China, the Netherlands, as well as the United States. Investigators at New Mexico State University have developed a Regional ET Estimation Model (REEM) which uses real time satellite information combined with climate data and localized ET measurements to calculate ET values for various crop canopies regardless of the type of crop, density, soil moisture content or other growth factors.

## Activities performed

*Field work*

The field work consisted of data collection from the research towers located at Bosque del Apache National Wildlife Refuge (Figure 1). The activities on the field included: verification of proper functioning of eddy covariance flux towers; field measurements (water level, weather data, etc.), and downloading information from flux towers. The field work (Figures 2 to 6) was carried out by the NMSU Civil Engineering Water Resources group (Brad E. Kirksey, Brice A. Carpenter, Zack Libbin, and Michelle Cathey).

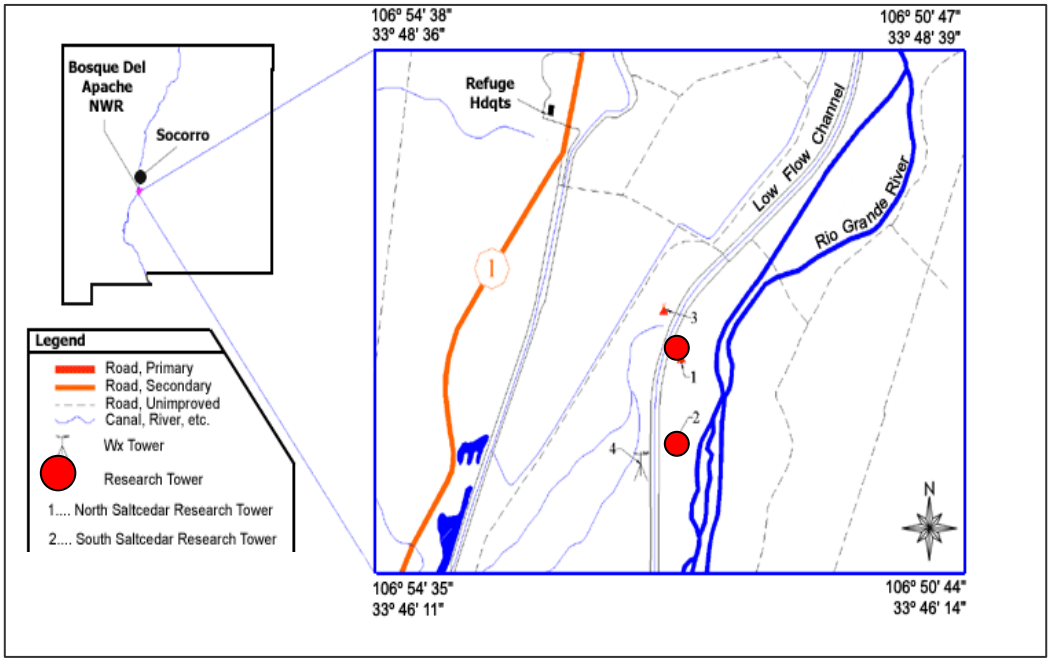


Fig. 1 Location of flux towers at Bosque del Apache National Wildlife Refuge.

Fig. 2 Research towers at Bosque del Apache National Wildlife Refuge.

Fig. 3 Aspects of the Rio Grande and vegetation canopy
at Bosque del Apache National Wildlife Refuge.

Fig. 4 Saltcedar canopy (view from top of tower) and eradication by mechanical removal.

Fig. 5 Data collection from towers and inspection of rain gauge
at Bosque del Apache National Wildlife Refuge.

*Maps*

The comparison of the satellite derived evapotranspiration (ET) with point measurements from one propeller eddy covariance (OPEC) towers at the research site showed excellent agreement. The comparison between ET estimated by REEM algorithm and measured ET is presented in Table 1. Figure 6 shows the correlation between predicted and measured net radiation.

Table 1 Evapotranspiration from saltcedar at Bosque del Apache National Wildlife Refuge.

| Flux Tower | Evapotranspiration, ET (mm/day) | |
|---|---|---|
| | REEM | Measured |
| South Saltcedar | 6.52 | 6.87 |
| North Saltcedar | 7.77 | 7.43 |

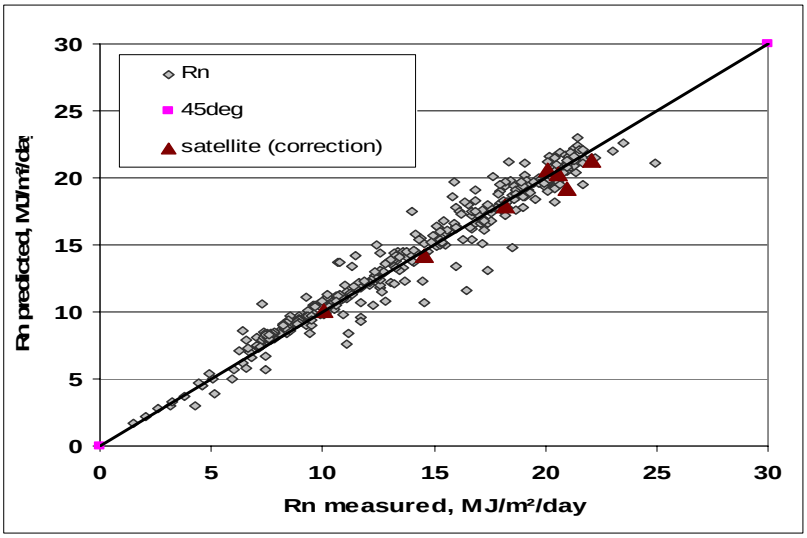


Fig. 6 Comparison of predicted and measured net radiation from saltcedar
at Bosque del Apache National Wildlife Refuge.

Evapotranspiration (ET) maps can be developed by using remote sensing information and the REEM algorithm (Figure 7). With ET mapping, the change in consumptive use from specific sites where saltcedar removal is being implemented can be compared to the ET before treatment.

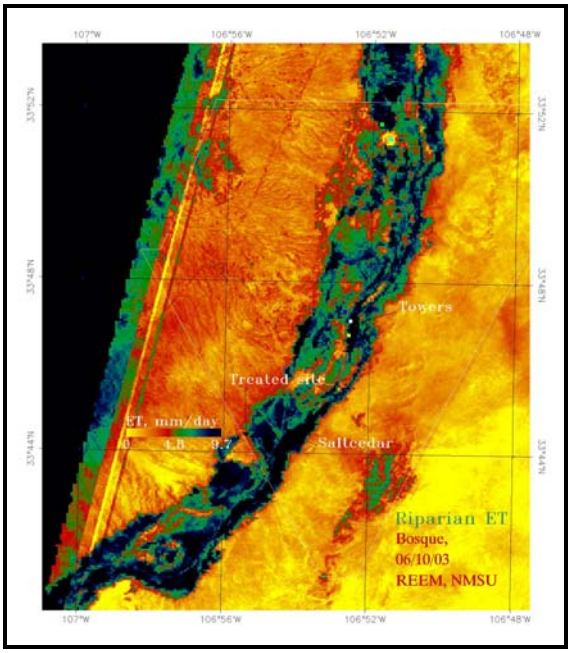


Fig. 7 Riparian evapotranspiration at Bosque del Apache National Wildlife Refuge.

*Project Dissemination*

The results of this research were presented in two forums in Las Cruces and Socorro, NM.

1) The poster titled "Riparian Evapo-transpiration Estimates on the Middle Rio Grande Using Remote Sensing" authored by Maritza Macias-Corral and faculty mentors, Dr. Zohrab Samani and Dr. Salim Bawazir, was presented at the Graduate Research and Arts Symposium at NMSU on April 13, 2006.

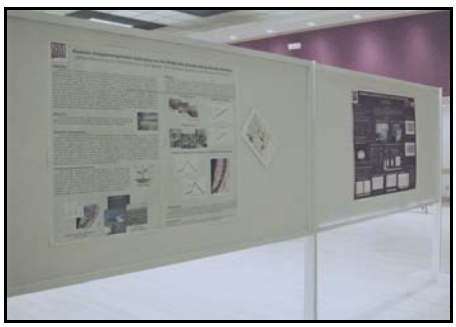
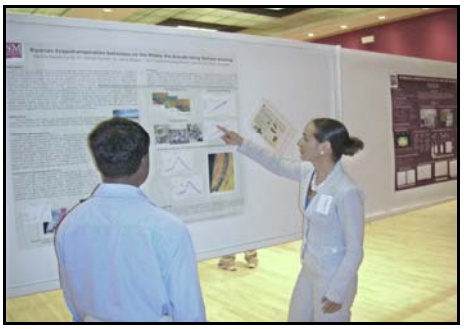

Fig. 8 Poster presented during the Graduate Research and Arts Symposium at NMSU, Las Cruces, NM.

2) The poster titled “Riparian ET Estimates on the Middle Rio Grande Using Remote Sensing” authored by Maritza Macias-Corral and faculty mentors, Dr. Zohrab Samani and Dr. Salim Bawazir, was presented at the 2006 New Mexico Water Research Symposium, at Socorro, NM on August 15, 2006.

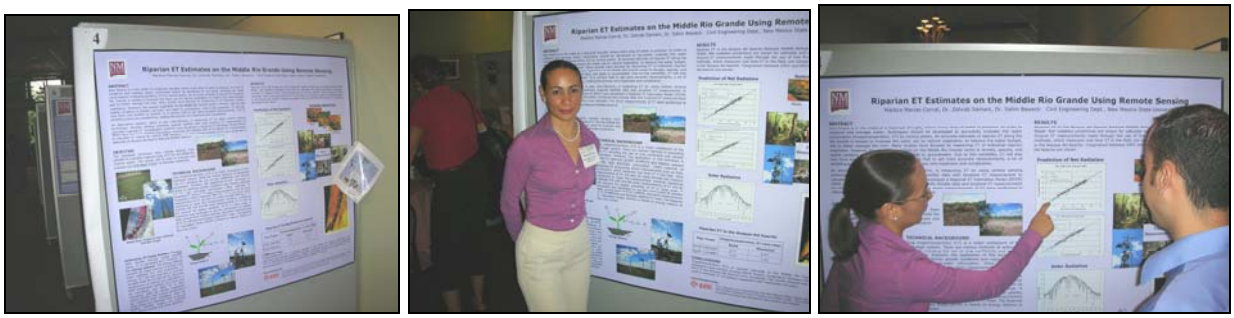


Fig. 7 Poster presented at the 2006 New Mexico Water Research Symposium at Socorro, NM.

## Conclusions

New technologies such as remote sensing are a valuable tool for prediction of important parameters such as ET of riparian vegetation. Accurate estimates of ET from riparian vegetation along the Middle Rio Grande with high spatial and temporal resolution are possible to obtain. The process, Regional ET Estimation Model (REEM), can provide real time ET values with high accuracy. Evapotranspiration from riparian vegetation is an important component of the water budget. The acquisition of this parameter allows a better estimate of the water budget for the Middle Rio Grande Region. Consequently, a better management of the Rio Grande and water allocation for human and environmental needs would be possible if regional ET from riparian vegetation is estimated more accurately in the water budget.

## Acknowledgements

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## Appendices

Posters presented at the Graduate Research and Arts Symposium (Las Cruces, NM) and New Mexico Water Research Symposium (Socorro, NM)