RESTORATION OF RIPARIAN VEGETATION USING GEO-ENGINEERING MATERIAL

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Introduction

Hydrologic alteration and operation of the Rio Grande have contributed to unsuccessful restoration of riparian vegetation restoration attempts by many organizations. This altered environment has allowed exotic and aggressive species of vegetation such as saltcedar (*Tamarix* spp.) to dominate and change the biodiversity of the ecosystem. Traditional methods of re-vegetation that relies on precipitation in the arid regions have had little or no success with the exception of pole plants for trees such as willows (*Salix* spp.) and cottonwoods (*Populus* spp). This investigation is part of a larger on-gong study by New Mexico State University, Stanford University Engineering Research Center-Re-inventing America's urban water infrastructure, and United States Bureau of Reclamation to investigate the use of geo-engineering material of clinoptilolite zeolite (CZ) in an effort to restore riparian regions, conserve water and improve biodiversity. . In this study, zeolite of clinoptilolite type mined by St. Cloud Mining Company at Winston, New Mexico was used to restore riparian vegetation.

Objective

The objective of this investigation is to determine :

- if using CZ effectively enhances restoration of native plants.
- if vegetation transplanted on CZ cores have a higher survival rate, growth rate, and moisture than plants transplanted in native riparian soil.

Background

One of the most invasive non-native plants in the United States that has affected riparian zones is Saltcedar (*Tamarix spp.*). According to Stromberg et al., (2007) Saltcedar tolerates drought stress and declining water tables due to its deep roots and other physiological adaptations. The most important factors to consider when undertaking a riparian restoration project are the water table fluctuations, soil texture, soil salinity, and browsing pressure from livestock and wildlife are considered according to Dreesen et al. (2002). Results from previous studies have demonstrated that CZ mineral could be used in arid regions of with shallow groundwater tables to increase water retention and allow groundwater levels to rise to the root zone caused by capillarity (Dung, 2011). Clinoptilolite Zeolite is a naturally-occurring volcanogenic sedimentary mineral mined at Winston, NM and in many regions of the world. Zeolite is made up of a crystalline structure that is porous and serves as a water moderator absorbing about 55% in their water weight and then releasing the water slowly as the plant needs it. . According to the National Science Conservation Service (NRCS) from the United States Department of Agriculture (2012) the annual precipitation in Southwest New Mexico ranges from twelve to sixteen inches according to records from 1971 to 2001, so by using CZ the survival rate of the transplanted riparian native plants will be higher.

References

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Methodology

The study was located at Caballo test bed site (33° 3'59.64"N, 107°17'13.20"W, Elevation 1288 m a.s.l.). Test bed is located in the riparian zone in the Rio Grande basin between Elephant Butte Reservoir in the north and Caballo Reservoir in the south. Saltcedar growing at the site was removed by US Bureau of Reclamation in 2008 using heavy plowing machinery in an effort to control and manage the spread of Saltcedar in this riparian region. In January of 2012 a total of 104 of CZ boreholes were drilled and installed in two plots at Caballo Test Bed site, NM by a research team from New Mexico State University, Civil Engineering Dept. In March, selected native riparian plants were transplanted in the CZ cores, and control individuals were transplanted in unamended riparian soil (RS). During June and July of 2012, vegetation survival and growth, groundwater levels, water and soil chemistry, soil moisture, and climate data were collected and analyzed to evaluate overall success of the restoration. . Figure 1 shows a diagram of the relative location of the two plots and groundwater piezometers within the restoration area as well as the experiment set up. Figure 2 shows a map of New Mexico indicating with arrows were the sites are located and a picture of the north plot (Plot 2). Figure 3 shows the plant arrangement inside the experimental plots. Four plants were selected to be used for restoration in the experimental plots. These plants were Saltgrass (*Distichlis spicata*), Giant sacaton (*Sporobolus wrightii*), Fourwing saltbush (*Atriplex Canescen*), and Emory's baccharis *(Baccharis emoryi*) and are shown in Figures 4 through 7.Figure 8 shows Plot 1 and the weather station located in the plot. The groundwater levels at two piezometers were taken periodically along with groundwater quality analyses during June and July of 2012.

Plant Arrangement

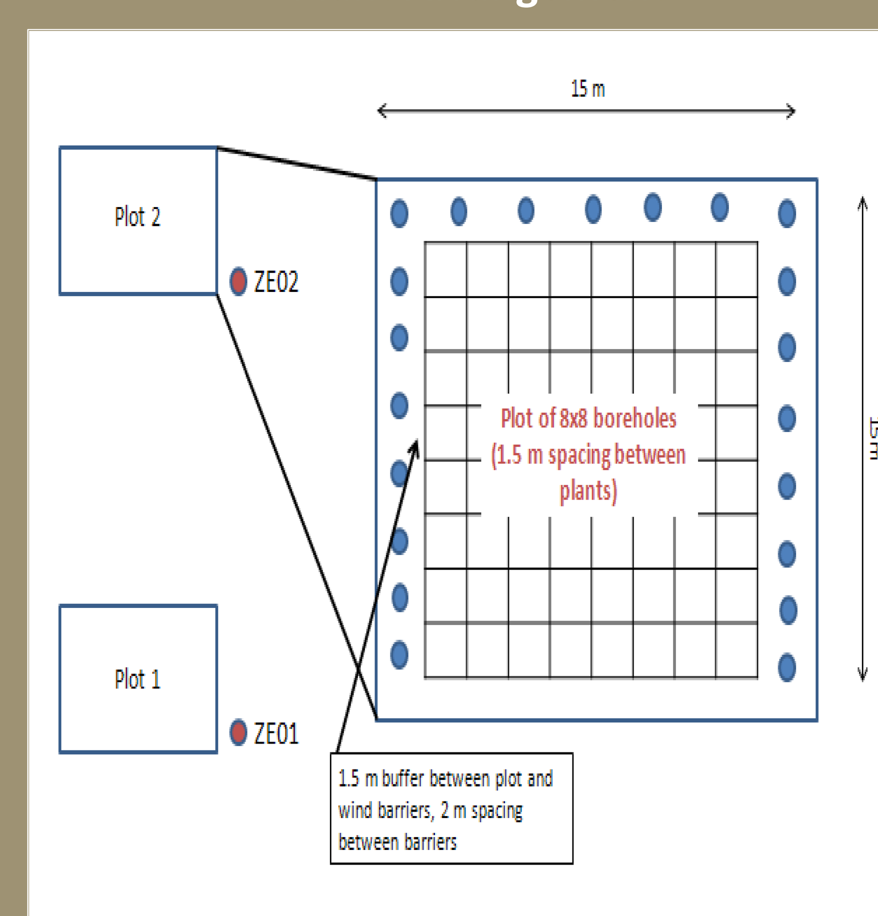

Figure 1. Relative location (not to scale) of the two plots, plant arrangement and groundwater piezometers in the restoration area at the Caballo Test Bed.

Experiment Set Up

Figure 3. Plant arrangement inside the experimental plots

Figure 4. Saltgrass (*Distichlis spicata*)

Figure 5. Giant sacaton (Sporobolus wrightii)

Figure 6. Fourwing saltbush *(Atriplex Canescens)*

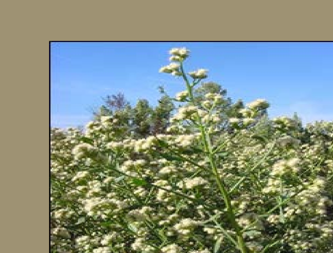

Figure 7. Emory's baccharis *(Baccharis emory)*

Figure 8. Weather station located in Zeolite-Saltgrass Plot 1

Figure 2. Picture of Plot 2 and a map of New Mexico indicating with arrows the location of the restoration site

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Preliminary Results

Plant survival in Plot 1 and Plot 2 are presented in Table 1.The Electrical Conductivity (EC) and Total Dissolved Solids (TDS) measured at the two plots are shown in Figures 9 and 10. EC ranged from 654.67 µs/cm in the river to 2170 µs/cm in Plot 1. Depth to groundwater table was about 3m. Volumetric moisture content in the plant root zone was very low (<0.2 cm^3/cm^3). The climate was very dry during the study period. Precipitation was very low (0.34 in.).

Table 1.Plant survival for Plots 1 and 2 measured from June 13th to July 25th,2012

	Baccharis		Fourwing Saltbush		Giant sacaton		Saltgrass	
Date	CZ*	RS**	CZ	RS	CZ	RS	CZ	RS
Plot 1								
13-Jun	6/8	6/8	8/8	8/8	1/8	3/8	0/8	4/8
9-Jul	6/8	3/8	6/8	8/8	1/8	2/8	0/8	3/8
25-Jul	6/8	3/8	6/8	8/8	0/8	2/8	0/8	3/8
Plot 2								
13-Jun	7/8	7/8	8/8	8/8	4/8	4/8	6/8	6/8
9-Jul	5/8	4/8	8/8	8/8	4/8	3/8	5/8	5/8
25-Jul	4/8	4/8	8/8	8/8	4/8	3/8	5/8	4/8

Note: Transplanting date was March 20th, 2012

*CZ is clinoptilolite zeolite

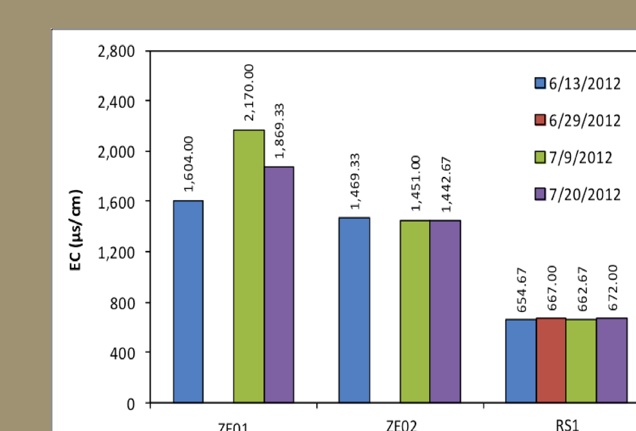

Figure 9. EC in groundwater collected in the ZE01 and ZE02 wells and water collected by the river

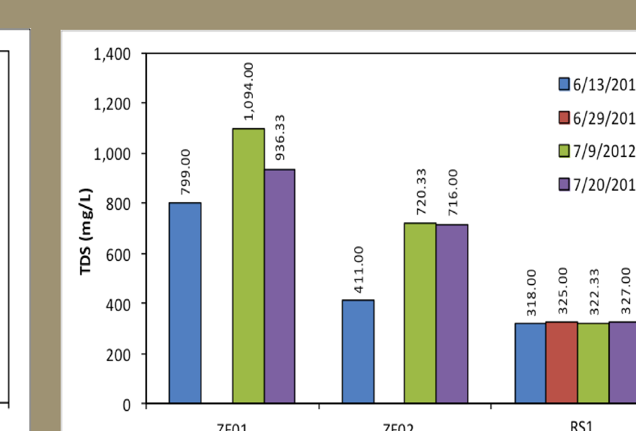

Figure 10. TDS in groundwater collected in the ZE01 and ZE02 wells and water collected by the river

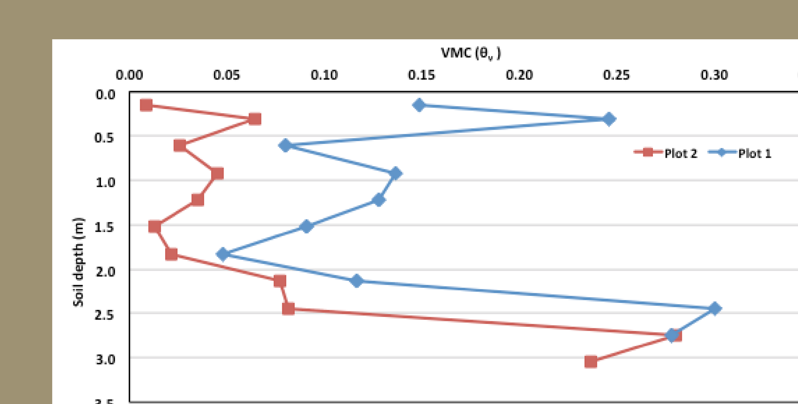

Figure 11. Relationship between soil depth and volumetric moisture content for Plots 1 and 2

Conclusion

Following preliminary are conclusions from this study:

- In Plot 1, 37.5 % of plants survived in CZ and 50 % survived in RS.
- In Plot 2, 66 % survived in CZ and 59 % survived in RS
- The CZ cores at Plot 1 disconnected from groundwater due to drought. This may have caused the plants not to survive.