Texas A&M AgriLife Research Center at El Paso

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Research and Results 2015

TEXAS A&M AGRILIFE RESEARCH
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Rio Grande Salinity Management: Preliminary Economic Impact Assessment

Dr. A. Michelsen, TAMU, Dr. T. McGuckin, NMSU, Dr. Z. Sheng, TAMU, Dr. R. Lacewell, TAMU, Dr. B. Creel, NMWRRI

Support Provided by: U.S. Army Corps of Engineers, USDA-NIFA, Texas A&M AgriLife Research, Texas Water Resources Institute, New Mexico Office of the State Engineer and New Mexico Water Resources Research Institute

BACKGROUND

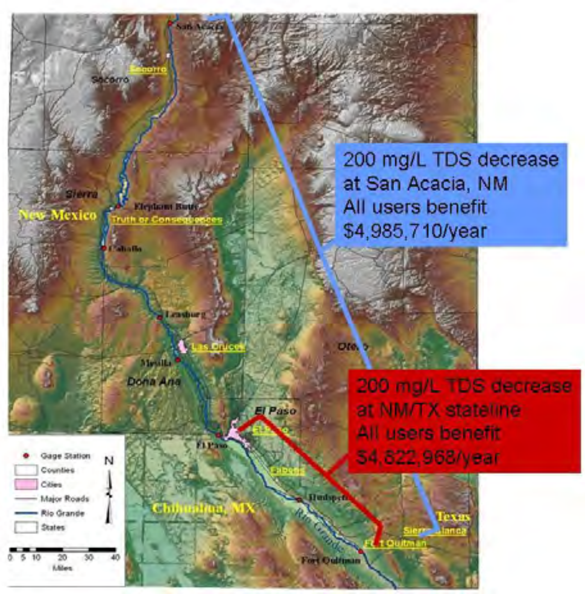
High concentrations of dissolved solids (also expressed as salinity) in the Rio Grande basin, are a major concern for water resource managers and water users. Elevated salinity concentrations adversely impact agricultural production, residential, commercial and industrial water users, and also have environmental consequences. The problems associated with high salinity take on greater importance as urban growth increases water demand. The Rio Grande Compact Commission, in collaboration with local water management entities, initiated a three state effort resulting in the creation of the *Rio Grande Salinity Management Coalition* (RGSMC) in January 2008. The RGSMC is composed of the Rio Grande Compact Commissioners from Colorado, New Mexico, and Texas, state water management agencies, local water utilities and irrigation districts, and university research organizations.

OBJECTIVES

The overall objectives of the RGSMC program are to better understand salinity concentrations, loading sources, and impacts in the Rio Grande basin from San Acacia, New Mexico to Fort Quitman, Texas, and to ultimately reduce salinity concentrations, increasing usable water supplies for agricultural, urban, and environmental purposes. Economic impacts attributable to salinity of Rio Grande water were estimated based on damage functions and calculation methods for residential, agricultural, municipal, and industrial uses within the study area.

PROGRAM RESULTS AND BENEFITS

- In this preliminary assessment, the total economic damage (cost) from Rio Grande salinity is estimated to be about $10.2 million per year: 76% for urban economic impacts and 24% for agricultural damages. The single category of the highest damages is residential, 42% of the total, followed by agricultural, commercial, and urban landscape.
- A 200 mg/L TDS reduction in salinity concentrations in Rio Grande water results in $5.0 million in benefit, of which approximately 80% would accrue to urban users in El Paso County, currently the only urban water uses of Rio Grande.
- Future growth in population and increased use of Rio Grande water for urban supplies would result in much higher economic impacts and make management of salinity concentration in the river increasingly important.
- Recommend to fill-in significant economic impact information gaps and refine the assessment analysis to improve evaluation of potential salinity management control alternatives.
- The preliminary assessment considered only existing conditions. Inclusion of full agricultural and other losses are anticipated to show much higher levels of damages.
- The results provide guidelines for evaluating and selecting alternative sites for salinity control.



Economic benefit of salinity reductions in the Rio Grande basin.

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Soil Salinity Assessment Using Electromagnetic Induction

Dr. Girisha Ganjegunte and John Clark, Texas A&M AgriLife Research

Support provided by: USDA-NIFA Rio Grande Basin Initiative through Texas Water Resources Institute and Texas A&M AgriLife Research; in collaboration with local growers (Art Ivey, Jim Ed Miller, Mark Ivey) and Dr. Bernd Leinauer, New Mexico State University.

BACKGROUND

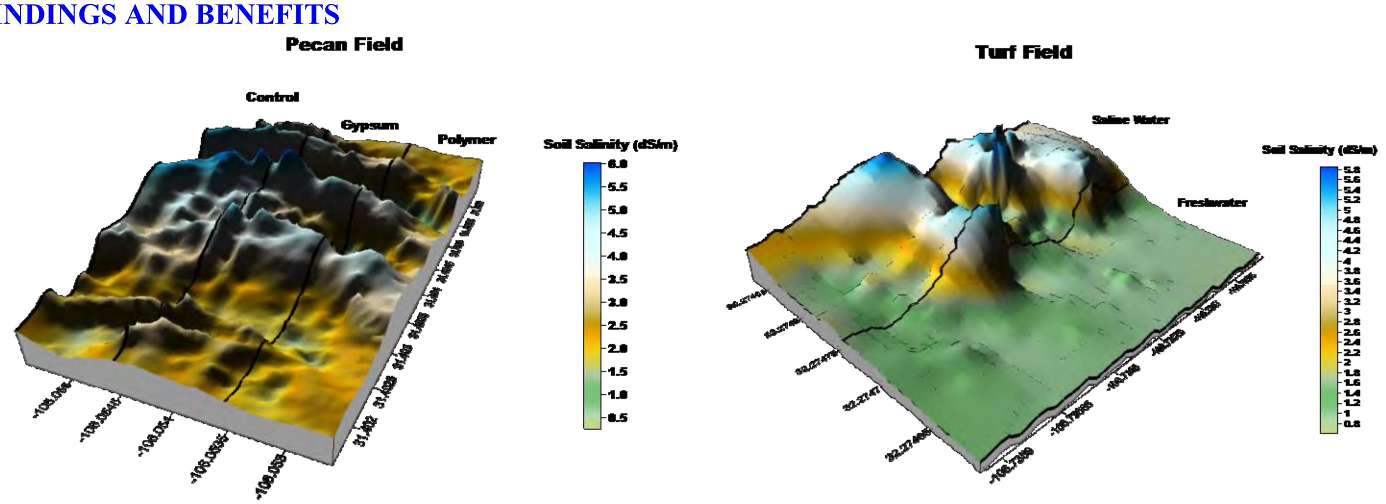
Salinity is a major problem affecting farm profitability, water quality and availability in arid regions such as the Far West Texas. Understanding salinity distribution within an irrigated area is necessary for developing effective salinity management practices. Conventional methods of assessing soil salinity at a detailed spatial resolution are expensive and time consuming. Electromagnetic induction (EMI) technique can determine soil salinity distribution in irrigated areas rapidly and in a non-invasive way. Advantages of this method are (i) high mobility, (ii) non-invasive way of salinity assessment and (iii) short time required to carryout the salinity assessment. However, EMI technique's accuracy is influenced by site specific factors such as soil clay content. This project evaluates the accuracy and factors affecting the accuracy of EMI technique to delineate salt distribution in the affected fields. The results of this project can help farmers to reduce salinity management costs by target application of amendments to salinity hotspots within the affected field.

Electromagnetic induction meter fitted with GPS unit

OBJECTIVES

- Evaluate the EMI technique for providing rapid and accurate assessment results of soil salinity and sodicity
- Determine soil factors that affect accuracy of EMI technique to facilitate technology transfer to other regions.
- Identify hot spots within an affected area to develop effective salinity management options, reduce costs, and increase farm profits.

FINDINGS AND BENEFITS



Examples of salinity distribution in pecan (left) and turf (right) fields obtained using EMI technique.

Initial results indicate that the EMI readings were strongly influenced by soil properties such as clay, field moisture, salinity and sodicity. EMI data had strong correlations with saturated paste salinity (EC_e) and sodicity (SAR) indicating that accuracy of technique was good. Results of the project also indicated that EMI technique can provide a rapid, inexpensive, and accurate salinity/sodicity distribution data both in agriculture and urban fields. Figures provided above clearly indicate soil salinity was much higher in control plots that did not receive any amendment in pecan fields and plots that received saline water irrigation in turf field. Study results can reduce cost of reclamation by targeting salinity hotspots within irrigated fields. Research results can also be used to evaluate effectiveness of current salinity management practices and develop efficient management practices that can improve soil quality and increase crop yields.

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Soil Salinity Management Using Synthetic Organic Polymer

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Texas A&M AgriLife Research

Support provided by: Texas A&M Agrilife Research, USDA-NIFA Rio Grande Basin Initiative through Texas Water Resources Institute
in collaboration with the local pecan grower Mr. Art Ivey

Pecan Orchard in El Paso County, Texas

BACKGROUND

Significant portion of the Rio Grande Project area between Elephant Butte reservoir in New Mexico and Fort Quitman in Texas is affected by salinity and sodicity. Soil salinity affects plant growth and yield through reduced water/nutrient availability and poor growing conditions. Pecan is a major cash crop in the region and it is highly susceptible to salinity. At present farmers use expensive deep tillage to improve soil permeability to leach accumulated salts. Synthetic organic polymers may offer an efficient and cost effective alternative to conventional method of sub-soiling. Application of polymer to salt affected soils may improve permeability by stabilizing soil structure by promoting better flocculation and improving pore continuity. Improved permeability can result in better leaching of salts below effective root zone of pecan. This project evaluates synthetic organic polymer's effects on soil permeability and salinity within the effective root zone of pecan.

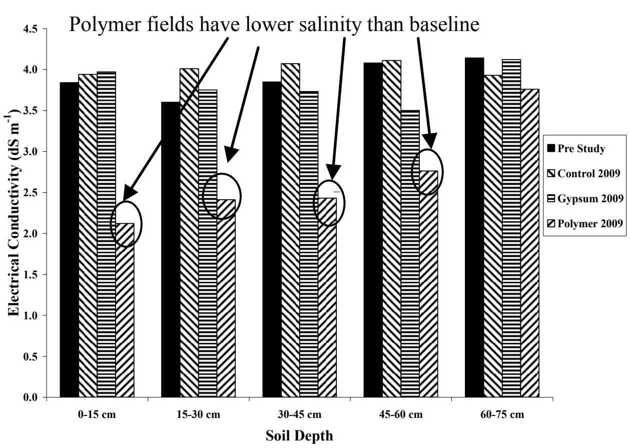
OBJECTIVES

- Evaluate effects of a synthetic organic polymer on soil permeability.
- Determine effects of synthetic organic polymer on soil salinity and sodicity in the effective root zone of pecan.
- Evaluate effects of polymer application on pecan yield.

Organic polymer being mixed and applied with irrigation water

FINDINGS AND BENEFITS

Results from the past three years have indicate that polymer application through irrigation water reduced salinity (see figure) and sodicity in top two feet of soil by 41% and 56%, respectively, compared to the control area that did not receive polymer application. As evidence of improved soil conditions, pecan nut yields increased by 34% in the polymer treated area over the control area. Study results suggested that polymer application can help in effective utilization of native Ca sources to counter sodicity and facilitate salt leaching. Polymer application maintained the improved permeability conditions created by land preparation activity prior to irrigation for longer time compared to control. These effects reduce the need for frequent deep tillage or sub-soiling to improve soil permeability and consequently reduce the cost of production and increase profits for growers in the region.



Soil salinity in polymer applied field is lower than that of control

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Evaluation of Salt Tolerance of Chile Peppers

Dr. Genhua Niu and Youping Sun, Texas A&M AgriLife Research Center at El Paso
Texas A&M University System

Supported by: Texas A&M AgriLife Research, Rio Grande Basin Initiative, USDA-NIFA

BACKGROUND

Use of saline water resources, primarily municipal effluent and brackish groundwater, for irrigating agricultural crops and urban landscapes is important to conserve freshwater throughout the Rio Grande Basin. In addition to water scarcity, soil salinity has long been recognized as a major problem throughout the Rio Grande Basin, which has resulted in reduction in yield, crop selection and irrigated acreage and loss in farm profitability. Specialty chile peppers are important crops in Texas and New Mexico but salinity currently limits the production. The goal of this project is to identify salt and drought tolerant cultivars of chile peppers and develop salinity management guidelines for irrigation management of chile peppers in the Rio Grande Project area.

OBJECTIVES

- Evaluate the salt tolerance of selected commercial varieties of chile peppers through laboratory, greenhouse and field studies.
- Understand salt tolerance mechanisms of chile peppers in order to aid breeding and biotechnological programs.

RESULTS AND BENEFITS

- Genotype variations in salt tolerance in over 20 varieties were found. Early Jalapeno was found to be one of the salt tolerant genotypes while Habanero was salt sensitive.
- Soil type and salinity of irrigation water affected seedling emergence. Emergence percent was generally high in loamy sand than silt loam.
- Salts accumulate at the top soil layer when irrigation water contains salts and the salinity of the top soil layer increases over time.
- Salt tolerance mechanisms in chile peppers include osmotic adjustment and partial exclusion of Na^+ and/or Cl^- ions from shoots.
- These results will help growers to select salt tolerant cultivars. Salt tolerant cultivars generally have higher yield in this region and thus bring more profitability to chile pepper growers and benefit the economy of the region.
- The research project on salt tolerance of chile peppers continues to evaluate more genotypes and at various growth stages through laboratory, greenhouse and field studies.

Salt tolerance of chile pepper study in the greenhouse

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Salt tolerance of Herbaceous Perennials and Groundcovers

Dr. Genhua Niu, Texas A&M AgriLife Research Center at El Paso, Texas A&M University System

Support provided by: USDA-NIFA Rio Grande Basin Initiative, Texas Water Resources Institute, Texas Water Development Board, El Paso Water Utilities and Texas A&M AgriLife Research

BACKGROUND

In order to conserve water, many municipalities in the Southwest encourage homeowners and businesses to reduce turf coverage in landscapes with incentive programs (e.g., El Paso, Texas and Las Vegas, Nev.). An alternative to turf may be the low-water use herbaceous perennials and groundcover species, which have been popular in recent years in landscapes because of low maintenance and increasing of diversity. As the fresh water supply is diminishing and urban populations continue to increase, use of recycled water to irrigate landscapes may be inevitable in the future. The major concern of using recycled water for landscape irrigation is the elevated salinity, which causes salt damage or even death to sensitive species. In order to minimize the potential damage, salt tolerance of popular herbaceous perennials and groundcovers needs to be determined.

Salt tolerance study in the greenhouse

Salt tolerance study in the field

OBJECTIVES

To determine the salt tolerance of commonly used herbaceous perennials and groundcovers under greenhouse and field conditions and to understand the general mechanisms of salt tolerance in these species.

RESULTS AND BENEFITS

- A wide range of salt tolerance was found among a number of tested herbaceous perennials and groundcovers. A list of salt tolerant plant species will be updated.
- Salt damage due to non-potable water irrigation will be minimized by avoiding planting salt-sensitive plants.
- Irrigation water cost can be reduced and availability of water supplies for nursery and landscape irrigation will be increased.
- Knowledge on salt tolerance mechanism of landscape plants will be increased.

Evaluation of Salt Tolerance of Garden Roses

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Texas A&M University System
Dr. Dave Byrne and Dr. Terri Starman, Department of Horticultural Science
Texas A&M University

Supported by: Texas A&M AgriLife Research, and Rio Grande Basin Initiative, USDA-NIFA

BACKGROUND

Roses are the most economically important ornamental plant in the world and have been cultivated for more than two thousand years. Roses are traditionally categorized as salt sensitive. However, our recent research has revealed that some cultivars may be more tolerant than others. As fresh water supplies become limited, reclaimed water is increasingly being used for irrigating landscapes and agricultural and horticultural crops. Information on how garden roses respond to lower quality irrigation water is important. The goal of this project is to identify the salt tolerant rose cultivars that can be grown in salt affected areas and/or irrigated with reclaimed water.

OBJECTIVES

- Evaluate the salt tolerance of selected garden rose cultivars that are potentially heat and drought tolerant for southern regions.
- Evaluate salt tolerance of the Earth-Kind roses. Earth-Kind is a special designation given to selected rose cultivars by the Texas AgriLife Extension Service through the Earth-Kind landscaping program. It is based on the results of extensive research and field trials and is awarded only to those roses demonstrating superior pest tolerance, combined with outstanding landscape performance.

Screening salt tolerance for various rose cultivars in the greenhouse

RESULTS AND BENEFITS

- A wide range of salt tolerance among 13 garden rose cultivars was found in the preliminary experiments. Moderately tolerant cultivars can be irrigated with saline solution at electrical conductivity up to 4.0 dS/m, 2-3 times higher than that of reclaimed water, without visual salt damage. Future research will confirm these results and continue to determine the salt tolerance of more rose cultivars.
- The identified salt tolerant rose cultivars will help beautifying landscapes with more colors while conserving high quality water. The threshold of salinity levels of roses, which cause plant injury, will provide guidance to irrigation management with reclaimed water in urban landscapes and nursery industry.
- The research results will help home owners and urban landscape professionals select salt tolerant roses to improve landscape performance for areas where lower quality water may be used for irrigation.

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Evaluation of Salt Tolerance of Bedding Plants

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Supported by: Texas AgriLife Research, and Rio Grande Basin Initiative, USDA-NIFA

BACKGROUND

Bedding plants are extensively used in landscapes throughout the country. However, their use in the Southwest U.S. is relatively limited due to the adverse climate conditions. Bedding plant production is the fastest-growing segment in the horticulture industry in the United States. New cultivars and species are being developed and released each year. Our recent research has revealed that some varieties are more stress tolerant than others. This information on responses to environmental stresses (salt, drought, and heat) of various bedding plant species and cultivars is important for consumers, growers, and breeders for selection of plant materials for improved landscape performance and to expand the use of these plants in areas where they are currently not widely used.

OBJECTIVES

- Evaluate salt tolerance of bedding plants which are also potentially heat and drought tolerant for the Southwest U.S. region.
- Understand salt tolerance mechanisms of selected bedding plants in order to aid breeding and biotechnological programs.

RESULTS AND BENEFITS

- Large variations exist among salt tolerance of the tested bedding plants.
- A number of salt tolerant bedding plants can be irrigated with lower quality water at moderate salinity (electrical conductivity of 3 to 5 dS/m or total dissolved solid at 2,000 to 3,000 ppm) without any visual damage, although plants became smaller and compact as salinity of irrigation water increased.
- Ornamental peppers ‘Calico’ and ‘Black Pearl’, Blue plumbago, vinca, Helenium ‘Dakota Gold’, gomphrena, and a number of petunia cultivars are moderately salt tolerant, Drought tolerant *Zinnia marylandica* Zahara Series are moderately salt sensitive.

Screening salt tolerance for bedding plants in the greenhouse

- By selecting salt tolerant bedding plants, landscape performance will be improved in areas where lower quality water is used or with high soil salinity.

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Drought Tolerance and Minimum Water Use of Landscape Plants

Dr. Genhua Niu, Texas A&M AgriLife Research Center at El Paso, Texas A&M University System

Support provided by: USDA-NIFA Rio Grande Basin Initiative, Texas Water Resources Institute, El Paso Water Utilities and Texas A&M AgriLife Research

BACKGROUND

Water conservation is critical for making the best use of limited water supplies in the Rio Grande region and throughout the Southwest, especially during drought. With up to 50% of total urban water consumption used for irrigation of landscapes in the Southwest during summer months, many municipalities have encouraged or passed landscape ordinances on the use of drought tolerant and low water use plant species. Knowledge of drought tolerance of landscape plants for the Southwest is limited. Existing lists of drought tolerant plants and water use are based largely on empirical observations. Native and other plants that are drought tolerant can actually be high-water users under well-watered conditions. To succeed in landscape water conservation, both drought tolerance and minimum water requirements to maintain aesthetic appearance need to be determined. There is little knowledge on minimum water requirements for landscape plants.

OBJECTIVES

The primary objectives of this study are to determine the relative drought tolerance of selected plant species under greenhouse and field conditions. The physiological responses to drought stress are also examined.

BENEFITS

- This study will develop the knowledge and information necessary to make recommendations of adapted or native ornamental landscape plant species appropriate for the Rio Grande region and the arid Southwest based on their drought tolerance and water use.
- Knowledge of actual water use of plants will help the nursery industry, landscape professionals and homeowners to enhance irrigation efficiency by scheduling irrigation timing and amount more accurately.
- By grouping plants according to their relative drought tolerance and water use, landscape irrigation schedule and efficiency will be improved and water will be conserved.
- Knowledge of minimum water use will help landscape professionals and homeowners to keep aesthetic value while conserving irrigation water.

Drought tolerance and water use study of herbaceous flowering plants in the field.

Determining Water Use and Crop Coefficient of Landscape Plants

Dr. Genhua Niu and Denise S. Rodriguez, Texas A&M AgriLife Research Center at El Paso;
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Texas A&M University System

Support provided by: USDA-NIFA Rio Grande Basin Initiative, Texas Water Development Board, Texas Water Resources Institute, El Paso Water Utilities and Texas A&M AgriLife Research

BACKGROUND

Increasing competition among agriculture, industry and municipal water users in arid and semi-arid regions has brought attention to water conservation and the need to improve irrigation efficiency. As landscape irrigation accounts for 40 to 60% of total household water consumption in the Southwest, conserving and reducing the amount of water used for landscape irrigation is critically important. Irrigation efficiency can be improved by grouping plants with similar water requirements and by scheduling irrigation based on specific plant needs. However, limited information exists on actual water requirements of landscape plants.

Parallel experiments were conducted by growing the same species in lysimeters and containers. Their water use and crop coefficients were determined and compared.

OBJECTIVES

The water use of container-grown plants can be accurately obtained gravimetrically. The objectives of this study were to determine and compare the water use and crop coefficients of landscape plants growing in drainage lysimeters (simulation of landscape conditions) and in above-ground containers (nursery practices) simultaneously in the same field plot. These data will determine if the water use of the same plant species grown in the two culture systems is exchangeable.

RESULTS AND BENEFITS

- Plant water use, crop coefficient and overall growth parameters differed by species and culture system. However, the water use per unit leaf area of all species was not affected by the culture system. Therefore, by quantifying the leaf area, the plant water use in the two culture systems is exchangeable.
- Actual water use of plants will help the nursery industry, landscape professionals and homeowners to increase irrigation efficiency by scheduling irrigation timing and amount more accurately. Thus, irrigation water costs will be reduced and water will be conserved. In addition, runoff and groundwater pollution will be minimized.
- By grouping plants according to their relative drought tolerance and water use, landscape irrigation schedule and efficiency will be improved and water will be conserved.

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Sustainable Practices in Ornamental Crop Production Systems

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Dr. Ryan Stewart, Brigham Young University
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Support provided by: USDA-NIFA, Specialty Crop Research Initiative and Texas A&M AgriLife Research

BACKGROUND

Plant production facilities for ornamental container plants are high input systems using large amounts of water, fertilizer, pesticides, plastics, and labor. The use of renewable and biodegradable inputs while growing an aesthetically pleasing and healthy plant will improve the economic, environmental, and social sustainability of current production systems. Green industry stakeholders have identified production practices which reduce plastic and water use as a major focus to increase sustainability. However, the environmental and economic costs associated with these specific practices are undetermined.

OBJECTIVES

This collaborative, multi-university research project will analyze the use, impacts, economic costs and environmental effects of biocontainers from nursery production to landscape use. Specific objectives of this research are to:

- Evaluate the sustainability of alternatives to plastic containers for use in greenhouse and nursery systems,
- Evaluate the impact of biocontainers on irrigation management practices in containerized nurseries, and
- Evaluate the impact of biocontainers on landscape performance of selected crops and plantable pot degradation in landscapes.

FINDINGS AND BENEFITS

- The immediate impacts of this project will be directly related to alternative containers and water use efficiency. When adopted, the alternative pots will reduce the amount of plastic containers used during crop production. A reduction in the use of petroleum-based plastics is of benefit to the industry due to reduced negative environmental impacts and reduced energy usage during pot manufacturing.
- Information will be provided to industry leaders supporting critical decisions on the use of sustainable practices related to container choice and irrigation management on economic and environmental implications.
- Guidelines will be provided as a foundation for subsequent management tools leading to national or regional blueprint for identifying, implementing and assessing sustainable production practices in greenhouse and nursery settings.

Photo: Impatiens plants in different types of bio containers.

Salinity Impacts on Pecan Trees

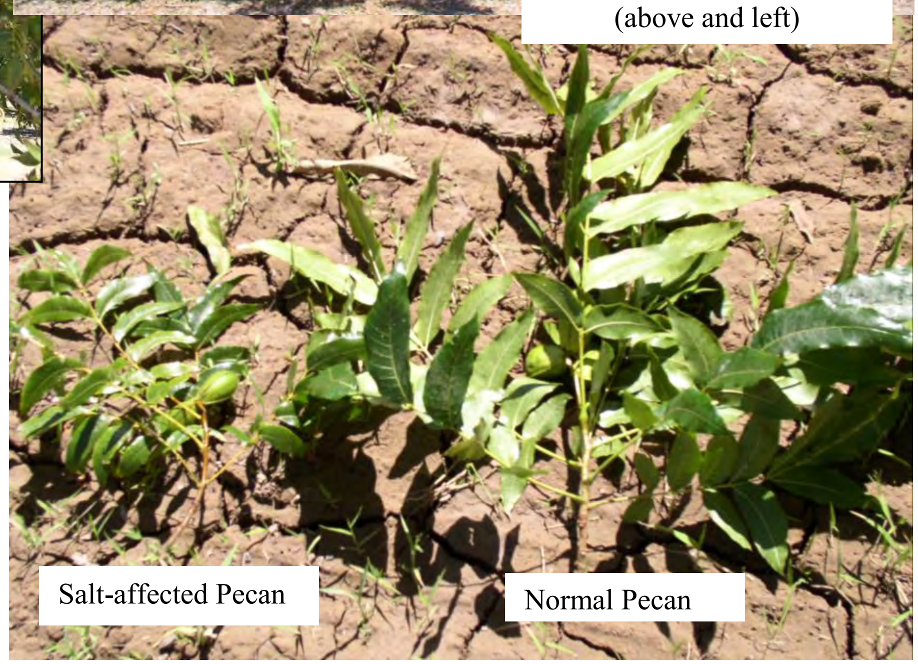
Dr. Seiichi Miyamoto, Texas A&M AgriLife Research

Support Provided by: Texas A&M AgriLife Research and USDA-NIFA

SALINITY AFFECTS

Pecan trees are susceptible to salt damage, especially to sodium (Na) and cloride (Cl). Sodium-affected trees show leaf tip-burn, whereas chloride-affected trees exhibit extensive foliage burn. The photographs shown here are typical cases of Na-affected trees in as little as one year after irrigation with salty ground water. These trees will defoliate sooner than others, and bud slower in the spring.

Salt-affected Pecan Trees (above and left)



MANAGEMENT RECOMMENDATIONS

If you have the choice, avoid use of salty ground water for irrigating pecans. Otherwise, blend salty ground water with project water which is generally less salty. If possible, the higher salinity ground water could instead be used to irrigate cotton which is more tolerant to salts. Managing soils to maximize water infiltration and drainage will also help to reduce damage from salts.

For additional details refer to **"Guidelines for Developing Soil and Water Management Programs"** by Dr. Seiichi Miyamoto.

Managing Pecan Orchards under Water Quality Constraint

Dr. Seiichi Miyamoto and Ignacio Martinez, Texas A&M AgriLife Research
In cooperation with participating area growers

Support provided by: USDA-NIFA Rio Grande Basin Initiative, Texas Water Resources Institute and Texas A&M AgriLife Research

BACKGROUND

The water supply from the Rio Grande Project is curtailed from time to time due to drought. Shortages are supplemented through pumping of groundwater by the irrigation districts as well as by individual growers. Unfortunately, groundwater in this area usually has elevated levels of salts, especially in the El Paso Valley. Pecan trees are sensitive to salts, and are among the first to be affected. There is a need to develop orchard management practices to minimize salinity impact.

APPROACH

The primary cause of salt accumulation in soils is inadequate permeability of clayey (low permeability) soils which occupy 75% of the El Paso Valley. The basic processes which cause slow permeability are reasonably well understood, and include high clay content, soil compaction, and poor soil aggregation. The key to improve permeability is to deal with these processes in an economical and sustainable fashion. Scientists at the El Paso Research Center have been experimenting with a minimum-till soil management system involving subsoiling, sanding, minimum-till surface chiseling, sodding, and supplemental uses of chemical amendment only if needed. Subsoiling (plough below the normal depth to break up the subsoil) is to improve subsurface drainage, sanding is to provide pore spaces for improving permeability, minimum-till chiseling and sodding are to alleviate soil compaction and improve soil aggregation.

RESULTS AND BENEFITS

Preliminary results show that orchard soils can be maintained with minimal of salinization with this system at a cost lower than the conventional systems. The primary benefit of these management techniques are to help sustain pecan production under water quality constraints. Pecans are the number one cash crop in the El Paso Valley and far west Texas, and are becoming a significant crop in other irrigated areas.

Soil management practices at a pecan orchard using the minimum-till surface chisel (left) and minimum-till subsoiler (right).

Pecan Rootstock Selection for Saline Areas

Dr. S. Miyamoto and I. Martinez, Texas A&M AgriLife Research
Dr. L. J. Grauke, National Genetic Resources for Pecans and Hickories, USDA-ARS

Support provided by: USDA-ARS, USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

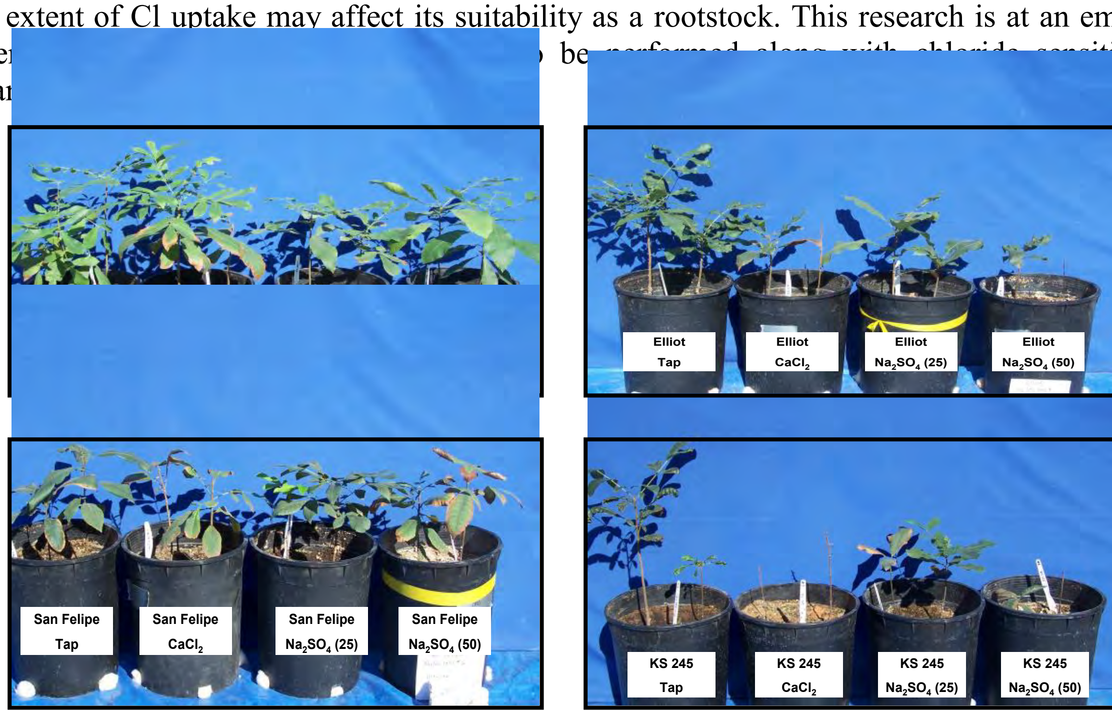
Pecan is the most valuable native nut crop in Texas, and is the number one crop in the El Paso County as well as in several adjacent counties in New Mexico. The climate of this region is well suited for growing pecans with little incidences of disease. However, pecan is among the most salt-sensitive crop currently grown, and salinity presents a serious constraint for production. The purpose of this long-term project is to select salt tolerant rootstock in cooperation with the Pecan Genetic Improvement Program of USDA-ARS.

OBJECTIVES

Our previous study has shown that pecan trees are most sensitive to sodium (Na) and Chloride (Cl) ions. Sodium ions damage roots, and Chloride ions cause leaf injuries. Development of rootstock which can tolerate higher soil salinity should help sustain pecan production in salt-affected areas. We are currently screening 17 rootstock accessions from USDA Genetic Resources collected from various parts of the US and Mexico.

RESULTS AND BENEFITS EXPECTED

We are seeing a significant growth rate difference among the tested accessions. Accessions which have a higher growth rate may prove to be a rootstock suitable for Na-affected areas. In Cl-affected areas, this trait is also desirable, but the extent of Cl uptake may affect its suitability as a rootstock. This research is at an emerging state, and the experimen[...] be[...]vity of nut-production cultivar[...]



Preliminary results indicate HD455 is tolerant to both Na^+ and Cl^- ions.

TEXAS A&M AGRILIFE RESEARCH

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USDA ARS

USDA United States Department of Agriculture National Institute of Food and Agriculture

Established the Guidelines for Landscape Uses of Reclaimed or Saline Water

Dr. S. Miyamoto, S. Khurram, I. Martinez, Texas A&M AgriLife Research
D. Ornelas and D. Tierre, El Paso Water Utilities

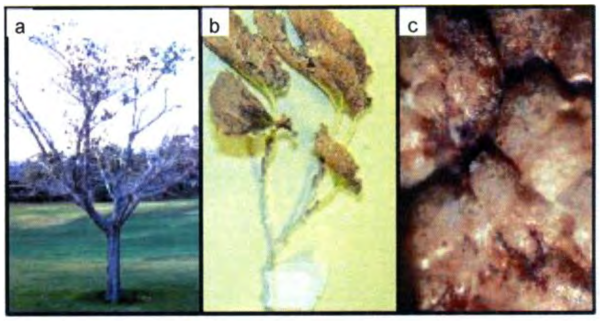
Support provided by: El Paso Water Utilities, Rio Grande Basin Initiative, USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

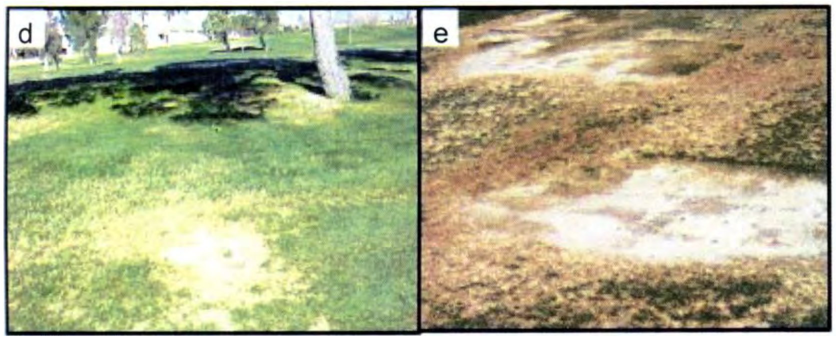
With increasing costs of securing potable water, reclaimed or saline water is beginning to be used for irrigating urban landscape. The experience in El Paso and far west Texas, however, indicates that under certain conditions, the use of water with elevated salinity can cause salt damage to landscape plants. Photographs below illustrate salt damage to broadleaf trees through sprinkling of salty water (a through c) and damage to turf as a result of soil salinization (photo d and e). The goal of this project is to develop management practices which minimizes salt problems.

OBJECTIVES

- Evaluate salt tolerance of plant species against sprinkler application of salty water.
- Develop cost-effective measures to reduce salt damage caused by foliar absorption.
- Screen plant species based on their tolerance to soil salinity.
- Develop practical ways of predicting salt accumulation potential.
- Develop soil and irrigation management practices which reduce soil salinization.



Sprinkler irrigation damage to plants from salts



Soil salinization damage to turf grass

BENEFITS

- Tolerance of landscape plants against sprinkling of saline water is highly species-dependent, and a plant-salt tolerance relationship was developed.
- Conversion to a low angle nozzel is a practical way to reduce leaf damage, but not all sprinkler heads can be retrofitted.
- Tolerance of plants against soil salinity varies tenfold; tolerant species grow well with irrigation water having 10,000 ppm of dissolved salts. Sensitive ones can suffer at 1,000 ppm.
- Soil salinization under normal irrigation practices is primarily a function of soil types and management, but seldom salinity of water used for irrigation. An empirical equation is now available for assessing salinization potential.
- Soil and irrigation management practices to reduce salinity hazards are being developed.

Soil Suitability for Development and Maintenance of Urban Turf Areas

Dr. S. Miyamoto and I. Martinez, Texas A&M AgriLife Research

Support provided by: U.S .Bureau of Reclamation, USDOI; USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

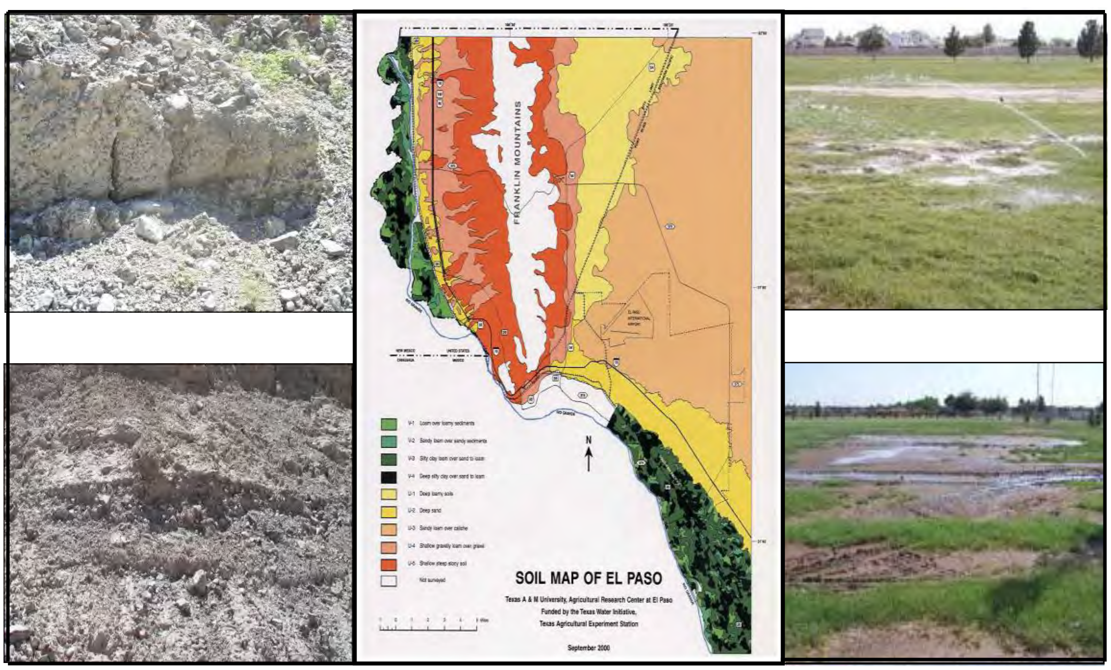
Urban turf areas, such as golf courses, sports fields, and urban recreational turf are an integral part of urban landscapes. In arid regions, maintenance requires large quantities of water. One approach to deal with this issue is to utilize wastewater or reclaimed water for irrigation. This approach has been successful, except in the situations where the soils (top as well as subgrade) do not have sufficient permeability. The purpose of this project is to develop ways to predict the potential for soil salinization of urban turf areas.

APPROACH

The conventional method of testing soil suitability for irrigated turf is based mainly on soil fertility testing which has little to do with soil permeability, especially that of subgrade. Our approach consists of two phases; the first phase is to determine the cases of soil salinization, and their relationship to soil type, series, and petrogenetic history. The second phase is to make measurements of soil properties which may have a high correlation with salt leaching potential. At this point, several soil series which are often associated with salinization were identified, and their petrogenetic background is being researched.

BENEFITS EXPECTED

Identification of soil types, series and their petrogenetic background may provide a method to judge soil suitability for irrigated turf areas. Soil test based approach, which is yet to be studied, may provide a way to predict soil salinization potential when the soil information is limited.



Soil suitability is important for establishing good turf - Entisols (left) and clayey (right) soils are susceptible to salinization and compaction.

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TEXAS A&M AGRILIFE RESEARCH

RECLAMATION Managing Water in the West

USDA United States Department of Agriculture National Institute of Food and Agriculture

United States-Mexico Transboundary Aquifer Assesssment

Dr. Ari Michelsen, Dr. Bill Harris, Dr. Zhuping Sheng, Danielle Supercinski, Dr. Yi Liu and Dr. Jesus Gastelum
Texas Water Resources Institute, Texas A&M AgriLife Research, Texas A&M University System in collaboration with
U.S. Geological Survey New Mexico Water Resources Research Institute, New Mexico State University, Arizona Water Institute, University of Arizona, International Boundary and Water Commission, Mexico Geological Survey (SGM), CONAGUA

Support Provided by: U.S. Department of Interior, USGS, The National Water Commission of Mexico (CONAGUA), USDA-NIFA and Texas A&M AgriLife Research

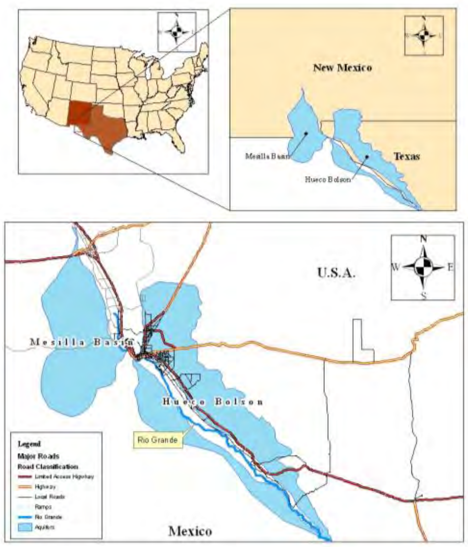

Illustration of Mesilla Basin and Hueco Bolson Aquifers in United States-Mexico boundary

BACKGROUND

The desert region of the United States–Mexico border is experiencing rapid economic and population growth where surface water is scarce and unreliable, making groundwater the primary—and in some areas the only—water source. Declining water tables and increasing use of border groundwater resources by municipal and other water users have raised serious concerns about the long-term quality and availability of this supply. Water quantity and quality are limiting factors that control future economic development, population growth and human health along the border. Knowledge of the extent, quality and movement of water in transboundary aquifers is currently inadequate, and managing shared groundwater resources requires cooperation in assessing and understanding these resources.

Through the ***United States–Mexico Transboundary Aquifer Assessment*** program, scientists from the U.S. Geological Survey, Texas A&M AgriLife Research, Texas Water Resources Institute, New Mexico State University's Water Resources Research Institute, and state agencies and their Mexican counterparts are working together to assess these shared aquifers. The Texas and New Mexico research groups, teaming with Mexican partners, are studying the Mesilla Basin Aquifer, which underlies portions of New Mexico and Texas (near El Paso) in the United States and Chihuahua in Mexico. In unique collaboration they are working together to collect and evaluate new and existing data to develop high quality, comprehensive groundwater quantity and quality databases and groundwater flow models for binational aquifers. ***This information is needed to understand availability and use of groundwater in these aquifers, and evaluate strategies to protect water quality and enhance water supplies for sustainable economic development on the United States–Mexico border***.

OBJECTIVES AND BENEFITS

Scientific information exchange and binational meetings

- Develop comprehensive, binational groundwater quantity and water quality databases
- Develop and improve groundwater flow models for binational aquifers to facilitate water resource assessment and planning
- Assess movement and interaction of water resources
- Analyze trends in groundwater quality, including salinity, nutrients, toxins, and pathogens
- Apply the new data and models to evaluate strategies to protect water quality and enhance supplies
- Compile and develop landuse and landcover characterization mapping information
- Develop hydrogeologic maps of surficial and bedrock deposits.
- Shared binational aquifer data and studies.
- An interim report has been published to summarize research findings and perspective for future work plan. http://pubs.usgs.gov/of/2013/1059/pdf/ofr2013-1059.pdf

USDA United States Department of Agriculture National Institute of Food and Agriculture

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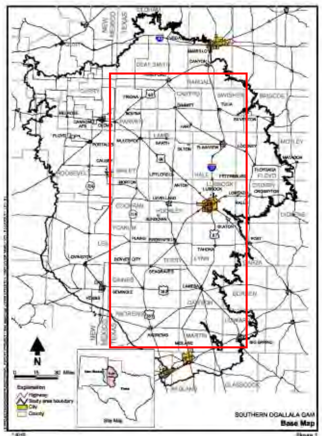
A Hydro-Econometric Analysis of Producer Water Use and Aquifer Hydrology in the Texas High Plains

Dr. C. Wang, Dr. J. Johnson, Dr. E. Segarra, and S. Zhao, Texas Tech University
Dr. Z. Sheng, Dr. J. Bordovsky. Dr. J. Gastelum, and Dr. Y. Liu, Texas A&M AgriLife Research

Support Provided by: USDA NIFA (2009-65102-05841), Texas Tech University and Texas A&M AgriLife Research



Southern Ogallala aquifer (TWDB 2003)

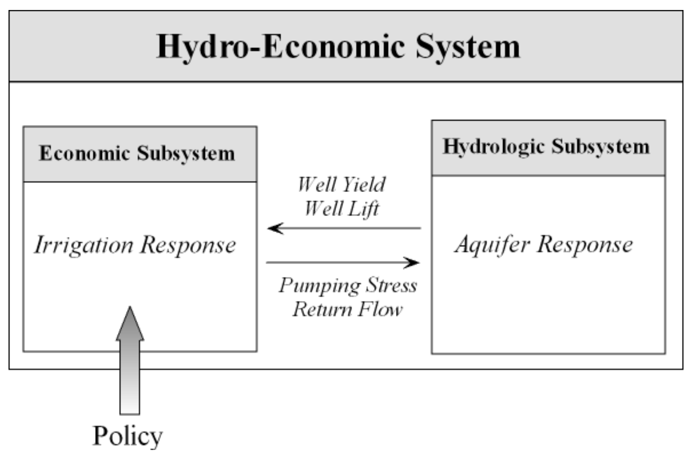
BACKGROUND

Conservation of ground water resources is vital to the agricultural economy of the Texas High Plains. The Ogallala aquifer provides 6.9 million acres of irrigated cropland in Texas, which accounts for almost 15 percent of the total irrigated acreage in the United States. The southernmost portion of the Ogallala Aquifer underlies this region and constitutes the only reliable water source for irrigated agriculture in the Texas High Plains. The critical importance of conserving ground water has been well recognized by local water authorities. Irrigation efficiency improvements are generally considered to be promising groundwater conservation measures. However, they may or may not slow down aquifer depletion, depending on a variety of economic and hydrologic factors such as irrigated acreage, irrigation technology, crop choice, and return flow. Further, producer's water use decisions and the underlying aquifer's movement are interlinked and therefore must be examined in a unified framework in order to anticipate policy impacts on aquifer depletion.

OBJECTIVES

The primary objective of the project is to develop a policy assessment tool for the Texas High Plains, to enable the impacts of water conservation policies to be soundly evaluated and better strategies developed to manage the ground water resources. The specific objectives in this project are to:

- Develop and estimate a hydro-econometric model, taking full account of producers' economic behavior and the underlying aquifer's hydrologic behavior.
- Test the hypothesis that improved irrigation efficiency slows down aquifer depletion.
- Simulate the short- and long-term impacts on the aquifer of a set of policy measures identified by stakeholders.
- Disseminate findings through targeted presentations and publications and
- Make publicly accessible the dataset and information in the hydro-econometric analysis.



Representation of hydro-econometric modeling system

ANTICIPATED RESULTS AND BENEFITS

- The hydro-econometric analysis eliminates arbitrary behavioral assumptions in mathematical programming-based policy evaluation models and enhances the Groundwater Availability Model with better estimates of pumping stress and return flow.
- The outcomes of this project include: (1) a dataset, available for public use, integrating county acreage data with hydrologic, economic, institutional, technology, and policy information; (2) a hydro-econometric model by which researchers can simulate policy impacts on the aquifer system; (3) evaluation of a set of water-conserving policy measures, including incentive-based programs for improving irrigation efficiency; and (4) dissemination of research results through targeted publications and presentations.
- Potential application for assessment of desired future conditions of the aquifer.
- Two dissertations and one book chapter published.

Texas A&M AgriLife Research Center at El Paso

Evaluation of Salt and Water Stress Tolerance of Oil Seed Crops

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Dr. M. Foster, Texas A&M AgriLife Research & Extension Center at Pecos
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Support provided by: Texas A&M AgriLife Research, Texas State Bioenergy Research Initiative Fund and USDA-NIFA

BACKGROUND

There is an increasing need to produce renewable energy throughout the world. Some oilseed crops, such as Safflower, Canola, Camelina, Salicornia, Jatropha and Lesquerella hold potential to provide bioenergy and/or lubricants to improve fuel efficiency. Previous studies have shown that the majority of these crops, except for lesquerella, are highly salt tolerant once established. This trait provides an opportunity to grow these crops in saline areas without competing with food production. However, exploratory trials conducted in the Southwest U.S. indicate that there are some difficulties with crop establishment.

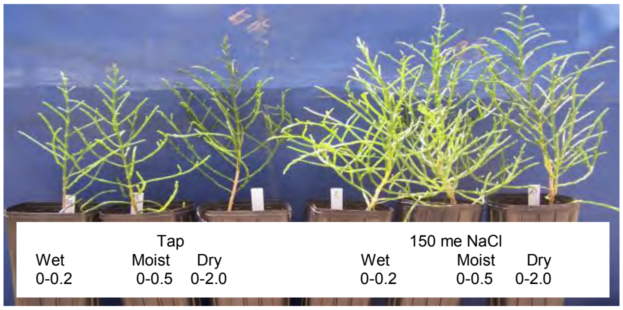
APPROACH

The first phase of this research program is to evaluate salt and water stress effects on seed germination in the laboratory. Seed germination experiments using petri-dishes (photo 1) are in progress. The second phase is to evaluate salt and water stress effects on seedling establishment. This activity is being initiated in AgriLife Research Center greenhouse at El Paso using several different soils from Far West Texas. We are also evaluating water stress effects on growth of salicornia (photo 2) using two types of water; nonsaline (Tap water - 700 ppm dissolved salts) and saline (150 me NaCl - 8700 ppm). The project is assisted by students from the University of Texas at El Paso.

Oil seed germination under tap (left) and 150 me NaCl saline water (right)

BENEFITS EXPECTED

The primary benefit of the current research is to help identify oilseed crops suitable for cultivation in saline areas. An additional benefit of the ongoing research is to determine if seed germination is limiting crop establishment or hypocotyl mortality (death of seedling stem found below the seed leaves) is the cause. This question needs to be answered for developing procedures for salt tolerance evaluation and improved salinity management for oilseed crop establishment.



Moisture stress effects on Salicornia growth under tap (left) and 150 me NaCl saline water (right)

This research on water stress tolerance of salicornia is especially significant. This plant species is native to estuaries and for this reason, it can tolerate salinity up to sea water. However, it is generally considered that it requires a lot of water and wet soils. Knowledge of plant physiology points to the possibility that this plant species can actually be drought-tolerant as the plant takes in salts, more water is taken up to dilute salt concentration inside root tissue. Particular significance is that if this hypothesis is true, this estuary plant can be grown in upland or coastal desert regions using conventional farming systems.

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Treated Wastewater Irrigation for Sustainable Bioenergy Crops Production

Dr. Girisha Ganjegunte and Dr. Genhua Niu, Texas A&M AgriLife Research
Dr. April Ulery, New Mexico State University, Las Cruces, NM
Dr. Yanqi Wu, Oklahoma State University, Stillwater, OK
Dr. Chenggang Wang, Texas Tech University, Lubbock, TX

Support provided by: Sun Grant Initiative, USDOT, El Paso Water Utilities, USDA-NIFA Rio Grande Basin Initiatives through Texas Water Resources Institute, and Texas A&M Agrilife Research. In collaboration with BGNDRF (Brackish Groundwater National Desalination Research Facility).

BACKGROUND

Switchgrass being grown in greenhouse soil columns

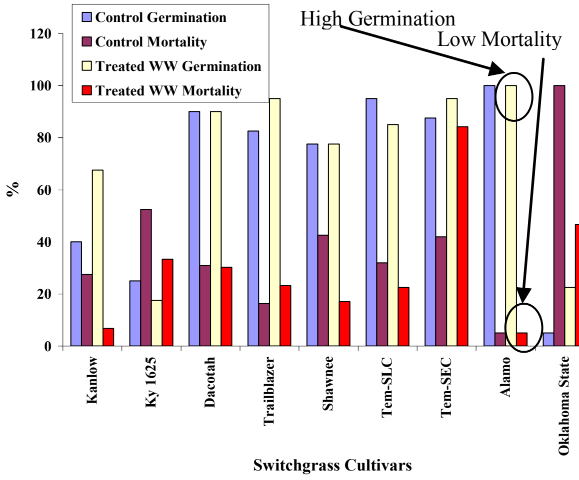
Meeting congressionally mandated Renewable Fuels Standards (RFS2) goal of using 36 billion gallons of bioenergy by 2022 requires a comprehensive regional strategy such as bringing addition area from different regions within the country under bioenergy crops. In the southwest U.S. region such as west Texas and southeast NM, bringing vast abandoned crop lands and areas having permeable soils under bioenergy crops can be a part of such a regional strategy. While the region has adequate supply of land, finding reliable source of water to produce bioenergy crops is the main challenge. This challenge can be met by developing marginal quality water sources such as municipal and industrial wastewater, graywater, and saline groundwater for bioenergy crops production. Use of marginal quality waters to irrigate bioenergy crops may prove beneficial, if the bioenergy crops can grow under elevated salinity and the effects on soil and shallow groundwater can be minimized by appropriate management.This project evaluates the feasibility of using treated urban wastewater for producing select bioenergy crops (e.g., switchgrass, sorghum, castor, and jatropha) and its effects on saline soils representing El Paso, TX and Almogordo NM (collected from BGNDRF- Brackish Groundwater National Desalination Research Facility) using greenhouse column study approach.

OBJECTIVES

- Determine germination and seedling mortality of select bioenergy cultivars
- Evaluate bioenergy crop performance under marginal quality water.
- Determine changes in soil salinity and potential for groundwater contamination.

BENEFITS

Salinity tolerance study results indicated that select cultivars of different bioenergy crops had tolerance to salinity of treated urban wastewater. Tolerant cultivars are now being grown in soil columns to evaluate plant performance and soil salinity changes under wastewater irrigation. Results of this research may help to utilize potentially large amounts of marginal quality waters for irrigating bioenergy crops. Use of marginal quality water to irrigate bioenergy crops in the arid southwest has several potential benefits such as extending the existing freshwater supplies, increased bioenergy feedstock production and improved farm income.



Salinity tolerance of different switchgrass cultivars

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Beneficial Effects of Cellulosic Bioenergy Crops on Soil Salinity

Dr. Girisha Ganjegunte, Dr. Genhua Niu, and Dr. Seiichi Miyamoto, Texas A&M AgriLife Research
Dr. Gary Peterson, Texas A&M AgriLife Research & Extension Center at Lubbock
Dr. Jorge Da Silva, Texas A&M AgriLife Research & Extension Center at Weslaco

Support provided by: Texas A&M AgriLife Research, Texas State Bioenergy Initiative and USDA-NIFA

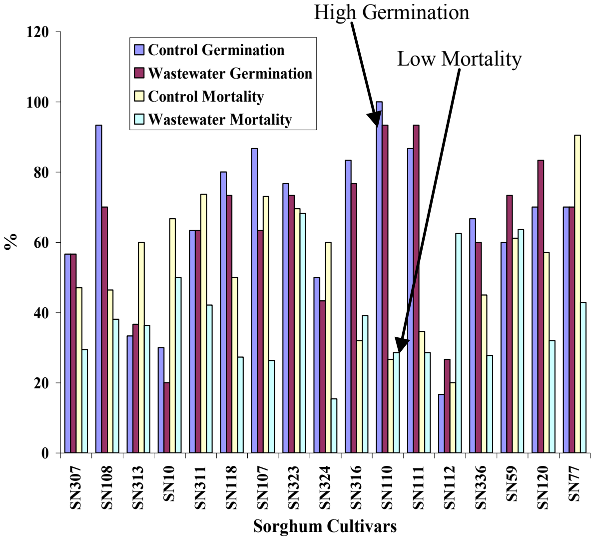
BACKGROUND

In the Far West Texas region, long-term irrigation with water having elevated salt concentrations has lead to serious salinity and sodicity problems. Elevated salinity and sodicity have resulted in poor soil conditions, reduced crop yields, and declining farm profitability. In the recent years, bioenergy is gaining popularity and demand for bioenergy is increasing. Far West Texas region has enormous potential for bioenergy crop production on marginal (salt affected/abandoned farm) lands using marginal quality water (treated urban wastewater/brackish groundwater) for a greater farm return. Bioenergy crops such as sorghum (*Sorghum bicolor*), miscanthus (*Miscanthus* spp.) and switchgrass (*Panicum virgatum*) may have beneficial effects on salt affected soils because of acidification of rhizosphere due to greater respiration (CO_2 production) of fibrous roots, which may ensure long-term sustainability. This greenhouse study evaluates effects of marginal quality water irrigation on ii) salt tolerance and performance of sorghum, switchgrass and miscanthus cultivars, ii) selected soil properties and iii) beneficial effects of fibrous roots on representative salt affected soil of the Far West Texas.

OBJECTIVES

- Evaluate salinity tolerance of sorghum, switchgrass and miscanthus cultivars for production under marginal water quality irrigation on salt affected soil.
- Evaluate performance of tolerant cultivar (s) sorghum, switchgrass and miscanthus bioenergy crops on salt affected soil under marginal quality water irrigation.
- Evaluate sustainability of marginal quality water irrigation by understanding the beneficial effects of sorghum, switchgrass and miscanthus roots on soil salinity.

Sorghum (SN 110) grown on salt affected soil using marginal quality water.



Salinity tolerance of different sorghum cultivars

BENEFITS

Results of salinity tolerance showed that sorghum cultivars “SN110” and switchgrass cultivar “Alamo” were most salt tolerant among cultivars tested. Results of this project may help to utilize potentially large amounts of marginal quality water for irrigating bioenergy crops while having beneficial effects on soil salinity. Outcomes of this project can help to understand sustainability issues associated with production of bioenergy crops on marginal lands irrigated with marginal quality waters. Use of marginal water to irrigate bioenergy crops in the far west Texas has several potential benefits such as extending the existing freshwater supplies, increased bioenergy feedstock production and improved farm income.

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USDA United States Department of Agriculture
National Institute of Food and Agriculture

Field Evaluation of Bioenergy Crops Performance on Saline Soils under Arid Conditions

Girisha Ganjegunte, Texas A&M AgriLife Research
Norman Meki and James Kiniry, USDA-ARS Southern Plains Area, Temple, TX

Support provided by: USDA-ARS Southern Plains Area, USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

Growth of switchgrass (Alamo) on saline soil

Energy sorghum (Blade) can be a potential bioenergy crop for saline soil

USDA estimates that about 27 million acres are required for producing 36 billion gallons of bioenergy by 2022 to meet congressionally mandated Renewable Fuels Standards (RFS2) goal.This can put immense pressure on agricultural systems. Corn (*Zea mays*) is the current biofuel crop of choice but it is a resource (fertilizers, insecticide, herbicide and water) intensive crop. Meeting RFS2 goal by corn alone can impair soil and water qualities. Second generation bioenergy crops such as switchgrass (*Panicum virgatum*), energy sorghum (*Sorghum bicolor*) and canola (*Brassica napus*) require less intensive practices. Finding additional land to produce bioenergy is a huge challenge. Producing second generation bioenergy crops on vast abandoned saline lands in the southwest U.S. with marginal quality waters (saline groundwater/recycling urban wastewater) can be an attractive strategy. This might help obtaining dependable feedstock supplies and reduce investment risk in the bioenergy industry. Before large investments are made in these potential bioenergy crops, it is critical to examine productivity of bioenergy crops under elevated salinity and their impacts on soil, water quality and other associated ecosystem. This study will evaluate second generation bioenergy crops performance under arid saline field conditions and apply the Agricultural Land Management and Numerical Assessment Criteria (ALMANAC) biophysical model to assess productivity of the proposed candidate bioenergy crops, impacts on soil salinity, and water quality.

Biodiesel canola (DKL-30-42) also performed well under elevated salinity

OBJECTIVES

- Evaluate performance of salt tolerant cultivars of bioenergy crop performance on saline soils under extremely arid conditions.
- Determine the effects of bioenergy crops on soil salinity and sodicity.
- Develop realistic estimates of bioenergy productivity under elevated salinity conditions, reduced water availability and water quality constraints using ALMANAC.

BENEFITS

Results of this research will identify salt tolerant cultivars of second generation bioenergy crops, provide realistic estimates of productivity under soil salinity and water quality constraints. Study outcomes will help in designing sustainable bioenergy production systems under elevated salinity conditions. Potential benefits of this research project include brining additional land under bioenergy crops, greater biofuel production and improved farm income.

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The in-house research arm of the U.S. Department of Agriculture

Texas A&M AgriLife Research Center at El Paso

Impacts of Creosotebush Control on Rainfall Infiltration and Forage Production in the Rio Grande Basin

Dr. Alyson McDonald, Texas A&M AgriLife Extension, Fort Stockton, TX
Dr. Girisha Ganjegunte, Texas A&M AgriLife Research at El Paso

Support provided by: USDA-NIFA Rio Grande Basin Initiative through Texas Water Resources Institute, Texas A&M AgriLife Research and Texas A&M AgriLife Extension Service

RATIONALE

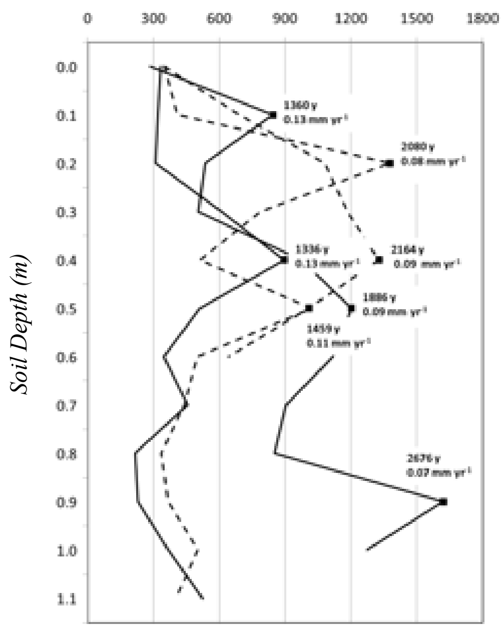
Larrea tridentata (creosotebush) dominates rangelands in the southwest U.S. Other studies have indicated that this plant may have a profound effect on rainfall interception and runoff. Control of creosotebush and conversion from shrub-land to grassland may significantly increase herbaceous plant productivity and rainfall infiltration. This hypothesis was tested at three study sites located in Pecos, Brewster, and Culberson counties in Texas. In 1982, herbicide was aerially applied to control creosotebush at the above locations. Woody plant cover, density, herbaceous cover and productivity along 100 m (328 feet) transects in treated and untreated areas at each location were determined.

Larrea tridentata (creosotebush)

OBJECTIVES AND RESEARCH METHODS

- Determine the effects of Creosotebush control on herbaceous plant productivity and rainfall infiltration (recharge).
- Use a chloride mass balance approach to assess rainfall infiltration and deep percolation in shrub-land and grass-land areas.

Atmospheric chloride is a stable isotope that enters the soil with rainfall. Thus, soil chloride content is a proxy for wetting front penetration and is an historic record of rainfall infiltration. The chloride mass balance approach has been used to assess rainfall infiltration and deep percolation in desert shrub communities, on fallow croplands and in pastures cleared of mesquite in South Texas. In this study we evaluated if the same approach can be used to estimate drainage in the above mentioned study sites. Soil samples were collected in 10 cm (4 inch) increments along transects to assess particle size distribution, root density, and chloride concentration and compared to estimates of computed recharge for depths of peak chloride concentration.

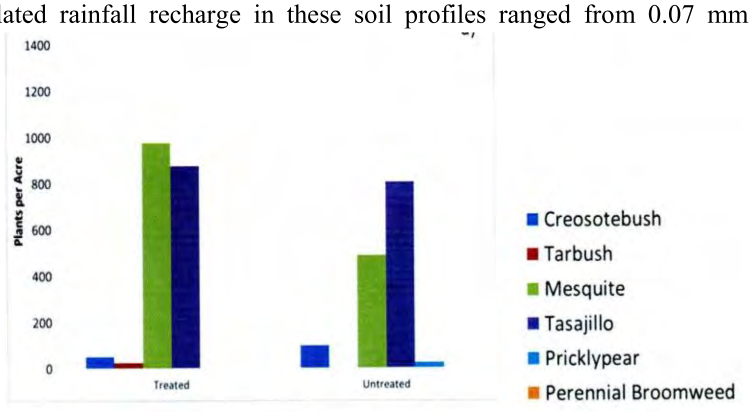


Chloride (mg L^{-1}) soil pore water

Soil chloride profiles, and accumulation times (y) And deep drainage (mm yr^{-1}) at depths of peak concentrations, in treated and untreated boreholes at County study site

FINDINGS AND BENEFITS

Depth and variability of chloride concentration varied among the sites, but appeared to be influenced more by soil texture and total annual rainfall than by brush control. Additionally, calculated rainfall recharge in these soil profiles ranged from 0.07 mm (0.003 inches) per year at Culberson site to 0.22 mm (0.009 inches) per year at the Pecos site; these values are substantially, as much as 2 orders of magnitude less than the widely used estimate of 2% recharge of annual rainfall. The results have been presented at Texas A&M AgriLife Extension meetings in Alpine, Rankin, and Van Horn. A Research and Extension publication entitled “Ecology and Management of Creosotebush” is being developed.



Density of brush species along belt transects in treated and untreated plots at Pecos County study site

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Hydrogeological Assessment of Salinity in the Pecos River

Dr. Zhuping Sheng and Dr. Seiichi Miyamoto, Texas A&M AgriLife Research
Dr. Alyson McDonald, Texas A&M AgriLife Extension Service
In collaboration with Dr. Kevin Wagner and Lucas Gregory, Texas Water Resources Institute

Support Provided by: Clean Water Act, Section 319 Program funding from the Texas State Soil and Water Conservation Board and the U.S. Environmental Protection Agency,USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

Gage Station of the Pecos River at Coyanosa

The Pecos River is the largest river sub-basin flowing into the Rio Grande from the United States. The Pecos River is the lifeblood of many communities within its reaches, serving mainly as an irrigation source, while also providing recreational uses, supplying recharge to underlying aquifers, and as a public drinking water supply for users in the downstream reaches. Elevated salinity levels in the river are threatening to prevent some of these uses, especially drinking water and irrigation. Coarse-scale evaluations of specific sources of salt loading to the river have been conducted and the general consensus is that there are four reaches where much of the salt loading occurs. One of them is in Texas between Coyanosa and Girvin and the others are upstream in New Mexico. In all cases, groundwater discharge to the river is seen as a primary delivery mechanism. The Coyanosa to Girvin reach of the river was also identified in the Pecos River Watershed Protection Plan (WPP) as the most critical area of the river needing to be addressed. The WPP further acknowledges the relative lack of data to support implementation of management measures aimed at reducing salinity impacts. This project will address the problems/needs described above by employing a data collection and assessment approach that combines ground-based hydrogeological data and heliborne Electromagnetic (EM) geophysical survey data.

OBJECTIVES

The primary goal of this project is to gain a better understanding of hydrological connection between surface water and groundwater along this reach as well as regional water resources. The specific objectives in this project are to:

- conduct appropriate historical data review and assessment to develop an understanding of hydrological connections between surface water and groundwater as well as inter-aquifer exchanges in the selected reach;
- work with a contractor to conduct an heliborne EM survey along the Coyanosa to Girvin reach of the Pecos River in Texas to rapidly collect high resolution surface, near surface and deep subsurface data on electrical resistivity; and
- derive information on geologic salt content over a large geographical area using integrated heliborne EM data and hydrogeological data.

ANTICIPATED RESULTS AND BENEFITS

The results from the project will be utilized to produce an accurate assessment of the water resources in the area and recommendations for remediation, which could result in great economic impacts by assuring reliable water supplies with improved water quality for both agriculture and urban users. The following results are anticipated at completion of the project:

- Integrated database and GIS coverage of assessed areas of the watershed, which includes data and information as well as analysis results from the desktop hydrogeological assessment and heliborne EM survey data.
- Technical report on preliminary hydrogeological assessment and heliborne EM survey and its data analysis.
- Delineation and mapping of potential saline intrusion areas as illustrated in EM results and
- Identification of saline intrusion hotspots and areas where ground truthing is needed as well as work plan for next phase.

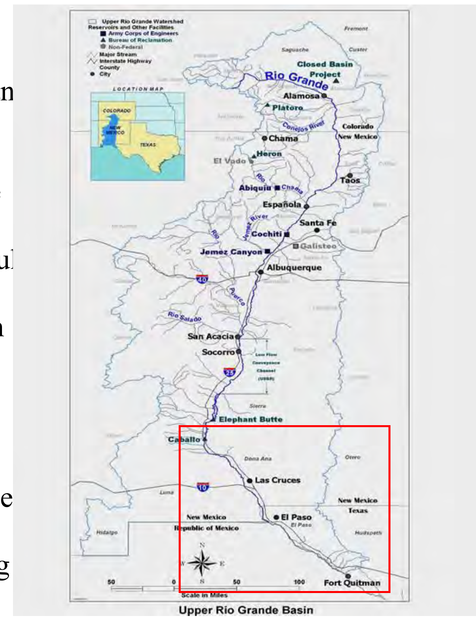
Development of RiverWare Model of the Rio Grande Flow for Flood Control and Water Operations Planning

Dr. Z. Sheng, Dr. A. Michelsen and Dr. B. Mohanty, Texas A&M AgriLife Research
Dr. P. J. King, Dr. C. Brown, Dr. B. Creel and Dr. K. Wood, New Mexico WRRI, NMSU
Dr. A. Granados, Universidad Autonmas Ciudad Juarez
A. Louise, M. Sidlow and A. Fitzner, U.S. Army Corps of Engineers

Support Provided by: U.S. Army Corps of Engineers, USDA NIFA, Texas A&M AgriLife Research, Texas Water Resources Institute, New Mexico State University and New Mexico Water Resources Research Institute, Paso del Norte Watershed Council

BACKGROUND

The U.S. Army Corps of Engineers in collaboration with the New Mexico Interstate Stream Commission, U.S. Bureau of Reclamation, U. S. Geological Survey, and U.S. Bureau of Indian Affairs, with cooperation from numerous other Federal, states, local an other agencies, have collaborated to develop the Upper Rio Grande Water Operations Model (URGWOM), using RiverWare® software. The model simulates the river flow and water operation in the Rio Grande basin from the Colorado–New Mexico state-line to just above Fort Quitman, Texas, 120 miles southeast of El Paso. A water quality component will also be included in future development of URGWOM that will be usefu for making management decisions to maintain optimal river ecosystem health while meeting downstream water delivery requirements. TAMU, NMSU and the UACJ team are developing the RiverWare model to simulate the river flow for the reaches between the Elephant Butte reservoir and Fort Quitman.



Upper Rio Grande Basin and Study Area

METHODS

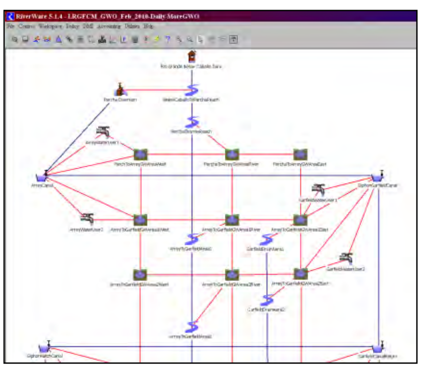


Illustration of RiverWare model node and flow configuration

- Collect and compile necessary data and analyse to expand the URGWOM RiverWare® model for water operations and flood control planning in the Rincon Valley and Mesilla Basin
- Collect and compile necessary data and analyses to expand the URGWOM RiverWare® model to simulate flows and water operations planning for the El Paso lower valley and District 009 in Mexico.
- Integrate the RiverWare model to simulate river flow and water operations scenarios for the entire study area (from Caballo Dam in New Mexico to Fort Quitman in TX) with enhancement in crop water consumption.
- Enhance coordinated water resources database by incorporating model input data and simulation data into the PDNWC database and GIS website.

PROGRAM RESULTS AND BENEFITS

- Workshops and trainings for water resources stakeholders are being held to demonstrate RiverWare modeling and use.
- Access to surface water flow and water quality data within the Rio Grande Project Watershed, and hydrologic simulations in this project will benefit regional stakeholders in many ways: better controlling flood surges with more responsive flood and water quality management and mitigation strategies; providing Federal Emergency Management Agency (FEMA) information in its disaster response plans and helping irrigation districts, water utilities, and federal water operators to more effectively and efficiently manage water deliveries.
- Three technical reports have been published: http://www.pdnwc.org.
- RiverWare models are available for flood control and water operations planning.

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Coordinated Water Resources Database & GIS for Watershed Management

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Dr. Christopher Brown, Dr. Bobby Creel, Dr. Phillip J. King, and Dr. Sue Tillery, New Mexico State University
Dr. Alfredo Granados, Universidad Autonmas Ciudad Juarez
Michael Fahy, El Paso Water Utilities
April Sanders and Michael Fies, U.S. Army Corps of Engineers

Support Provided by: El Paso Water Utilities, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, USDA-NIFA, Texas A&M AgriLife Research, Texas Water Resources Institute and, New Mexico State University and NM Water Resources Research Institute

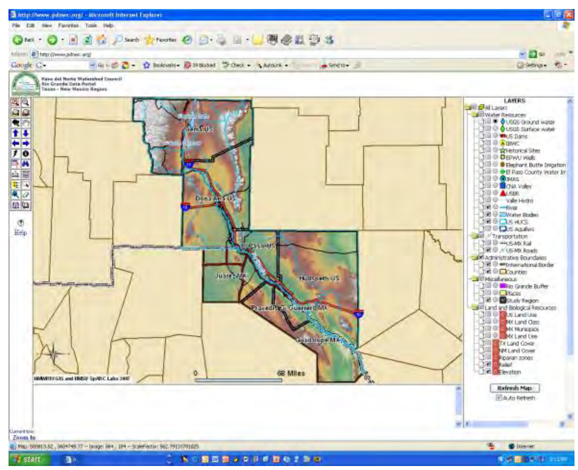
Telemetry Gage Station

BACKGROUND

The flow and water quality of the Rio Grande is measured and recorded at several points by various groups from Elephant Butte Dam, New Mexico down to Fort Quitman, Texas. Separate measurements are collected by federal agencies (USBR, USGS, IBWC), irrigation districts (EBID & EPCWID#1), El Paso Water Utilities, City of Las Cruces, and others. Prior to this collaborative program there has been little or no compilation, coordination or convenient method to access data from these numerous sources. In some cases information is collected using real-time technology, with each organization collecting and using information solely for achieving their individual mission. Even when information is shared, it may not be done in a timely manner. This absence of coordinated access and sharing of real-time and historical data may lead to unnecessary duplication of effort and wasted resources.

OBJECTIVES

- This Coordinated Water Resources Database & GIS is designed to coordinate, compile and provide timely Internet access to information for use by water management organizations, stakeholders and scientists.
- The Coordinated Water Resources Database & GIS is being developed by the **Paso del Norte Watershed Council** through collaboration of university scientists, and cooperation of Federal and State agencies, irrigation districts and water management and user organizations.
- Phase I identified sources, locations and parameters of water flow and quality measurement stations. Concurrently, a website is housed at NMSU-WRRI with a GIS interface with the Rio Grande irrigation network, measurement stations and information on archival water resources related data in the Paso Del Norte Region.
- Phase II created historical data digital records, facilitated sharing of real-time data, upgraded links to sources and access to information through the Coordinated Database website, assisted in coordination of water resources measurements and reporting (QA/QC) and provided data needed for development of conceptual model design and configuration of Riverware for the PdN Watershed.



Rio Grande Paso del Note Watershed ArcIMS website

PROGRAM RESULTS AND BENEFITS

- A web site with GIS interface for the Paso del Norte Watershed Coordinated Water Resources Database has been created, tested and refined and can be accessed at http://www.pdnwc.org/. It has been updated continuously.
- Two Technical Reports published by New Mexico Water Resources Research Institute and Texas Water Resources Institute: http://wrri.nmsu.edu/publish/techrpt/abstracts/abs327.html and http://wrri.nmsu.edu/publish/techrpt/abstracts/abs341.html
- Workshops for water resources stakeholders were held demonstrating use of database website with GIS interfaces, data availability, breadth of water resources information and applications in water resources management.

Installation of Rio Grande Project Area Monitoring Network

Dr. Zhuping Sheng, Dr. Ari Michelsen, and Dr. R. Srinivasan, Texas A&M AgriLife Research
Dr. Christopher Brown and Dr. Bobby Creel New Mexico State University
Michael Fahy, El Paso Water Utilities
Woody Irving, U. S. Bureau of Reclamation

Support Provided by: El Paso Water Utilities, U.S. Bureau of Reclamation, USDA NIFA, Texas A&M AgriLife Research, Texas Water Resources Institute, New Mexico State University, and NM Water Resources Research Institute

BACKGROUND

Over the last several years, the Paso del Norte Watershed Council's Coordinated Water Resources Database and GIS Program (Program) was developed to provide improved and integrated access to regional water resources data for regional water stakeholders to make timely decision in water operations and flood control. (Program available at http://www.pdnwc.org)

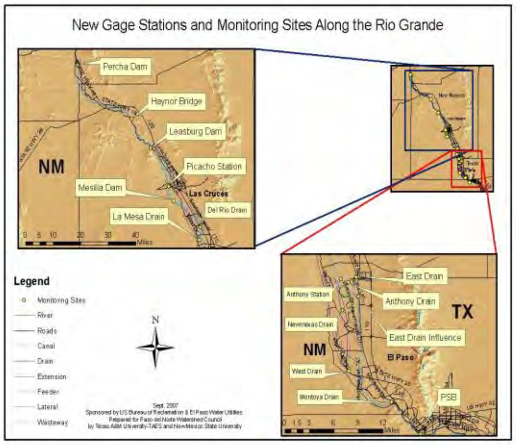
The flow and water quality monitoring of the Rio Grande were enhanced as the major components of the Coordinated Database and GIS Project further developed from August of 2005 through July of 2007 through funding provided by the United States Bureau of Reclamation through the Water 2025 Challenge Grant Program to the El Paso Water Utilities, TAMU, and NMSU.

Gage Station below Elephant Butte Dam

OUTCOMES

Tasks accomplished in the phase of work funded by the USBR include the following specific outcomes:

- Installation and calibration of additional 15 new monitoring stations and equipment, and inclusion of these monitoring sites in publically Web-based GIS map products to fill data gaps and provide additional real-time data.
- Linking to additional monitoring sites installed by EBID through their Project work and inclusion of these sites and data in several Web-based GIS map products.
- Development and implementation of a user needs survey focusing on new data sets of interest, enhanced access mechanisms, and other suggestions to improve the Program website.
- Development and deployment of an on-line downloadable Microsoft Access database of Rio Grande Project water resource data to provide search and query functions.
- Implementation of suggestions from a User Needs Assessment, including increased access to the database and website using Firefox and Mozilla Web browsers.



PROGRAM RESULTS AND BENEFITS

- A technical report provides a summary of database and GIS coverage for new monitoring stations (http://twri.tamu.edu/reports/2008/tr320.pdf). Additional documentation of related Project activities is provided through Final Project Reports being submitted by the City of Las Cruces (CLC) and Elephant Butte Irrigation District (EBID) for the work conducted through linked USBR-funded Projects.
- The installation and public and stakeholder access to these new monitoring stations provides critical water flow and quality information enabling improved management and use of the region's scarce water resources.
- Workshops for water resources stakeholders are being held demonstrating use of database website with GIS interfaces, data availability, breadth of water resources information, user needs and RiverWare modeling.

Fate of Salvaging Water with Saltcedar Control on the Pecos River

Dr. Zhuping Sheng, Texas A&M AgriLife Research
Dr. Charles Hart and Alyson McDonald, Texas A&M AgriLife Extension

Support provided by: U.S. Environmental Protection Agency, U.S. Department of Agriculture, NIFA
Rio Grande Irrigation Efficiency Initiative, Texas Water and Soil Conservation Board, International Boundary and Water Commission,
Texas A&M AgriLife Research, Texas A&M AgriLife Extension and Texas Water Resources Institute

BACKGROUND

The Pecos River in West Texas is a major tributary to the Rio Grande. The flows of the Pecos River have declined due to many causes – some natural and some man-induced. For example, invasive saltcedar along the river banks now consumes large quantities of water depleting river flows.

In 1999 a saltcedar control program was initiated along the Pecos River in Texas below the New Mexico State line with the expectation that water would be salvaged for other uses. It was also anticipated that water quality could be improved, in particular a reduction in salinity. Preliminary analysis indicates saltcedar control may yield as much as a 60% to70% reduction in water loss at the study site below the Red Bluff reservoir. However, the information used to develop this estimate did not account for the close interconnection between ground and surface water in the area. Accurate knowledge of the potential water savings from saltcedar control is crucial for determining the benefits and cost effectiveness of this program. This project is part of the Pecos River Watershed Protection Plan led by Dr. Charles Hart, Alyson McDonald, William Thompson, Dr. Lonnie Jones, Michael Mecke, Dr. Seiichi Miyamoto and Dr. Zhuping Sheng.

Alyson McDonald checking the water level logger on an untreated Salt Cedar stand.

Salt cedar killed by Arsenal

OBJECTIVES

The primary objective of this study is to assess the water savings from saltcedar control on the Pecos River. To accomplish this, additional wells will be installed to monitor ground water levels and subsurface flow patterns and to characterize the aquifer beneath treated and untreated sites with borehole exploration. Corresponding measurements of river level and flow will be collected including releases from Red Bluff Reservoir. The combined surface and ground water information will then be analyzed to evaluate changes in water consumption between treated and untreated areas.

OUTCOMES AND BENEFITS

- Invasive saltcedar is a problem throughout the Southwestern U.S., yet there is limited knowledge regarding water consumption and potential water savings from its eradication. This research provided important new information about water savings from saltcedar control and ground and surface water consumption of saltcedar.
- This information will also be used to evaluate cost effectiveness of saltcedar control and to evaluate methods and policies for improved watershed management and riparian restoration.

Alternate Water Source and Route Benefit Ascarate Park

Dr. Zhuping Sheng, Texas A&M AgriLife Research
Dr. Larry Brown, Consulting Service

Support provided by: El Paso County Water Improvement District No.1, U.S. Bureau of Reclamation El Paso Field Office, USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

The Franklin Canal conveys water from the Rio Grande through many of El Paso's urban neighborhoods on its way to irrigate thousands of acres in agricultural production and landscape use. Recent studies indicate a great potential for water savings by lining this canal. El Paso County and El Paso County Water Improvement District No. 1 (EPCWID No. 1 are interested in the feasibility of rerouting canal diversions and filling Ascarate Lake with salvaged water conserved by lining a portion of the Franklin Canal. Ascarate Lake is used for recreation purposes, but the lake has occasionally been closed due to contamination. Inflow from the Franklin Canal not only would provide an alternate water source, but may also improve water quality.

Unlined Franklin Canal above Ascarate Lake, El Paso, TX

OBJECTIVES

- Evaluate the feasibility of rerouting water from EPCWID No. 1's Franklin Canal to Ascarate Lake.
- Analyze potential water savings from canal lining and provide EPCWID No. 1 with sufficient information necessary to evaluate planning and management of the alternate canal route to facilitate water delivery.

GPS survey at Ascarate Lake

FINDINGS

- Canal delivery efficiency ponding tests and flow measurements were conducted and these confirmed potential water savings by lining the Franklin Canal that could provide an alternate source of water for Ascarate Lake.
- A Global Positioning System (GPS) survey showed that sufficient elevation difference exists to allow gravity feed of water by pipeline from the Franklin Canal to Ascarate Lake. However, the elevation difference between Ascarate Wasteway and Ascarate Lake is not sufficient for direct inflow without modification of the Ascarate Wasteway.
- There is also potential for this water to be utilized for additional purposes. For example, water flow into the lake could serve as an alternate source for irrigation of Ascarate Golf Course and the surrounding parks, which currently use ground water. Water rights would need to be negotiated.

BENEFITS

- The data and information developed through this study are helping El Paso County Parks and Health Departments and EPCWID No.1 evaluate a water supply and management alternative for Ascarate Lake. Results from this study indicate that lining the Franklin Canal and providing Ascarate Lake with conserved water are feasible.
- These changes have the potential to conserve water, improve lake water quality, enhance the quality of life in the neighborhoods along which the canal passes, increase recreational use opportunities, and preserve the canal's importance as a historical landmark.

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Salinity Simulation of the Rio Grande Above Amistad

Dr. S. Miyamoto, H. Manwar, Dr. F. Yung, Texas A&M AgriLife Research
Dr. R. Muttiah, Texas A&M AgriLife Research and Extension Center at Temple
Dr. K. Inosako, Department of Agricultural Engineering, Tottori University, Japan

Support provided by: Texas Higher Education Coordinating Board, USDA-NIFA and Texas AgriLife Research

BACKGROUND

Salts are the most frequent contaminant which limits full utilization of water resources in Texas. The Rio Grande is not an exception. Salinity at Amistad International Reservoir has risen close to the federal drinking water standard of 1000 ppm in 1986/87 and again in 1994. The reason for these increases is unknown. The goal of this project is to understand the cause(s), and to develop a simulation model useful for evaluating various salinity control options.

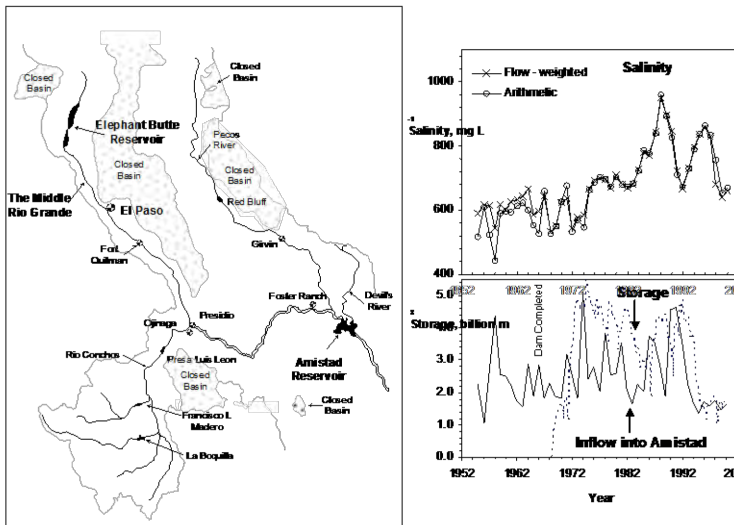
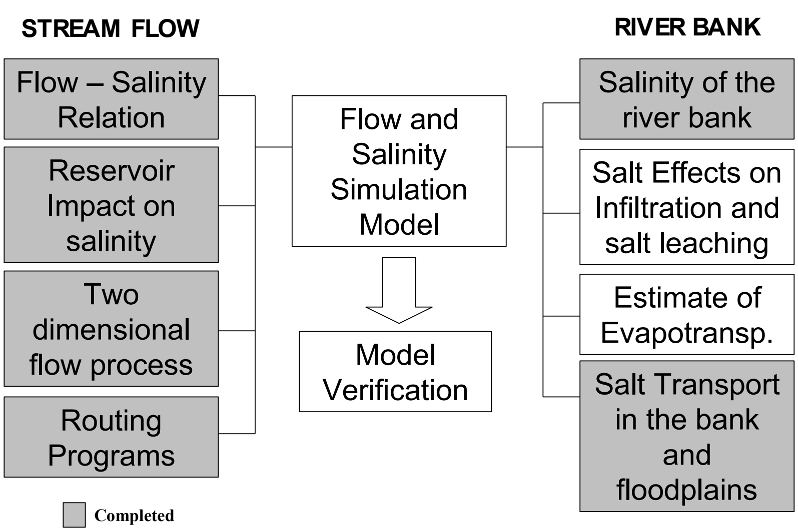


Fig. 1. The Rio Grande Basin above Amistad.

APPROACH

- Determine the extent of salt storage in river banks and floodways.
- Analyze the historical salt balance in various reaches of the Rio Grande above Amistad.
- Analyze flow and salinity relationships at major tributaries and reservoirs.
- Develop a realistic salt and water transport model considering streamflow-river bank interaction



CURRENT FINDINGS

- Salts stored in river banks and floodways vary with location, but amount to as much as 150 tons/ha in the root zone depth of 1.2 m in the reach below El Paso. For the floodway area between El Paso and Presidio, the storage is estimated at 1.2 million tons.
- The quantity of salts which were flushed during 1986 flood was estimated at 1.1 million tons based on IBWC flow and salinity data. This quantity was sufficient to raise salinity of the reservoir to 960 ppm.
- The salt and water transport model currently being developed will include both instream processes and inbank processes.

Identification of Salt Sources Entering the Pecos River

Dr. S. Miyamoto, Dr. F. Yuan, and S. Anand Texas A&M AgriLife Research
In cooperation with Will Hatler at the Texas Cooperate Extension Office at Fort Stockton
and the Staff at the Clean Rivers Program

Support provided by: U.S. Environmental Protection Agency, USDA-NIFA and Texas A&M AgriLife Research, Texas A&M AgriLife Extension

BACKGROUND

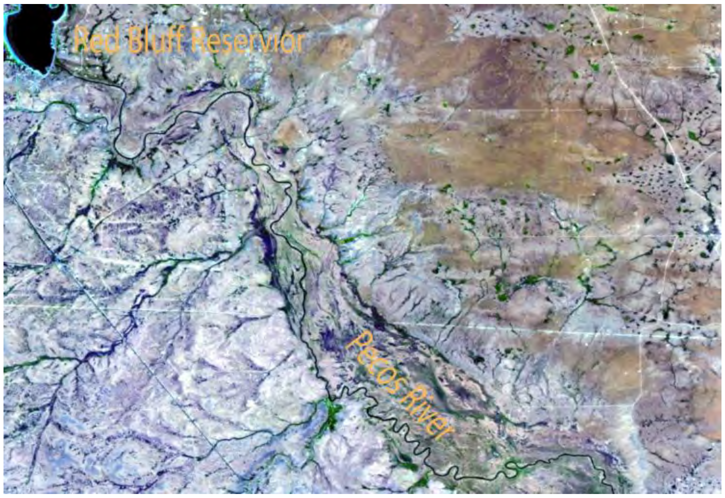
The Pecos River is known for its high salt levels, and a new project is underway to determine the sources of salts. This project is a part of a three-year study by scientists at the District Extension Office at Fort Stockton and El Paso Agriculture Research Center for identifying sources of contaminants which adversely affect water quality of the Pecos River. This research will provide information necessary for developing possible management options for reducing contaminant loading into the river.

The Pecos River Salt Cedar Control Tour

APPROACH

The first phase of research involves water sampling and analysis of the samples for the purpose of identifying locations and nature of salt sources which are entering the Pecos River below the New Mexico-Texas State Border. Water samples collected are being analyzed for cations and anions by the Clean Rivers Program, and isotopes for source identification.

The second phase involves monitoring of flow and salinity at selected locations near the potential salinity entry points or reaches. This data is needed for determining the quantity and quality of the salt sources entering the Pecos River. These activities are conducted in cooperation with the Texas Clean Rivers Program.



Satellite image of the Pecos River

BENEFITS

The research will help in understanding the quantity of and where salts are entering into the Pecos River. This type of information is necessary to develop effective salinity control strategies. Salinity control at the Pecos River would benefit ranchers and land owners, and riparian ecosystems along the River. However, the biggest benefit is likely to be helping to maintain salinity of the Amistad International Reservoir below 1,000 ppm, the upper limit of the Federal Secondary Drinking Water Standard.

USDA United States Department of Agriculture
National Institute of Food and Agriculture

TEXAS A&M AGRILIFE RESEARCH

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TEXAS A&M AGRILIFE EXTENSION

ET Tower Provides Information for Water Conservation

Dr. Zhuping Sheng, Dr. Y. Liu, Dr. AlMountaz El Hassan, Zhuming Ye, Zhiqing Chen, Jonathan Nogueira,
Texas A&M AgriLife Research
Tony Rancich, Five R Enterprises Inc.

Support Provided by: USDA NIFA, Texas A&M AgriLife Research, Texas Water Resources Institute, and 5R Enterprises, Inc.

BACKGROUND

Prolonged drought conditions in the Paso Del Norte region have increased the need to find ways to conserve limited water resources. In order to develop effective water conservation measures in agricultural irrigation, a better understanding of and accurate measurements of the field level hydrologic cycle and interaction among atmospheric water, surface water (irrigation) and groundwater is required. With USDA NIFA support from the Rio Grande Basin Irrigation Water Conservation Program and Five R Enterprises Inc., we established an Evapotranspiration (ET) Monitoring Tower and a weather station at Five R Enterprises pecan farm in El Paso County in July 2010.

Researchers are maintaining the ET tower

EQUIPMENT AND OUTCOMES

An 18-meter high ET tower with an Open Path Eddy Covariance (OPEC) system manufactured by Campbell Scientific, Inc. has been in operation in this field over thousand acres since July 2010.

This OPEC system measures carbon dioxide flux, latent heat flux, sonic sensible heat flux, momentum flux, a computed sensible heat flux, temperature, humidity, horizontal wind spend, and wind direction, net radiation, soil heat flux, soil temperature and soil water content. The data is collected at a preset time intervals for example, hourly. The data is then sent to the Research Center through radio modems and internet connection at the farm. Special software is used to communicate with and monitor dataloggers and analyze the data. In addition, a weather station collects temperature, humidity, horizontal wind speed and wind direction, net radiation, precipitation and groundwater level.

Users can view data and graphs on the internet. Specially, farmers can obtain real-time weather and hydrologic information. These accurate local measurements are providing the information needed to increase irrigation system efficiency, conserve water and improve other farm operations.

Collecting data from weather station

PROGRAM RESULTS AND BENEFITS

- The ET monitoring data enables a better understanding of water movement within the atmosphere, soil and plants as well as consumptive use of water by pecans.
- Provides the real time ET and weather data and information needed for farmers to make timely decisions in irrigation scheduling to conserve water and improve crop yield.
- These stations can be incorporated into the statewide ET network, developed by Texas AgriLife Research and Extension for the State of Texas, to fill data gap in Far West Texas.
- Through collaboration and data sharing with NMSU and USBR scientists, work is under way to develop a regional database.
- Continued data collection can help us gain a better understanding of hydrologic impacts of climate changes in arid regions.

Evaluation Of Irrigation Efficiency Strategies For Far West Texas

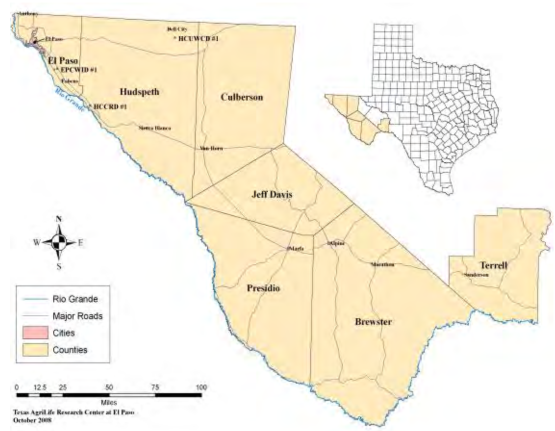
Dr. A. Michelsen, M. Chavez, Dr. R. Lacewell, Dr. J. Gilley, Dr. Z. Sheng

Texas A&M AgriLife Research

Support Provided by: Texas Water Development Board, Rio Grande Council of Governments, USDA NIFA and Texas A&M AgriLife Research

BACKGROUND

The Texas State Water Plan addresses how each of 16 regions will supply projected water demands for the next 50 years. Water availability in these plans is based on supply conditions experienced during the drought of record, that is, the severe drought conditions in the 1950's. In arid Far West Texas (Region E in the State Plan), agriculture is projected to have the largest unmet demand for water during drought. In the Far West Texas Water Plan, the primary strategy proposed to mitigate the impact of insufficient water supplies for agriculture is implementation of water conservation best management practices. However, the conservation practices identified were generic and gave a wide range of potential water savings compiled from many other sources and for other locations and conditions. The applicability to and actual water savings of the proposed practices in Far West Texas were generally unknown.



Far West Texas Water Planning Region (E)

OBJECTIVES

This research evaluated the applicability, water savings potential, implementation feasibility and cost effectiveness of seventeen irrigated agriculture water conservation practices in Far West Texas during both drought and full water supply conditions. Factors considered in evaluating conservation strategies included water sources, use, water quality, cropping patterns, current irrigation practices, delivery systems, technological alternatives, market conditions and operational constraints. The study examined potential water savings in over 90% of the irrigated agricultural acreage in Far West Texas.

Lined American Canal Extension in El Paso

PROJECT RESULTS AND BENEFITS

- This study found very limited opportunities exist for significant additional water conservation in Far West Texas irrigated agriculture due to various reasons.
- The applicability of most of the strategies is closely related to the water source (surface water or ground water), delivery system (gravity flow or pump/pressurized systems) and water quality. Elevated salinity is a factor in the ability to conserve water in all areas.
- Lining or pipelining district canals provides great potential for water conservation. However the cost for lining canals is too great for agricultural use.
- Additional irrigation scheduling and tail water recovery systems provide very small potential for economic and efficient additional water conservation.
- If all of these strategies were implemented, the total potential water savings during drought and full supply years are estimated to be 32,587 and 76,926 acre-feet, which would satisfy less than 25% of the projected unmet agricultural water demand under drought-of-record conditions.
- Overall, there are no silver bullets for agricultural water conservation in Far West Texas short of taking irrigated land out of production when water supplies are limited. Some of strategies have been incorporated in the regional water plan.

Low pressure linear sprinkler system

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TEXAS A&M AGRILIFE RESEARCH

USDA

RIO GRANDE COUNCIL OF GOVERNMENTS
Judge Jake Brisbin, Jr. Executive Director

On-Farm Irrigation Scheduling Tools to Improve Water Use Efficiency

Dr. Girisha Ganjegunte, and John Clark, Texas A&M AgriLife Research

Support provided by: US Bureau of Reclamation, USDOI; USDA-NIFA Rio Grande Basin Initiative through Texas Water Resources Institute and Texas A&M Agrilife Research in collaboration with the local growers

Flood irrigation is common in the region due to soil salinity

BACKGROUND

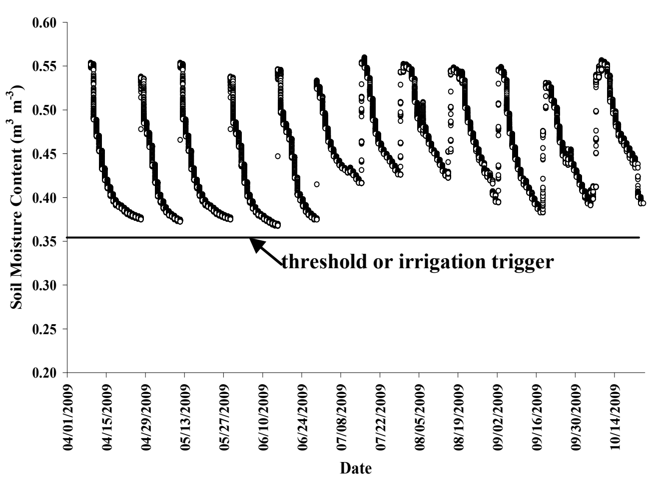
Pecan (*Carya illinoinensis*) is one of the major irrigated crops in the El Paso region and water use of pecan trees is greater than that of most row crops. Irrigation efficiency and crop water use efficiency can be improved by scheduling irrigation based on soil moisture content. In recent years, new inexpensive sensors have been developed to monitor real-time soil moisture conditions. In addition to soil moisture content, some sensors can measure soil salinity. High soil salinity has long been recognized as a major concern for irrigated agriculture in Far West Texas. Therefore, sensor needs to be able to provide accurate data on soil moisture conditions across a wide range of soil salinity. In this project, we examine the accuracy of different sensors (ECH$_2$O 5TE, Tensiometer, Water Mark) to provide real time soil moisture for the development of improved irrigation scheduling for pecan orchards in the region. The results of this research have the potential to reduce irrigation costs, conserve water and increase farm profits.

Example of a soil moisture sensor installed in the field

OBJECTIVES

- Evaluate the accuracy of three different soil moisture sensors to provide real time soil moisture measurements over a range of soil types and salinity conditions.
- Develop improved irrigation scheduling based on sensor soil moisture data to improve on-farm water use efficiency and conserve freshwater resources.
- Estimate water savings due to improved irrigation scheduling.

FINDINGS AND BENEFITS



Real time sensor data on volumetric soil moisture at each irrigation event

Results indicated that while all three sensors were successful in following the general trends of soil moisture conditions during the growing season. Accuracy of measurements by tensiometer was relatively greater than that of ECH$_2$O 5TE and Watermark. Sensors data showed that in all irrigation events the soil moisture content was well above the threshold level, indicating that excess water was applied by conventional method. Preliminary results indicate that at least one-irrigation could be saved per season by irrigating fields based on soil moisture data. With an estimated 9,000 acres under irrigated pecan production in El Paso County Water Improvement District #1, about 3,000 acre feet of freshwater can be saved. The results of this study can help in improving water use efficiency in pecan orchards, conserve precious freshwater resources and increase farm profits.

TAMU and NMSU Scientists Help Irrigation Districts in Water Conservation

Dr. Zhuping Sheng, Texas A&M AgriLife Research
Dr. Phillip J. King, Department of Civil Engineering, NMSU

Support provided by: El Paso County Water Improvement District No. 1, Elephant Butte Irrigation District, Hudspeth County Conservation and Reclamation District No. 1, U.S. Bureau of Reclamation El Paso Field Office, U.S. Department of Agriculture NIFA Rio Grande Basin Initiative, Texas AgriLife Research, New Mexico State University, and Texas Water Resources Institute

BACKGROUND

- Surface water from the Rio Grande is delivered for agricultural and urban use in our region by about 700 miles of canals and laterals maintained by two irrigation districts.
- An unknown quantity of the water delivered by these canals is lost through natural seepage and evaporation.
- Texas AgriLife Research and New Mexico State University scientists are working together to conduct studies to quantify canal seepage losses and opportunities for water conservation through lining canals in irrigation districts in Texas and New Mexico.

Canal seepage loss ponding test, Franklin Canal, El Paso, Texas

OBJECTIVES

- To determine water losses from canal seepage.
- To assess potential water savings by lining canals and delivery system improvements.
- To help irrigation districts prioritize canal lining and optimize the design of lined canals.
- To conserve water and increase available water supplies.

Water flow measurement in the Franklin Canal, El Paso, Texas

FINDINGS AND BENEFITS

- Research results from the canals tested show seepage losses ranging from 10% to 30% of the total amount of water delivered.
- Losses vary significantly from location to location due to different soil types and hydraulic conditions. The results show higher seepage loss rates in the upper valley than in the lower valley probably due to high permeability of soil.
- Two different methods are being used to measure seepage losses. Ponding test results show water seepage rates from 160 acre-feet to 362 acre-feet per mile along a portion of the Franklin Canal. Another method, current meter inflow-outflow measurements, show even higher seepage losses ranging from 884 acre-feet to 1,986 acre-feet per mile during the irrigation season.
- Average savings from lining 10 miles of canals could provide water for as much as 1,000 acres of crops or 8,000 households.
- Canal lining is expensive. The results from this study are assisting irrigation districts in targeting canals that will result in the highest water conservation.
- Substantial quantities of water can be saved by reducing canal seepage losses. This research is being used to increase water delivery efficiency and extend our limited water supplies.

Use of Reclaimed Effluent and Salty Groundwater for Cotton Production

Dr. Zhuping Sheng and Dr. Girisha Ganjegunte (2007)
Dr. Naomi Assadian and Dr. Zhuping Sheng (2005-06)
Texas A&M AgriLife Research

Supported provided by: The Texas State Support Committee, Cotton Inc., United States Department of Agriculture NIFA Rio Grande Basin Initiative, Texas Water Resources Institute, Texas A&M AgriLife Research and Rogelio Sanchez Texas State Prison

BACKGROUND

Reclaimed water, salty ground water and waste water by-products are used on cotton fields in West Texas to supplement river water supplies and to dispose of biosolids as a soil amendment. Concentrations of total salinity and sodium of typical reclaimed water are often double compared with potable water. And, salinity of shallow groundwater is often double that of reclaimed water and agricultural drainage water. Reclaimed and ground water are important alternative supplies, but unmanaged long-term use may be detrimental to the productivity of irrigated soils. Cotton production will be significantly reduced if high salinity irrigation water is not managed and/or curtailed. Inadequate leaching of soils inevitably causes buildup of salts in soil. Excess leaching to move salts beyond the crop's effective root zone increases water demand and the potential of groundwater contamination.

Cotton irrigated with graywater at Rogelio Sanchez Texas State Prison.

PROJECT OBJECTIVES

- Investigate reclaimed and salty ground water use and management to minimize salinity impacts and maximize the use of these supplies.
- Evaluate effectiveness of using biosolids with marginal water for conditioning soils to buffer salinity, maintain soil tilth and prevent aggregate instability.
- Develop low cost, pre-irrigation water purification strategies to decrease salinity and sodicity.

APPROACH AND RESULTS

Bench-scale experiments were conducted at the Texas AgriLife Research Center at El Paso. For soil conditioning, the main variables evaluated included: types of irrigation water: saline and effluent; biosolids type (including a limed sludge); and soil type for replicated soil columns. Leaching fraction (with a crop) was maintained at approximately 30% and leachate was monitored regularly. Field experiments were conducted in the 2nd and 3rd year of this program to assess effects of soil conditioning and irrigation water on cotton production. Preliminary results show positive impacts of soil conditioning on cotton production. Soil salinity was also evaluated during and after the irrigation season. No significant impacts of salinity were observed for both brackish water and gray water irrigation. However long-term impacts should be further evaluated.

Bench-scale soil column tests

BENEFITS

The results of this research are contributing to:

- Improving water conservation and extending existing water supplies through reuse of reclaimed and salty ground water.
- Developing sustainable strategies for cotton production irrigated with elevated salinity water sources.
- Providing effective waste management and enhancing production by disposing of biosolids as a soil amendment.

Water Conservation through Reuse of Graywater

Naomi Assadian, Zhuping Sheng and George Di Giovanni

Supported provided by: United States Bureau of Reclamation, U.S. Department of Agriculture NIFA, Rio Grande Basin Initiative, Rogelio Sanchez Texas State Prison, Texas Water Resources Institute, and Texas A&M AgriLife Research

BACKGROUND

The use of graywater for landscape applications is an accepted practice for many communities, industries, and institutions and can significantly increase the amount of water available. Graywater, generally considered to be domestic and industry wastewater (with the exception of toilet water), and may contain grease, food particles, hair, detergents, pharmaceuticals, and personal care pollutants. Most of these constituents are biodegradable, but some may be sodium-based, which can result in graywater degrading the soil structure, potentially harming landscape in an arid environment. Recommendations for application rates of graywater have been developed in other states (e.g. Massachusetts), but these may not be appropriate for arid regions such as West Texas. This demonstration will test and provide recommendations for appropriate application rates for graywater in arid regions to improve water conservation in a manner that will not harm plants or degrade soils susceptible to salt accumulation.

OBJECTIVES

This project evaluates potential graywater sources in the region, estimate quantities of water that may be recovered, and develops application rates and baseline quality parameters of graywater in West Texas. The results of this project will provide tested recommendations of safe and appropriate levels of graywater application in arid regions. The goal is water conservation by reusing wastewater for crop irrigation and landscape uses in arid regions.

APPROACH AND RESULTS

A demonstration program was conducted at Rogelio Sanchez Texas State Prison, El Paso, Texas, using graywater to irrigate vegetables. Research activities included: construction of a graywater conveyance system, chemical characterization of graywater sources, maintenance of the demonstration site with vegetable crops, measurement of soil salinity, sodicity and soil moisture (using sensors) at the surface and subsurface layers, identification and quantification of potential graywater sources in the region, and development and distribution of educational materials on graywater landscape use. The 3 year experiment results with tomato, chili and bell pepper demonstrated that graywater use for production of vegetables is feasible and even outperformed over brackish groundwater. No significant impacts of salinity were observed for both brackish water and gray water irrigation. However long-term impacts should be further evaluated.

BENEFITS

- This project demonstrated and evaluated the use and feasibility of graywater on crop production in arid environments.
- This project provided new information on appropriate graywater use and sustainable crop production application rates.
- Testing and demonstrating the use of graywater and distribution of research findings will encourage and enhance water conservation and extend water supplies by preserving native water resources.

Beneficial Uses of Reject Water from Electric Cooling Towers

Dr. Girisha Ganjegunte, Texas A&M AgriLife Research
Dr. Calvin Trostle, Texas A&M AgriLife Research and Extension Center at Lubbock

Support Provided by: El Paso Water Utilities, USDA-NIFA Rio Grande Basin Initiatives and Texas A&M AgriLife Research

Cooling Tower Reject Water stored in a pond at El Paso Electric Newman power plant in northeast El Paso, TX.

BACKGROUND

El Paso Water Utilities (EPWU) supplies reclaimed water to Newman power plant of El Paso Electric Company for cooling processes. After several cycles, the reject water from cooling towers (blowdown water) is discharged into a 45 acre pond and about 3 million gallons of cooling tower reject water is produced per day. Current management of this water is non productive disposal on EPWU property located in the Bowen Ranch for evaporation. Blowdown water is slightly saline (EC = 3.0 dS m^{-1}, TDS ~ 2000 mg L^{-1} and SAR=17). The purpose of this project is to evaluate the suitability of using cooling tower reject water for irrigating moderately sensitive to tolerant crops (e.g. Alfalfa-*Medicago sativa* L.). In water scarce areas such as El Paso, use of non-potable water sources such as electric power plant cooling tower reject water to irrigate suitable crops or landscapes may be a productive and efficient method to manage this water.

OBJECTIVES

Sustainability of cooling tower reject water agricultural irrigation depends on its effects on soil salinity, plant (alfalfa) performance and potential for groundwater contamination. The specific objectives of this project are to:

- Examine study site, soil and cooling tower reject water suitability for alfalfa cultivation.
- Evaluate performance of selected cultivar(s) of alfalfa and changes in soil salinity under cooling tower reject water irrigation using greenhouse soil columns.
- Determine fate of salts in the effective root zone and leachate to understand potential for groundwater contamination.

Greenhouse soil column study evaluated cooling tower reject water irrigation effects on alfalfa performance, soil salinity, and leachate chemistry.

FINDINGS AND BENEFITS

Study site with gentle slope and well drained soil was suitable for cooling tower reject water irrigation. Chemical analysis of cooling tower reject water indicated its suitability for irrigation on well drained soils with naturally occurring calcium carbonates (caliche). Although past 32 years of limited land application and evaporation disposal had increased soil salinity it was below threshold level of alfalfa. Alfalfa cultivar SW 9720 was the most salt tolerant among cultivars tested. Alfalfa irrigated with cooling tower reject water produce three times the biomass compared to local cultivars grown with freshwater. Hay quality of alfalfa produced using cooling tower reject water was “prime grade”. Salinity of column soils irrigated with cooling tower reject water increased highlighting the need for soil management. Study results indicated minimum risk to groundwater contamination at the study site, however, nitrate contamination could be a concern in shallow groundwater areas. Research results indicated the potential for beneficial uses of about 3,350 acre-feet/year cooling tower reject water produced at the Newman Power Plant in Northeast El Paso.

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Salinity and Sodicity Assessment by EMI at Chamizal Memorial

Dr. Girisha Ganjegunte and John Clark, Texas A&M AgriLife Research

Support provided by: El Paso Water Utilities, USDA-NIFA and Texas A&M AgriLife Research. In collaboration with Congressman Beto O'Rourke (TX-16), and Chamizal Memorial Park, U.S. National Park Service

BACKGROUND

Congressman Beto O'Rourke (TX-16) has made restoration of vegetation in the Chamizal Memorial park one his top priorities. His office approached the El Paso Texas A&M AgriLife Research Center for help in developing suitable management practices to restore the deteriorated turf grass. Chamizal National Memorial Park was constructed in 1969 to commemorate the Chamizal Convention (treaty) of 1963 that ended a long-standing border dispute between the U.S. and Mexico. It serves as one of the main park and recreation areas in the El Paso region. Several factors may be contributing to poor turf grass conditions and bare areas. These include the use of fine textured upland soil to create artificial mounds to provide variation in topography, the choice of tall fescue which is not heat or salt tolerant and malfunctioning irrigation systems or management practices which could result in salt accumulation in the root zone. An electromagnetic induction (EMI) technique was used to measure and evaluate salinity and sodicity in the turf areas for developing appropriate salinity management practices to improve vegetation conditions at the park.

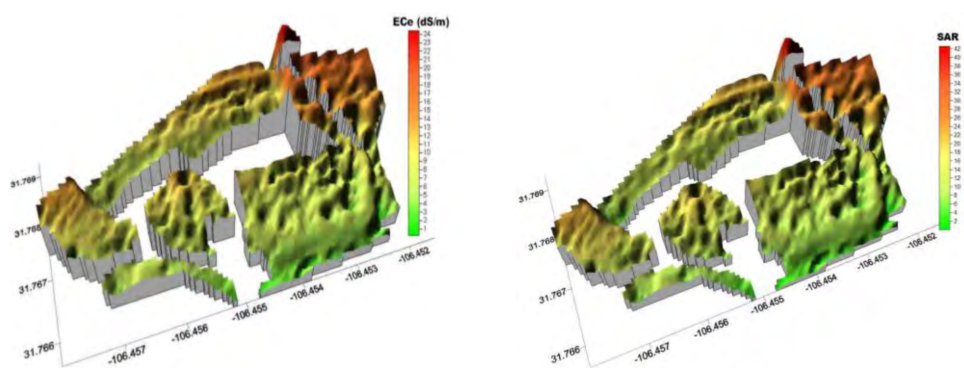
Chamizal Memorial Park

OBJECTIVES

- Measure and assess salinity and sodicity distribution in the root zone of turf areas of Chamizal Memorial.
- Develop appropriate management practices for landscape managers to improve vegetation conditions at the Chamizal Memorial.

FINDINGS AND BENEFITS

- Bare spots in the park coincided with areas with high salinity (EC_e) and sodicity (SAR) confirming that salinity is a major reason for poor vegetation conditions.
- A majority of the park soils had salinity and sodicity levels that exceeded the tolerance limit of the type of grass planted. Evapo-concentration of salts already present in the soil and irrigation water contributed to high soil salinity.
- Greater salinity levels were associated with higher clay content soil which retains salts. These and low amounts of irrigation water delivered by faulty irrigation system resulted in lower moisture conditions further stressing turf and other vegetation.
- Results of this study were used to develop appropriate salinity management practices as well as suggestions for improving vegetation conditions such as soil amendments and alternative irrigation equipment and management practices.
- Recommendations to improve soil and turf grass conditions have been conveyed to the park managers as well as to the Congressman's office.



Salinity and sodicity distribution within the turf areas of Chamizal Park

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Texas A&M AgriLife Research Center at El Paso

NUTRIENTS RECOVERY FROM BELT PRESS FILTRATE WASTEWATER

Dr. Girisha Ganjegunte and John Clark, Texas A&M AgriLife Research

Support provided by: El Paso Water Utilities, USDA-NIFA and Texas A&M AgriLife Research

BACKGROUND

El Paso Water Utilities produces a large quantity (about 175 million gallons per year) of Belt Press Filtrate (BPF) wastewater. BPF wastewater is water removed from treated wastewater sludge to better manage sludge disposal. BPF wastewater is enriched with nutrients such as ammonium (NH_4 ~ 500 to 1000 mg/L), phosphorus (PO_4^{2-} ~172 mg/L) and potassium (K ~136 mg/L). To meet water quality regulations, the concentration of ammonium in BPF wastewater needs to be significantly reduced to less than 10 mg/L (parts per million) before it can be discharged into the Rio Grande. Treatment of BPF ammonium is a major cost in wastewater treatment. Reducing the ammonium concentration and quantity of BPF water can significantly reduce the cost of wastewater treatment. This study explores methods and the technical feasibility of recovering nutrients from BPF and storing them in a compost medium for use as an organic fertilizer.

Belt Press Filtrate Wastewater

OBJECTIVES

- Develop and evaluate chemical methods to optimize conditions for more efficient recovery of nutrients from belt press filtrate.
- Analyze the efficiency of fixing nutrients present in belt press filtrate in compost by bio-physico-chemical processes.
- Evaluate BPF nutrient retention in amended compost under the high temperature and dry conditions of El Paso, TX and similar arid regions.

Ammonium being removed (precipitate at the bottom of the beaker) from BPF

RESULTS

- Laboratory studies of new removal methods indicate that the ammonium concentration in the BPF can be reduced by 94%.
- Factors such as molar ratios (relative concentrations of different reactants), pH and initial concentration of ammonium were found to be key conditions influencing/or affecting ammonium removal.
- Excess initial ammonium favored precipitation of ammonium as Magnesium Ammonium Phosphate or Struvite
- Initial magnesium ion concentration in the BPF is one of the primary limiting factors.
- A pH of >8.5 is required for effective removal of ammonium.

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United States Department of Agriculture
National Institute of Food and Agriculture

Protecting Our Water: Tracking Sources of Bacterial Contamination

Dr. George D. Di Giovanni, Texas A&M AgriLife Research
Dr. Terry Gentry, TAMU; Dr. Joanna Mott, TAMU-Corpus Christi; Dr. Suresh D. Pillai, TAMU

Support provided by: Texas State Soil and Water Conservation Board, Texas Commission on Environmental Quality, U.S. Environmental Protection Agency, Brazos River Authority, USDA-NIFA, Texas Water Resources Institute, and Texas A&M AgriLife Research

BACKGROUND

Numerous surface waterbodies in Texas are classified as having high levels of fecal coliform bacteria, an indicator of fecal pollution. The presence of high numbers of fecal coliforms indicates that disease-causing microorganisms (pathogens) sometimes found in animal and human wastes may also be present. Current laboratory tests used to identify *E. coli* and other fecal coliform bacteria do not provide information on whether the source of pollution is from sewage, runoff of animal wastes, failing septic tanks, wildlife or other sources. The sources of pollution need to be identified to implement effective pollution control strategies to improve water quality and reduce human health risk during contact recreation. Bacterial source tracking (BST) techniques may be used to help identify human and animal fecal pollution sources.

Lake Waco, Texas, site of one of several bacterial source tracking studies
Photo: US Army Corps of Engineers

OBJECTIVES

- To develop state-of-the-art genetic fingerprint BST libraries for *E. coli* bacteria isolated from known human and animal fecal sources collected from impaired Texas watersheds.
- Use the developed *E. coli* BST libraries to identify the animal or human origin of *E. coli* bacteria obtained from water samples, thereby identifying human and animal nonpoint sources of fecal contamination.
- To provide BST data which can be used by the Texas State Soil and Water Conservation Board (TSSWCB) and the Texas Commission on Environmental Quality (TCEQ) to develop water quality protection strategies.

RiboPrint genetic fingerprinting of E. coli bacteria at Texas AgriLife Research Center, El Paso, Texas. Insets, E. coli isolated from water and fecal samples

FINDINGS AND BENEFITS

- Results of this research helped identify nonpoint human and animal sources of fecal pollution impacting several Texas waters, including: Lake Waco, Lake Belton, Leon River, Peach Creek, San Antonio area waters, Lake Granbury, and Buck Creek. Results are being used to develop effective water quality protection plans to improve and conserve our water resources and protect human health.
- Data from recent projects have allowed the development of a statewide BST library. Use of the developed Texas *E. coli* BST Library is providing significant cost and time savings for current and future projects.
- The project team received a **Texas Environmental Excellence Award**, the state's highest environmental honor, for this research.

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Genotyping Cryptosporidium Recovered From Water Regulatory Slides

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Rebecca M. Hoffman, Wisconsin State Laboratory of Hygiene, University of Wisconsin– Madison
Gregory D. Sturbaum, CH Diagnostic & Consulting Service, Inc. and ALS Laboratory Group

Support provided by: Water Research Foundation, US Environmental Protection Agency, Drinking Water Quality Regulator for Scotland; United Kingdom Drinking Water Inspectorate, ALS Laboratory Group – Australia; USDA-NIFA and Texas A&M AgriLife Research

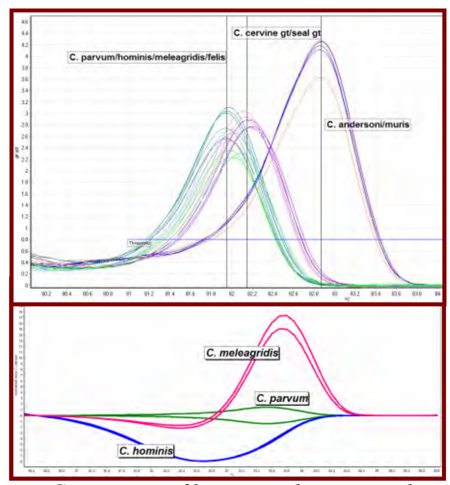
BACKGROUND

Current drinking water quality regulations in the US, United Kingdom, Australia and other parts of the world require monitoring for the parasite *Cryptosporidium* due to continued waterborne disease outbreaks and its risk to human health. There are currently over 20 recognized species and 60 genotypes of *Cryptosporidium*, most of which are frequently found in water. Of these, only three species (*C. parvum*, *C. hominis*, and *C. meleagridis*) are responsible for the vast majority of human disease. The current regulatory methods for the detection of *Cryptosporidium* in water rely upon immunofluorescent assay microscopy. Due to cross-reactivity of antibodies used in the assay, both human and animal associated *Cryptosporidium* oocysts are detected. Further, the microscopy methods are not capable of determining the species or genotype of the *Cryptosporidium* detected. This is a significant limitation when gauging the public health risk posed by this parasite. Development and application of a polymerase chain reaction (PCR) assay for genotyping *Cryptosporidium* oocysts recovered from water regulatory slides is greatly needed to help identify human and animal sources of waterborne *Cryptosporidium* for watershed management and to refine risk assessment models.

An international technology transfer workshop was held at the Texas AgriLife Research Center at El Paso

OBJECTIVES

The first phase of this research involved method development and was completed under Water Research Foundation Project 4099. The overall objective of Project 4099 was to develop a simple and reliable method for genotyping single *Cryptosporidium* oocysts recovered from water regulatory slides that could be readily transferred to water quality testing laboratories with minimal or no molecular biology experience. The second phase of research is currently being conducted under Water Research Foundation Project 4284. Project 4284 includes an international technology transfer workshop and international round-robin method evaluation to help transfer this technology to end users.



Genotyping of human pathogenic and animal associated Cryptosporidium by real-time PCR high resolution melt analysis

FINDINGS AND BENEFITS

- The developed method includes removal of oocysts from slides, DNA extraction, and genotyping using conventional PCR or real-time PCR with high resolution melt analysis. Preliminary single lab evaluation revealed an 80% detection rate for field slides seeded with single flow cytometry sorted oocysts.
- The published Water Research Foundation Project 4099 report includes a detailed sample processing protocol, reagent preparation protocols, electronic worksheets, and a method demonstration/training DVD.
- An international technology transfer workshop was held at the Texas AgriLife Research Center at El Paso. The workshop included participants from ten partner laboratories located in the US, Canada, Scotland, England, Wales, and Australia.
- An international round-robin method evaluation is currently underway with the participation of 26 analysts from 13 partner laboratories located in 7 countries.
- Application of the developed method will bring added value to regulatory monitoring, aid the development of effective watershed management strategies, and help refine *Cryptosporidium* human health risk assessment models.

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Detection of Infectious Cryptosporidium in Drinking Water

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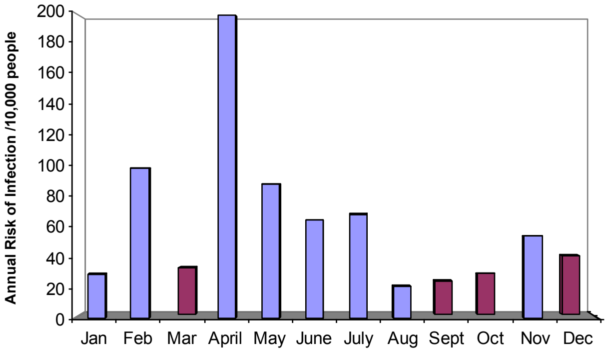
Dr. Paul A. Rochelle and Anne M. Johnson, Metropolitan Water District of S. California, La Verne, Calif.
Dr. Theresa Slifko, Sanitation Districts of Los Angeles County, Los Angeles, Calif.

Support provided by: Water Research Foundation, USDA-NIFA and Texas A&M AgriLife Research



Distribution of Cryptosporidium annual risk of infection based on monthly data from the Aboytes, Di Giovanni, Abrams et al. (2004) 2-year study of 82 treatment plants in 14 states. Dark shaded bars represent the limit of risk detection (i.e., no oocysts were detected). The USEPA goal for annual risk of infection is 1/10,000 people.

BACKGROUND

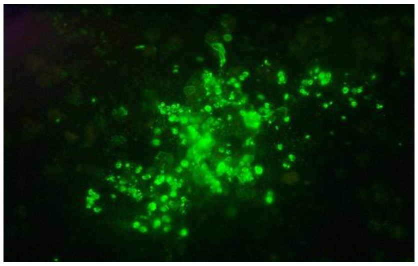
Waterborne transmission of the protozoan parasite *Cryptosporidium* remains a significant threat of disease with severe consequences for persons with weakened immune systems. New drinking water standards under the US Environmental Protection Agency (USEPA) Long Term 2 Enhanced Surface Water Treatment Rule are aimed at reducing the risk of cryptosporidiosis.

Properly operating drinking water treatment plants that utilize conventional filtration methods usually remove *Cryptosporidium* from source water efficiently. However, a study by the American Water Company (Aboytes, Di Giovanni, Abrams et al., 2004) evaluated finished drinking water samples from 80 surface water treatment plants across the US for the presence of infectious *Cryptosporidium* using a cell culture-polymerase chain reaction (CC-PCR) technique (Di Giovanni, Hashemi, Shaw et al., 1999). This study concluded that nearly all conventional treatment plants are at risk for passing infectious oocysts. Based on this study, the overall risk of *Cryptosporidium* infection for conventionally treated drinking water was 52 infections/10,000 people/year, and that an additional treatment barrier, such as ultraviolet light disinfection, is needed to meet the USEPA risk goal of 1 infection/10,000 people/year. Comparison of the CC-PCR method to two additional cell culture methods that have been used for disinfection studies and correlated with animal infectivity is needed to better understand the human health significance of the CC-PCR results. The additional two cell culture techniques for the detection of infectious *Cryptosporidium* are the cell culture reverse transcription polymerase chain reaction (CC-RT-PCR), and the cell culture focus detection (FDM) microscopy method. Additional drinking water sample analysis is needed to better understand the results of this earlier study.

OBJECTIVES

Phase I: Determine the sensitivity, specificity, and accuracy of the CC-PCR (benchmark method), CC-RT-PCR and FDM assays for the detection of low numbers of infectious *Cryptosporidium*.

Phase II: Determine the prevalence of infectious *Cryptosporidium* in finished drinking water using the most robust cell culture method determined in Phase I. A total of 260,000 Liters of drinking water from different drinking water systems across the US will be analyzed over the course of the study.



Detection of Cryptosporidium infected lab-grown human intestinal cells using the FDM immunofluorescent microscopy method

FINDINGS AND BENEFITS

After extensive testing, the FDM method followed by PCR-based genotyping of *Cryptosporidium* clusters of cell culture infection was selected for Phase II. Over the 22 month field study, 184 paired field samples from 14 different treatment plants were processed by each lab (368 samples total), for a total analysis of 342,853 L of drinking water. No field samples tested positive, while controls have provided consistent and appropriate results. However, the lack of positive samples may have been due to the selection of utilities that participated in the study, since most had historically very low levels of *Cryptosporidium* in their source water. In any case, in contrast to the American Water study, results of the current study indicated that treatment plants with quality source water are unlikely to pass infectious *Cryptosporidium*. Additional analysis of drinking water from plants with lower quality source water using the standardized cell culture infectivity assay developed in this study is needed to better understand the risk posed by *Cryptosporidium*.

Pathogens In Rio Grande River Water

Dr. George D. Di Giovanni, Texas A&M AgriLife Research

Support provided by: USDA-NIFA, Texas Water Resources Institute and Texas A&M AgriLife Research

BACKGROUND

Few studies have evaluated the microbial quality of the Rio Grande River despite its critical role in agriculture and potable water supply for the region. Furthermore, no prior studies exist on the occurrence of the parasites *Cryptosporidium* and *Giardia* in Rio Grande River irrigation water. *Cryptosporidium* and *Giardia* cause diarrheal illness and have been responsible for numerous waterborne and foodborne disease outbreaks. The disease caused by *Cryptosporidium* is called cryptosporidiosis and there is currently no cure for the disease which normally lasts about two weeks in healthy individuals. However, cryptosporidiosis may be fatal in people with weakened immune systems, such as chemotherapy patients, the young and elderly and organ transplant patients. Under the Clean Water Act the US Environmental Protection Agency mandated 2 years of *Cryptosporidium* monitoring of potable supply surface waters, including the Rio Grande River, beginning in 2006. If high levels of *Cryptosporidium* are found, costly upgrades to drinking water treatment plants may be required. Until recently, the risk from waterborne *Giardia* was considered lessened. However, concern is growing over the risk it poses as it has recently been found in high densities in wastewater treatment plant effluents using more reliable detection methods.

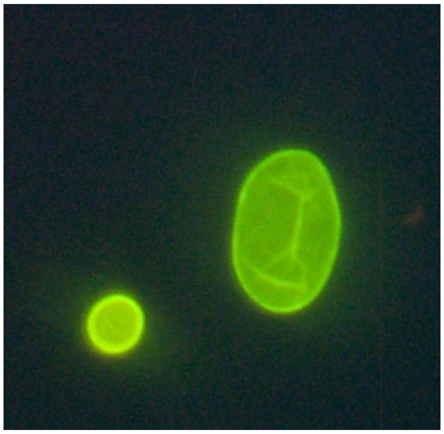
Franklin Canal delivering Rio Grande water for agricultural and urban water use, El Paso, Texas

OBJECTIVES

- Protect our food supply, water supply, and public health by providing timely and useful information on the occurrence, infectivity and potential human health risk of the pathogens *Cryptosporidium* and *Giardia* in Rio Grande River water in the El Paso, Texas region.
- The infectivity and characterization of *Cryptosporidium* and *Giardia* strains present in Rio Grande River water will be determined using state-of-the-art cell culture and molecular methods to better assess the risks posed to human health by these pathogens.
- Levels of *Cryptosporidium* and *Giardia* in Rio Grande River water are also being quantified using the conventional EPA Method 1623 (the current regulatory standard) to develop a baseline occurrence of these organisms and estimate the potential impact of future regulations on drinking water treatment costs.

RESULTS AND BENEFITS

- Large seasonal differences in levels of *Cryptosporidium* and *Giardia* in the Rio Grande water have been identified. Pathogen levels are much higher during the non-irrigation season than during the irrigation season, mostly due to the contribution of wastewater treatment plant effluents. Fortunately, drinking water plants use groundwater instead of Rio Grande water due to the low river flow and salinity during the non-irrigation season. During the irrigation season, releases from Elephant Butte reservoir and return flows increase the volume of river water and lead to a 20-fold or greater decrease in levels of *Cryptosporidium* and *Giardia*.
- Genetic typing (genotyping) is underway to determine the human or animal origin of the detected *Cryptosporidium* and *Giardia*, and the potential risks to human health.
- The results of this research will provide fundamental information on the occurrence of *Cryptosporidium* and *Giardia* in Rio Grande River water and gauge the potential human health risks posed by these pathogens.



Cryptosporidium oocyst (left) and Giardia cyst (right) under epifluorescent microscopy

Molecular Detection of Infectious Viruses in Water

Dr. George D. Di Giovanni, Texas AgriLife Research
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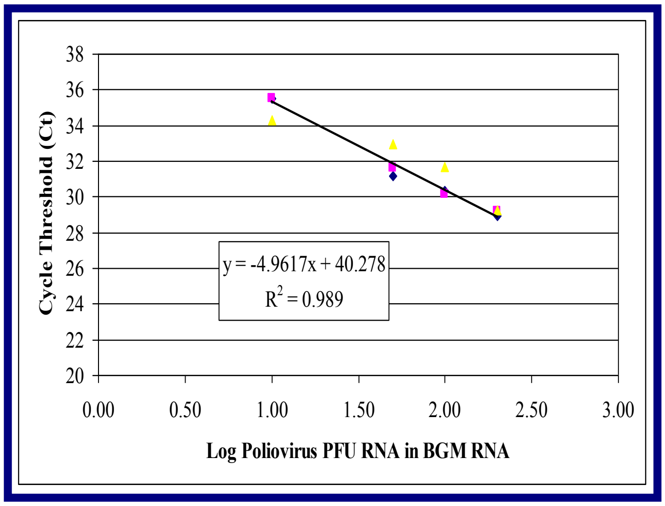
Support provided by: American Water Works Association Research Foundation, USDA-NIFA and Texas A&M AgriLife Research



Poliovirus host cell capture quantitative polymerase chain reaction (HCC-qPCR) standard curve used to quantify viruses in water samples

BACKGROUND

More than 140 different enteric viruses are known to infect humans causing a wide range of diseases, from diarrhea to heart infections. Enteric viruses have been found in raw surface water and wastewater. Compared to bacteria, enteric viruses are resistant to conventional water and wastewater treatment. It is suspected that many waterborne disease outbreaks for which no cause was identified (about 47% of all reported outbreaks) may be due to viruses. Viruses are frequently not identified as the cause of outbreaks due to the limitations of current detection methodology and the failure to examine clinical specimens for viruses. The conventional detection method uses growth of the viruses in cell culture (animal tissues grown in the laboratory). However, this method is costly and may take weeks to complete. In addition, some viruses, such as hepatitis A and noroviruses, are difficult to grow in cell culture. Although sensitive, molecular methods alone cannot distinguish between infectious and noninfectious viruses. Methodologies that are both quantitative and address infectivity are needed to assess the public health risks associated with exposure to viruses in water.

OBJECTIVES

- Develop analytical methods for the rapid and quantitative detection of infectious viruses in water. Our approach uses brief contact of purified water samples with cell culture (animal or human cells) to “capture” the viruses in the samples, followed by a molecular assay to detect the captures viruses. This assay is referred to as host cell capture quantitative sequence detection (HCC-QSD).
- Evaluate different host cell lines and virus combinations to identify the most effective cell lines for the host cell capture of human enteric viruses. Poliovirus and Buffalo Green Monkey kidney cells, and reovirus and Vero cells will be used as model systems.
- Evaluate the ability of HCC-QSD to distinguish potentially infectious viruses from chlorine and ultraviolet light disinfected viruses.

FINDINGS AND BENEFITS

- Using the model virus and cell line systems, HCC-QSD method was refined and a new protocol developed. As anticipated, ultraviolet light inactivation of virus was difficult for HCC-QSD to detect due to the mechanism of inactivation. However, chlorine disinfection trials using poliovirus demonstrated equivalent results between the conventional cell culture assay and HCC-QSD in quantifying virus inactivation.
- This research will aid in the development of a standard method for routine monitoring of infectious viruses in water by providing a technological foundation for the water industry and EPA.

Human Health Risks From Contaminants in Reclaimed Juarez Wastewater

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Supported provided by: The Center for Border Health Research, USDA-NIFA, Texas Water Resources Institute, and Texas A&M AgriLife Research

Sheep grazing at experimental field plots amended with biosolids and irrigated with reclaimed wastewater, Juarez Valley, Mexico

BACKGROUND

The Paso del Norte region of the U.S. - Mexico border not only includes the major urban areas of El Paso and Ciudad Juarez with a combined population over 2 million, but also areas with intensive agriculture and livestock industries. Almost 90% of agriculture and livestock activities in the Juarez Valley of Mexico rely on the use of reclaimed wastewater. Juarez Valley reclaimed wastewater is a blend of raw and marginally treated (sedimentation) wastewater, and receives limited disinfection for the control of microbial pathogens. Pathogens, such as the parasites *Cryptosporidium* and *Giardia*, present in the reclaimed wastewater may be transmitted from humans to animals and ultimately back to humans. Residents of Juarez Valley communities may also be exposed to heavy metals in reclaimed wastewater, biosolids and locally produced meat products. Some heavy metals, such as chromium and lead, may have long-term adverse effects on agro-ecosystems, crop products and human health. For these reasons, there is a need to identify and quantify the existence of pathogens and heavy metal contaminants in irrigated and biosolid amended soils, and their movement into edible crops and animals to estimate the magnitude of risk to human health.

PROJECT OBJECTIVES

- Determine the presence of heavy metal pollutants and the microbial pathogens *Cryptosporidium* and *Giardia* in Juarez Valley reclaimed wastewater used for irrigation, lime stabilized biosolids, and soil.
- Assess metal and pathogen movement to oat forage and grazing sheep under field conditions in the Juarez Valley.

Aguas negras or "black water" wastewater canal, Juarez Valley, Mexico

FINDINGS AND BORDER IMPACTS

- The study found that the agricultural use of reclaimed wastewater and biosolids in the Juarez Valley, Mexico does not lead to increased levels of metals in oat forage or in sheep grazing on the forage. Therefore, consumption of locally produced meat products poses a low risk of exposure to heavy metal contaminants.
- High levels of the parasites *Giardia* and *Cryptosporidium* were found in the reclaimed water. Genetic fingerprinting determined that the types of *Giardia* found in sheep feces differed from those found in the reclaimed irrigation water. *Cryptosporidium* was not found in sheep feces, despite the presence of infectious *Cryptosporidium* in the irrigation water. While agricultural use of reclaimed water in the Juarez Valley does not appear to pose a risk to livestock, human contact with the reclaimed water poses a significant health risk and should be avoided.
- This international project between Mexican scientists, Texas AgriLife scientists and the Center for Border Health Research has fostered collaborative efforts to benefit the health of both U.S. and Mexican communities in the Paso del Norte region.

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Texas Water Resources Institute
make every drop count

CENTER FOR BORDER

USDA United States Department of Agriculture
National Institute of Food and Agriculture

Solutes and Viruses in Soil Subirrigated with Reclaimed Wastewater

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Support provided by: The Texas Department of Agriculture, USDA-NIFA, Texas Water Resources Institute and Texas A&M AgriLife Research

TDA, AgriLife Research, AgriLife Extension tour of research program

BACKGROUND

Wastewater reuse for agriculture and managed landscapes will aid in meeting growing water demands and conserve current potable supplies in arid regions such as the upper Rio Grande floodplain. Opportunities exist to use alternative water supplies for irrigation such as treated municipal wastewater. However, wastewaters often contain microbial and chemical contaminants that may affect public health and environmental integrity. Wastewater pretreatment strategies and advanced irrigation systems may limit contaminant exposure to crops and humans. Subsurface drip irrigation (SDI) shows promise for safely delivering reclaimed wastewater. The closed system of SDI subsurface pipes and emitters minimizes the exposure of soil surfaces, above ground plant parts, and groundwater to reclaimed wastewater. However, the persistence and movement of waterborne viruses are of growing scientific and public concern with the recent increase in wastewater reclamation efforts.

OBJECTIVES

- Determine the feasibility of subsurface irrigation of a crop with a blend of untreated and treated wastewater effluents.
- Assess the movement of salts, nutrients, and bacteriophage (viruses of bacteria) as a surrogate for human viruses introduced into soil using subsurface drip irrigation with reclaimed wastewater.

Sampling irrigated spinach

Above: Reclaimed water tank. Below: Research team members with subsurface drip irrigation soil columns

FINDINGS AND BENEFITS

- There is potential to reclaim both untreated and treated wastewater effluents as an irrigation blend. The wastewater blend can be pretreated to reduce fecal coliforms to meet Texas Type I wastewater reuse guidelines for edible crops.
- Subsurface drip irrigation prevented the virus movement onto spinach leaf surfaces.
- Bacteriophage persisted in both sandy and clayey soils for a 28-d period after the last irrigation. Our results suggest that human viruses could also persist in soils for extended periods using SDI. Therefore, virus inactivation strategies may need to be an integral part of treating reclaimed wastewater, regardless of irrigation delivery system.
- The potential for salt and sodic hazard in soils increased with wastewater irrigation and with subsurface drip irrigation. In this study, pretreatment did not remove wastewater salinity or sodicity.
- Beneficial and safe use of reclaimed wastewater for subsurface drip irrigation will depend on management strategies that focus on irrigation pretreatment, virus monitoring, field and crop selection, and periodic leaching of salts.
- *For details see* Assadian, N. W., G. D. Di Giovanni, J. Enciso, J. Iglesias, and W. Lindemann. 2005. The transport of waterborne solutes and bacteriophage in soil subirrigated with a wastewater blend. Agriculture, Ecosystems and Environment 111:279-291.