POSTER ABSTRACTS

Concentrate Stream as a New Potential Media for Growing Algae

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Poster Abstract 1

The scarcity of drinking water is an ever-increasing quandary, and there is a need to desalinate different sources of water such as saline and inland brackish water. There are different desalination methods that can be applied in combination with available local energy sources to treat water in dry places. EDR technology system, in which electrical current is utilized to reduce the ionic content of water, has significantly increased over the past two decades. By using this method, the salinity of concentrate stream increases with each subsequent separation stage. As a consequence, reject water is disposed which is costly, while there still remains a precious water resource. Any attempt to minimize the cost of disposal and make beneficial use of concentrate can have great benefits in terms of water usage and impact on the environment.

Algae have been considered a renewable and sustainable feedstock for the production of biofuels from non-food sources which can lessen our dependence on fossil fuels. Algae can utilize water from concentrate for its growth by using nutrients and salts available in the concentrate.

In this research, concentrate stream of EDR with TDS of 5.54 g/L was used to grow microalgae, Chlorella sorokiniana (UTEX 1230). A factorial design statistical experiment with CRD arrangement was conducted to grow algae in five different media (concentrate, BBM, three levels of concentrate (25%, 50% and 75%)) under 16-8 light cycle at 25oC. It was found that the algae grown in 50% concentrate resulted in the highest increase of biomass production. The biomass derived from 75% concentrate was considerable as well.

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Progress Report on Development of an Annotated Bibliography for Transboundary Aquifer Systems of the Mesilla Basin-Paso Del Norte

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Poster Abstract 2

The goal of the 2007 United States-Mexico Transboundary Aquifer Assessment Act is to characterize, map, and model priority transboundary aquifer systems along the United States-Mexico border at appropriate levels of detail. Mandated studies include assessment of aquifer systems of the Mesilla Basin-Paso del Norte region (pop. about 2 million) by the New Mexico and Texas offices of the U.S. Geological Survey (USGS) and Water Resources Research Institutes at NMSU (NM WRRI) and TAMU AgriLife Research Center-El Paso (TAMU-EP). Work involves collaboration with a binational group of organizations who share interests in the western Texas, southern New Mexico, and northern Chihuahua region. An initial task involved compiling a bibliography on transboundary aquifers of the study area, with the NM WRRI leading this effort in collaboration with the Departamento de Ingeniería Civil y Ambiental at the Universidad Autónoma de Ciudad Juárez, the USGS, and TAMU-EP. A preliminary annotated reference list, with provisional alphanumeric cross-referencing codes for almost 750 items, has now been created. Major topics include: bibliographies and reviews; historical documents; environmental and geologic settings; basic hydrogeologic concepts; GIS/remote sensing and land-use planning; regional geohydrology; basin to local-scale aquifer systems (hydrogeology, hydrochemistry, geophysics, and groundwater-flow models); and paleohydrology. Short summary statements (English/Spanish) are being prepared for specific references as needed; with EndNote® software being used to facilitate bibliography, reference-list and foot-note word processing. After peer review, the NM WRRI plans to create a bilingual (online) publication for internet-site posting in collaboration with USGS Water Science Centers in New Mexico and Texas, and TAMU-EP.

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Effects of Seasonal Well Operation on Hydrologic Conditions and Public-Supply Well Vulnerability

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Poster Abstract 3

As part of the National Water-Quality Assessment Program, the U.S. Geological Survey investigated the effects of seasonal variability in pumping stress on the vulnerability of public-supply wells in two deep basin-fill aquifers to contamination with constituents of natural and anthropogenic origin. Historical water-quality data for multiple public-supply wells in Modesto, California (117 wells) and Albuquerque, New Mexico (95 wells) indicate that seasonal variation in the concentrations of contaminants of concern (nitrate and uranium in Modesto and arsenic in Albuquerque) is relatively common. In Modesto, groundwater from supply wells is more likely to be younger and have higher nitrate and uranium concentrations during the summer (high) pumping season than during the winter (low) pumping season. In Albuquerque, groundwater from supply wells is more likely to be older and have higher arsenic concentrations during the winter (low) pumping season than during the summer (high) pumping season. Seasonal variability in contaminant concentrations in both study areas is driven by the effects of well operations on vertical hydraulic gradients in the aquifer and on the period of time that a supply well is idle, allowing its well bore to act as a conduit for vertical groundwater flow. The length and (or) depth of the screened interval influence the magnitude and chemical characteristics of flow through the well bore. Results of this investigation show that supply-well vulnerability can be dependent on seasonal pumping stress and suggest that even in aquifers dominated by old groundwater, changes in well design and operation could help reduce vulnerability to selected contaminants.

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Drought Management Planning at Ute Reservoir, Quay County, NM

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Poster Abstract 4

A mass-balance reservoir model has been developed and employed to define appropriate drought recurrence intervals and manage competing interests at a multi-use reservoir in New Mexico. Ute Reservoir was constructed on the Canadian River by the State of New Mexico to provide a sustainable, municipal and industrial (M&I), water supply of 24,000 acre-ft/year to eastern New Mexico. The Eastern New Mexico Water Utility Authority (Authority) is building the Ute Pipeline Project under authorization and funding by US Bureau of Reclamation. The project will divert 16,450 acre-feet of water annually from the reservoir for the Authority's use.

The model was developed to examine changes in reservoir elevation due to withdrawal of the full 24,000 acre-ft/year contracted to NM communities. This model assessed the impacts of various drought management strategies, with the goal of maximizing reservoir yield, preserving reservoir storage and conserving water elevations. Scenarios were examined that address a range of potential drought trigger elevations and curtailments. These scenarios were developed utilizing the concept of a 'prudent reserve' – defined as the quantity of water in storage required to meet prescribed low-flow events. Based on this concept a scenario whereby reductions in demand of 10, 20, and 30% are achieved at elevations corresponding to 8, 7, and 6 years of storage required to meet a 5 consecutive year low flow event appears to achieve favorable results (maintain a high project yield, reservoir elevations, and minimizing spills, and supply deficits). Future work could evaluate out-of-basin aquifer storage and the impacts of climate change.

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Six Decades of Water Levels in the Albuquerque Area (1950 – 2008)

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Poster Abstract 5

The Albuquerque area is the major population center in New Mexico and experienced more than a five-fold population increase between 1950 and 2010. Before 2008, groundwater was the primary source of Albuquerque's public water supply, but since that time the city has started to divert San Juan/Chama river water transported via the Rio Grande to augment municipal water supplies. Consequently, there is interest in understanding how groundwater levels changed from 1950 to the present in response to groundwater pumping, surface-water diversions and conservation measures. Previous studies have described water-level declines in the production zone from pre-development to the present (2002 and 2008) using measured water levels. To give a more detailed history of water-level changes, maps were created by contouring water-table elevations and water levels in the production zone that were simulated with a recently updated transient groundwater-flow model at 10-year intervals between 1950 and 2008. The maps also compare the simulated decline of the water-table and water levels in the production zone to their estimated pre-development levels. Both the water table and production zone water levels decline over time with the largest change occurring between 1970 and 1980, which was a period of rapid population growth. Declines in the water table and production zone water levels occur around major pumping centers, and are largest in the production zone. A comparison of simulated hydrographs to observed water levels at selected locations indicates that simulated water levels are generally within 5 meters of measured water levels.

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Using Household Graywater on Bermudagrass (Cynodon dactylon)

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Poster Abstract 6

Water is becoming a rare resource. The conservation and reuse of water is becoming increasingly more important; worldwide consumption of fresh water has more than doubled since World War II and is expected to rise another 25 percent by 2030. However, aesthetic residential landscapes provide numerous homeowner benefits; including dust abatement, moderation of temperatures, reduced air condition requirements, increased home value and increased use of home landscapes. In order to maintain our desired residential landscapes, alternative conservation strategies will be required to minimize the impact to potable water sources. The reuse of graywater collected from individual households may provide this additional water resource. Graywater is wastewater from clothes washers, bathtubs, showers, and sinks, but not from kitchen sinks, dishwashing machines, and toilets. The use of graywater on turfgrass and landscape plants will reduce the average consumption of potable water. The objectives of this study are to determine the potential water savings with the use of graywater on residential lawns, and to monitor the potential soil chemical property changes. The results to date show no detrimental effects to using graywater on turfgrass. The increased levels of both sodium as well as nitrate levels from the graywater source could change the soil chemistry as the research progresses. Proper irrigation and the leaching of sodium and nitrate will validate the use of graywater as an alternative irrigation source for home lawns.

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Real Time Measurement Site on the OSE Website

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Poster Abstract 7

On the website of the Office of the State Engineer and Interstate Stream Commission: www.ose.state.nm.us we have a page called "Real-Time Water Measurement Information System". The OSE/ISC are the State agencies responsible for the administration of water rights. As such we have installed water measurement stations that through satellite or radio telemetry can be accessed through this page. As the title implies, diversions in cubic feet per second or gallons per minute from OSE/ISC installed water measurement stations in fifteen-minute interval data points can be viewed in real time with only a few hours of lag time. The quantity of water diverted by the major water users in several river basins around the State of New Mexico can be downloaded from this site. Links to the gages that the United States Geological Service or other agencies manage in these same basins can be accessed through this page.

This page was first made available to the public during the 2011 Irrigation Season. The OSE/ISC uses the site to generate water use reports and for management purposes. Most of the data in the 2011 Gallinas River basin annual water use tables was compiled from data obtained from this page.

A reason for this site is to help the major water users manage their water resources. It also helps the OSE/ISC Water-Masters identify if there is any problem with the stations they are responsible for maintaining. The interested public can see how the water is being used in these basins.

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Potential Groundwater Recharge from a Domestic Sewage Disposal Field in Eastern Bernalillo County, New Mexico

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Poster Abstract 8

In semi-arid regions, the infiltration of effluent from domestic sewage disposal fields (disposal fields) can be a significant contribution to groundwater recharge; however, limited data exist to quantify recharge from disposal fields. Eastern Bernalillo County, New Mexico is part of the rapidly growing Albuquerque metropolitan area. Increasing water use in this semi-arid area has raised concerns about the effect of development on the availability of water resources. Quantifying the amount of recharge from disposal fields is critical to water resource planning and management. Information from this study will provide a better understanding of the importance of recharge from disposal fields to hydrologic budgets in semi-arid climates.

A water-balance approach was used to estimate the amount of potential groundwater recharge occurring from a disposal field in Eastern Bernalillo County during 2011. Potential groundwater recharge due to effluent was estimated as the volume of effluent dosed to the disposal field in excess of the volume of effluent lost through evapotranspiration (ET) from the disposal field. The amount of effluent lost through ET from the disposal field was estimated as the amount of potential ET loss on the disposal field in excess of potential ET loss off the disposal field in the surrounding terrain. Model calculations of potential ET were calibrated with actual ET measurements collected using a portable ET chamber. Preliminary results indicate that potential recharge from disposal-field effluent during 2011 was 75 to 87 percent of the volume of effluent dosed to the disposal field.

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Santa Fe Watershed Investment Program - Water Customers Protecting Their Water Source

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Poster Abstract 9

Santa Fe's watershed investment program was born in the ashes of the 2000 Cerro Grande Fire, which cost $970 million in compensation, suppression and rehabilitation, and made national headlines for several weeks. The fire prompted Santa Fe to assess the vulnerability of its 17,000 acre Santa Fe River municipal watershed, which supplies up to 40% of the city's water, to a similar event. From 2002 to 2007, the USFS treated 5,500 acres of ponderosa pine forest in the lower, non-wilderness portion of the municipal watershed, where pre-treatment tree density was between 1,000-2,000 trees per acre, while historic density was between 20-50 trees per acre. In 2007, the City of Santa Fe and partner groups including the USFS, the Nature Conservancy and the Santa Fe Watershed Association, completed a 20-year watershed management plan which guides forest maintenance work and new treatments. The plan proposed paying for ongoing project costs through a Payment for Ecosystem Services finance model, which passes costs along to the beneficiaries of the healthy watershed: Santa Fe's water customers. In 2008, the city and the USFS established a financial collection agreement, allowing the city to cost-share half of the ongoing project costs. In 2009 the City instituted a rate increase which will be used to cover future project costs once state funds expire. The project has drawn interest from other communities in the west, whose drinking water systems face similar wildfire risks, yet lack the financial resources to treat their watersheds to reduce critical fuel loads.

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Historic and Predicted Hydrographs for the Gila Basin: Assessing Gila Water Projects in New Mexico

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Poster Abstract 10

The Arizona Water Settlements Act of 2004 ("AWSA") provides New Mexico an additional annual average of 14,000 acre-feet of water in the Gila Basin, and authorizes the New Mexico Interstate Stream Commission (ISC) in consultation with the Southwest New Mexico Water Study Group or its successor, to determine how the water will be used. The AWSA also requires that any such decision be subject to the requirements of the National Environmental Policy Act and the Endangered Species Act – in other words, the ecological systems of the Gila Basin must be evaluated and considered before any project may go forward. The ISC has adopted a policy that requires full consideration of both the environment and water demands, now and into the future.

A crucial component of this evaluation is an understanding how the Gila and its tributaries behave under base flow conditions, seasonal variations, and runoff events. This is particularly important for predictive modeling, as climate change, potential stream diversions, and fire effects will have a significant imprint on any conclusions that may be drawn. With a robust stakeholder involvement process, the ISC has launched these hydrologic studies, and – combined with other studies on Gila Basin hydrology, geomorphology, water needs, and ecosystems – will use the results to inform its decisions on which, if any, AWSA projects should go forward.

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Using Geothermal Water and Cow Manure for Growing Chlorella Sorokiniana

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Poster Abstract 11

In near future the demand for energy could double or even triple as the global population grows and developing countries expand their economies. Fresh water is also going to be a major limitation for energy production. Using alternative sources of water and energy can be solution for combating shortage of these two resources. Microalgae are promising source for clean, sustainable, and renewable, energy. Geothermal water is a source of water rich in dissolved CO2 and different nutrient content. However, it is lacking nitrogen, the major source of nutrient for the growth of algae. In this study, geothermal water from the A-mountain site of New Mexico State University is used in the laboratory of the Institute for Energy and the Environment (IEE) for growing chlorella species of microalgae (UTEX-1230), using different concentrations of manure (0.4% to 8%, by vol., in various concentrations) as a source of nutrient. The results indicated high amount of manure, 3.2% by vol., can change the color of media and block the light which is highly needed for algae growth. However lower amount, 1.6% by vol., can boost the growth of algae, but it is not comparable to BBM, the widely used nutrient to grow algae.

Using relatively inexpensive sources for water and nutrients can lower the cost of producing biofuels from algae.

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Groundwater Hydrology and Estimation of Horizontal Groundwater Flux from the Rio Grande in Albuquerque, New Mexico

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Poster Abstract 12

In 2003, the U.S. Geological Survey, in cooperation with the Bureau of Reclamation and the U.S. Army Corps of Engineers, began a detailed hydrologic characterization of the Rio Grande riparian corridor in Albuquerque, New Mexico, to provide hydrologic data to enhance the understanding of hydraulic interactions among the river, riverside drains, and shallow alluvial aquifer.

Throughout the Albuquerque Rio Grande riparian corridor, groundwater flows away from the Rio Grande towards riverside drains. Results of slug tests indicate that shallow (less than 50 feet) alluvial hydraulic conductivities range from 3 to 240 feet per day (ft/d) with a median of 50 ft/d. Based on groundwater-level measurements, the average of median daily horizontal hydraulic gradients ranged from 0.002 to 0.011.

Groundwater fluxes calculated using hydraulic conductivities and Darcy's law ranged from about 1.2 to 32.4 cubic feet per day per linear foot of river (ft3/d/ft), and those calculated using temperature and the Suzuki-Stallman method ranged from 6.9 to 15.6 ft3/d/ft. While the calculated Darcy's law and Suzuki-Stallman fluxes are similar, comparisons to measured fluxes derived from seepage surveys of riverside drains near the Montaño Bridge indicate that the calculated flux of water from the Rio Grande at the Montaño Bridge accounts for only 18 to 50 percent of the measured drain fluxes.

The results of this study indicate that groundwater flux rates within the Rio Grande riparian corridor are highly variable and scale dependent and that seepage from the Rio Grande is not the only source contributing water to the riverside drains.

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Desalination in a Pilot-Scale Electrodialysis Process: Selective Removal of Divalent Ions in Comparison with Monovalent Ions

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Poster Abstract 13

Desalination as an artificial process by which saline/brackish water is converted to fresh water is considered as a solution to global drinking water crisis. Electrodialysis (ED) is a membrane based separation process in which the partial separation of the components of an electrolyte solution occurs due to applied electrical voltage. Although Electrodialysis Reversal (EDR) technology has been commercially used since the early 1960s, the fundamental understanding of this technology is not fully developed. Groundwater resources, which are very important sources of drinking water in many parts of the world as well as southwest region of the United States, have various water chemistries. Therefore, ions with higher levels preferentially should be removed selectively, since most of the other ions exist within acceptable range based on drinking water standards. In this study, selective removal of different divalent cations and anions using pilot-scale EDR has been studied. The experiments were done at different levels of temperature, linear velocity, feed water conductivity and applied voltage. The EDR pilot scale set up has been installed in Brackish Ground Water Desalination Research Facility, BGNDRF, located in Alamogordo, New Mexico. The EDR stack was composed of 40 cell pairs in which CR67 and AR204 were used as cation and anion exchange membrane, respectively. The obtained results show that the CR67 and AR908 membranes remove divalent cations (such as calcium) and anions (such as sulfate) better than monovalent ions at various operating conditions, respectively. However, the selectivity values of the EDR process depend on the experiment operating condition.

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Efficient Irrigation Technologies: Helping to Meet Public Policy Goals In Landscape Water Conservation

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Poster Abstract 14

Landscape irrigation in residential and industrial areas has been identified as a major source of high potable water use during the summer months. Consequently, water utilities and municipal ordinances encourage strategies aimed at conserving potable water use in landscape irrigation. There are several options to reduce or eliminate the amount of potable water used for irrigation. First, potable water could be eliminated completely and replaced by recycled or low quality ground water that does not meet standards for human consumption. This strategy has been applied by numerous communities for parks, athletic fields, and golf courses and is also being considered for residential developments. In order to make the use of recycled water a successful long term strategy, salinity tolerance needs to be included as a criterion for plant recommendations. Second, the planting of low water use and/or drought tolerant plants has been suggested and communities have published lists with low water-use plants. However, consumptive water use of plants is the result of the amount of water available in the rootzone and plants often exhibit luxury consumption (high water use) when abundant water is available. Recommending certain plants must be accompanied by education measures on sufficient irrigation and/or the installation of scheduling technology that enables irrigation in adequate amounts at the appropriate intervals. Third, adopting the most efficient method of irrigation available reduces water losses significantly and can have a significant impact on water conservation efforts. Subsurface irrigation systems and micro or streaming sprinkler technology have been shown to irrigate uniformly and keep losses to a minimum. The presentation will use water conservation goals set forth by municipalities or water utilities and discuss the impact of the aforementioned strategies on meeting these goals in urban landscape irrigation.

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Existing Models for Membrane Desalination

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Poster Abstract 15

Technologies that were originally developed to desalinate water are widely applied remove salt from water supplies. Of the several available desalination technologies, two membrane processes (reverse osmosis and electrodialysis) are most widely used in the United States. Membrane distillation is another separation method that is a thermally driven in which separation is enabled due to phase change.

This study reviews the existing transport models of membrane desalination. Transport models relate fluxes through the active layers to driving forces and provide mechanistic descriptions of how material water molecules or mineral ions depend on the feed; travels from one side of the membrane to another side. Many mechanistic and mathematical models have been proposed to describe reverse osmosis membranes and one of the models proposed for describing electrodialysis is an irreversible thermodynamics model by Kedem and Katchalsky (Tanaka, 2007).

Mechanistic transport models may also be used to predict how a particular membrane will perform in a new process, or may help development of new membranes. Reverse osmosis models can be divided into three types; irreversible thermodynamics models (Kedem-Katchalsky and Spiegler-Kedem) (Kedem & Katchalsky, 1958); nonporous or homogeneous membrane models (solution-diffusion, solution-diffusion-imperfection, and extended solution-diffusion) (Wijmans & Baker, 1995); and pore models (finely-porous, preferential sorption capillary flow, and surface force-pore flow) (Sourirajan, 1970; Merten, 1966; Matsuura & Sourlrajan, 1981; Sourirajan & Matsuura, 1985). A hydrophobic membrane displays a barrier for the liquid phase, letting the vapor phase pass through the membrane's pores in membrane distillation. The driving force of the process is given by a partial vapor pressure difference commonly caused by a temperature difference (http://en.wikipedia.org).

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Overview of Desalination Technologies

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Poster Abstract 16

The objective of this work is to present an overview of current and future technologies applied in the desalination of brackish and seawater to produce fresh water for supplementing drinking water supplies. The three basic categories of water desalination are membrane technologies, thermal technologies, and chemical approaches (Younos & Tulou, 2005). Membrane technologies are the most common technology of desalination in the United States, while thermal technologies are commonly practiced in areas with abundant fossil fuel with low cost such as Middle East (Watson et al., 2003). Chemical approaches include processes such as ion exchange, which is considered impractical for treating waters with high levels of dissolved solids. Chemical approaches have the potential of implementation in future and currently are mostly under research and development for possible applications to desalination.

Membrane treatment processes can be categorized to pressure-driven and electrical-driven technologies. Pressure-driven membrane technologies include reverse osmosis, nano-filtration, ultrafiltration, and microfiltration (Duranceau, 2001). Electrical-driven membrane technologies that are effective with salt removal include Electrodialysis, Electrodialysis Reversal and Electro-deionization (Brunner, 1990). Thermal technologies are based on the concept of evaporation/distillation physical processes. These technologies are applied to desalination of seawater. Some common processes include multi-stage flush, vapor compression and some variation of those technologies. The ion exchange technologies for water treatment are often used for water softening among other applications. The ion-exchange system can best be described as the interchange of ions between a solid phase and a liquid phase surrounding the solid (Arden, 1968; Wachinski, 1997; Sengupta, 1995). Several new technologies are being researched with potential for future applications to desalination. New technologies include Membrane Distillation, Freeze Separation, Freezing with Hydrates, Vacuum Distillation are also based on thermal technology (http://en.wikipedia.org/wiki/Desalination). All of these technologies are applied as a desalination method to increase the availability of potable water.

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More Water for New Mexico

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Poster Abstract 17

The North America Water and Power Authority (NAWAPA) can provide water solutions for the North American Continent and New Mexico. NAWAPA is a North American Continent Plan for more water. NAWAPA takes fresh water that flows into the Arctic and Pacific Oceans that people don't use and transports it south to continental locations where people can use the fresh water. The project is large in scope and creates an estimated 4 million jobs that can't be exported to lower priced labor market countries overseas, because the NAWAPA creates water related infrastructure and jobs in North America. New Mexico gets jobs in the design, financing, construction, agriculture and operation of the system plus the Rio Grande River flowing full, possibly all year, and expanded agriculture and lower cost hydroelectric power. New Mexico information and the NAWAPA XXI Project are downloadable below:

> The overall NAWAPA Plan, NAWAPA XXI report 93p is at
> http://larouchepac.com/files/20120403-nawapaxxi-forweb_0.pdf
> http://larouchepac.com/node/22218
>
> For SW NM details see video minute 16:14 to minute 17:53 within
> http://larouchepac.com/nawapaxxi/feature

The 30 million acre feet of water per year enters NM from AZ via a tunnel west of Truth or Consequences, NM crossing northwest over the NM, creating new and expanding exiting water storage, then exits NM into Colorado under Raton Pass and two places south. New Mexico gains 186 miles of water tunnels, over 400 miles of water canals including a tripling of our NM irrigated land plus hydroelectric power to NM customers that currently import expensive power from Arizona.

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A Two-City Case Study in Transboundary Aquifer Management

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Poster Abstract 18

The Middle Rio Grande (MRG) basin has been identified by the Bureau of Reclamation as an area of potential future conflict because of inadequate water supplies. Climatic changes, increased populations, and increased demands for water may exacerbate the problem. Improved management of these scarce water resources, which is necessary in reducing the stress on this system, may require novel approaches. This work focuses on the potential for coordinated management between cities situated along the MRG. Following Chermak, Patrick and Brookshire (2005) we develop a dynamic game theoretic model that considers not only the benefits of the individual agents under non-cooperative and cooperative management scenarios, but also the impacts on ground and surface water resources. This model will provide the theoretical basis for a systems dynamics model (SD) for Albuquerque, which relies on surface water augmented by ground water and Rio Rancho, which relies on groundwater. From this model we will be able to consider the impact of coordinated or cooperative management, compared to the status quo of individual management plans, under various scenarios of population growth, drought, and incentives and consider the impact on the groundwater levels as well as impacts on the Compact.

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Using Electrodialysis Reversal Concentrate as Medium for Algal Biomass Production

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Poster Abstract 19

Currently, research efforts in microalgae as a feedstock for biofuel production are focused on making the process cost effective. By utilizing waste from other systems, the cost of all processes involved can be minimized. Membrane processes such as Electrodialysis Reversal (EDR) have proven to be practical and effective methods for the treatment of low quality water. For this reason, the number and scale of desalination plants are increasing to meet water remediation demand. Although EDR systems are efficient with high water recovery rates, the process does produce a waste concentrate that requires disposal. Disposal options can be costly and have negative environmental effects. Similarly, cow manure is plentiful waste product and an inexpensive nutrient source.

In this experiment, microalgae was grown in a medium of EDR concentrate and cow manure. Chlorella sorokiniana was cultured in EDR concentrate and deionized water for comparisons among different media for biomass production. The results indicate highly significant biomass increase when low amounts of manure, 1mg/l, were used in concentrate media.

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Reusing Anaerobic Digested Sludge and Desalination Concentrate as Water Media and Nutrient for Growing *D. salina* and *S. platensis*

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Poster Abstract 20

Renewable energy, microalgae is one of the world recognized oldest life forms and one of the future green energy source that will may solve issues such as energy security and CO_2 emissions. Algae are well known for their high growth rate when given the correct nutrient combination light, carbohydrate, CO_2, N, P and K and warm water. Algae can produce lipids and proteins in large amounts over short periods of time. The simple structure of Algae allows efficient converting solar energy into chemical energy.

Algae use nutrients from wastewater (such as anaerobic digested sludge) and are capable to growing in low quality land this alleviates competition with lands that are specifically used to grow food. Therefore, oil productivity from microalgae culture exceeds other oilseeds crops. For sustainable, pollution control, and cost-effectiveness, wastes need to be reuse in microalgae production.

In this study, microalgae were grown by reusing concentrate from desalination. Two species (D. salina and S. platensis) and two levels of conductivities of concentrate were used in our studies. Most of our data show longer culturing times are required for *D. salina* and *S. platensis* to reach the maximal growth due to the higher conductivities (31,800 and 25,442 μS/cm for *D. salina*; 35,900 and 21,500 μS/cm for *S. platensis*). The dry weight productions from our studies are comparable to that of the literature data where seawater and pretreated seawater; $NaNO_3$, and Zarrouk's nutrients were used.

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The Economics of Drought in the Middle Rio Grande

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Poster Abstract 21

The timing and severity of drought may severely impact water availability, especially in semi-arid climates like the American Southwest. Utilizing a Systems Dynamics model, we consider the residential water use for the cities of Albuquerque and Rio Rancho, New Mexico over a 50-year time horizon.

These two cities comprise about 30% of the state's total population and the majority of the population along the Middle Rio Grande. While they are adjacent to each other they are very different in terms of population and sources for water supply. Both cities see increasing water scarcity in the future, but are considering different ways of coping. Rio Rancho is experimenting with injection of reclaimed water into the aquifer. Albuquerque is focusing on a number of plans, including reliance on surface water with groundwater being a drought reserve. Specifically, we consider the impact of water usage in these cities under varying drought scenarios on the physical system. In our preliminary results, we find that droughts that occur in later periods when we have larger populations have larger impacts and the duration of the drought is important. This impacts not only human consumption, but also the flows in the river and the aquifer level. While alternative policies can provide some relief, the type of policy, the severity of that policy, and the timing of drought are important - as may be the form of economic growth in an area. We estimate economic impacts of the alternative scenarios.

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Estimated Probability of Postwildfire Debris Flows in the 2012 Whitewater-Baldy Fire Burn Area, Southwestern New Mexico

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Poster Abstract 22

In May and June of 2012, the Whitewater–Baldy Fire burned approximately 300,000 acres of the Gila National Forest, in southwestern New Mexico. The burned landscape is now at risk of damage from post-wildfire erosion, such as that caused by debris flows and flash floods. A pair of empirical hazard-assessment models developed using data from recently burned basins throughout the intermountain western United States was used to estimate the probability of debris-flow occurrence and volume of debris flows along the burned area drainage network and for selected drainage basins within the burned area. The models incorporate measures of burn severity, topography, soils, and storm rainfall intensity to estimate the probability and volume of debris flows following the fire. A combined hazard ranking was also developed for selected drainage basins incorporating the predicted probability and estimated volume for those basins.

In response to the 25-year-recurrence, 30-minute-duration rainfall, modeling indicated that 24 basins, 19 percent of the total, have high probabilities of debris-flow occurrence. High probability basins were concentrated in the west and central part of the burned area, including tributaries to Whitewater Creek, Mineral Creek, and Willow Creek. Estimated debris-flow volumes ranged from about 3,000–4,000 cubic meters (m^3) to greater than 500,000 m^3 for all design storms modeled (including the 2-year and 10-year recurrence storms). Basins with the highest combined probability and volume Relative Hazard Ranking include tributaries to Whitewater Creek, Mineral Creek, Willow Creek, West Fork Gila River, West Fork Mogollon Creek, and Turkey Creek.

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Surface Water and Groundwater Interactions in Semiarid Irrigated Floodplains of Northern New Mexico

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Poster Abstract 23

Deep percolation from irrigation can provide a significant amount of aquifer recharge in alluvial floodplains. A better understanding of surface water and groundwater interactions in irrigated floodplains is needed for properly assessing the mechanisms of water transport through the vadose zone and for estimating potential aquifer recharge from deep percolation in these systems. Primarily based at the NMSU-Alcalde Science Center in Alcalde, NM, we are conducting a study aimed to quantify different components of the water budget in different crop fields with alluvial soils. We are conducting several studies on different crops (alfalfa, grass hay, strawberry, and jujube) with different irrigation techniques (flood, sprinkler, and drip) to characterize changes in soil water storage, water movement through the vadose zone, and shallow groundwater level rise in response to deep percolation from irrigation. We have instrumented these crop fields to measure total amount of water applied, changes in soil moisture, and drainage below the root zone. In addition, we have installed and instrumented different monitoring wells to track water table fluctuations in response to irrigation deep percolation. Climate data from nearby, previously installed, weather stations are being used to calculate evapotranspiration. Preliminary results show a relatively rapid movement of water through the upper 50 cm of the vadose zone for crops irrigated under flood and under sprinkler conditions. Results from this study can contribute to the better understanding of the surface water and groundwater interactions in floodplain irrigated valleys of northern New Mexico under different irrigation techniques.

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Concentrate Management Strategies for Inland Desalination

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Poster Abstract 24

Ninety-six percent of municipal desalination plants in the United States are located inland[1], where increasing challenges to concentrate management have resulted in high-recovery and zero liquid discharge (ZLD) systems recently being considered for many municipal applications[2]. In various inland locations in the United States, conventional concentrate management options are not cost-effective and thus, desalination plants are not being built[2]. This is particularly problematic in the inland arid southwestern portion of the United States, where both surface water disposal and disposal to publicly owned treatment works are limited[2].

However, the economic future of the arid Southwest will demand some combination of water conservation, recycling, and the creation of "new water" from the extensive brackish water resources available in the area[3]. It is estimated that 75% of the groundwater in New Mexico is too saline for most uses without treatment[4], and that these large volumes of once-ignored saline/brackish water could provide much needed relief to existing fresh water supplies[5]. As the costs associated with concentrate disposal may be the biggest roadblock to widespread inland desalination[3], [6], it is necessary to investigate the best practices for concentrate management. Conventional options for inland concentrate management include:

- Disposal into surface water bodies
- Disposal to municipal sewers
- Evaporation ponds
- Deep well injection
- Irrigation of plants tolerant to high salinities (halophytes)

Where the main factors that influence the selection of a disposal method are:

- Volume of concentrate
- Quality of concentrate (especially considering heavy metals and chemical additives)
- Physical and geographical considerations
- Capital and operating costs
- Possible future expansion/reduction of the facility
- Public acceptance

A systematic approach to determine the best practices for concentrate management, while simultaneously pursuing technologies with high-recovery capabilities, will enable arid inland regions to explore the potential for desalinating their brackish water supplies.

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Comparison of Optimization Methods for Multipurpose Reservoir Management

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Poster Abstract 25

Water resources projects in arid regions are critical to the health, safety, economic development, and environment in which project beneficiaries live. Such projects consist of physical infrastructure and operations, which can lead to very complex and competing management decision criteria. Various methods for identifying optimum management strategies and decisions have been developed over the years, with Linear Programming (LP) making early inroads, and more sophisticated approaches such as Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) allow more complex and realistic objective functions and constraints to be implemented.

This poster examines the application of GAs and PSO to the Zyandeh Rood River in central Iran. A major multipurpose reservoir on the river controls water for municipal/industrial purposes, irrigation, and hydropower generation. Optimizing the total economic benefits to the system users using GAs and PSO allows for comparison of the performance and optimum solutions for the two methods, and demonstrates their utility. Such methods may be applicable to river/reservoir systems in the United States, including the Rio Grande.

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Can Clinoptilolite Zeolite Conserve Nitrogen Fertilizer in Agricultural Loamy Sand Soils?

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Poster Abstract 26

In southern New Mexico, large agricultural areas composed of sand and sandy loams require numerous nitrogen fertilizations per season to meet crop nutrient needs. However these areas are prone to leach large amounts of nitrogen to shallow groundwater. The objective of this study was to investigate the effects of applying CZ to sandy soils to the retention and transport of nitrate-nitrogen (NO_3—N) and ammonium-nitrogen (NH_4+–N). Adsorption and leaching experiments were carried out by applying a nitrogen fertilizer solution (Urea-ammonium-nitrate, UAN®32) to four soil treatments to simulate crop irrigation. The treatments were composed of 100% CZ, 100% loamy sand (LS), a mixture of 80%:20% (LS:CZ), and a mixture 60%:40% (LS:CZ) by mass, respectively. Results from the experiments showed an inverse relationship between NO_3–N adsorption and the amount of CZ added to soil caused by anion exclusion, and a direct relationship between NH_4+–N adsorption and the amount of CZ mixed with LS due to ion entrapment by the CZ molecules. Except at the highest nitrogen solution concentration used in the experiments, there was no significant difference in NO_3–N and NH_4+–N adsorption between the two soil mixtures; 80%:20% and 60%:40% (LS:CZ). It is recommended that other types of fertilizers that do not include NO_3–, such as ammonium sulfate ($(NH_4)_2SO_4$), be used in LS soils amended with CZ to reduce the risk of leaching. Otherwise, fertilizers containing ammonium nitrate could be applied to LS soils amended with CZ at reduced rates but at higher frequencies to meet plant demands.

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Restoration of Riparian Vegetation Using Geo-Engineering Material

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Poster Abstract 27

Hydrologic alteration and operation of the Rio Grande have contributed to unsuccessful riparian vegetation restoration attempts by local, state and federal organizations. These alterations have allowed exotic invasive species such as saltcedar (Tamarix spp.) to spread and dominate riparian plant communities in the southwestern United States. A pilot study was conducted at a saltcedar-managed area near Caballo, New Mexico to investigate the use of geo-engineering, clinoptilolite zeolite (CZ), as a wicking material to restore native vegetation. In January 2012, a total of 104 CZ boreholes were drilled and installed in two 60 ft x 60 ft plots at Caballo Test Bed site. In March of the same year selected native riparian plants were transplanted into the CZ cores, and control individuals were transplanted into in-situ riparian soil (RS). During June and July of 2012, vegetation survival and growth, groundwater levels, water and soil chemistry, soil moisture, and climate data were collected and analyzed to evaluate the success of the restoration. The climate was dry and hot, precipitation was low (0.34 in), and depth to groundwater (DGW) was about 2.6 m. Plant survival for the CZ cores in Plot 1 was 37.5% versus 50% in the RS cores while Plot 2 had a survival percentage of 66% in the CZ cores compared to 59% in RS cores. In Plot 1, the decrease in the groundwater and moisture levels caused low unexpected survival rates for CZ. The study is still in progress to determine the final establishment rates for transplanted vegetation.

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Managed Riparian Zones to Conserve and Improve Water Quality and Improve Habitat

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Poster Abstract 28

Managing natural systems has always been a challenge to water resource managers and decision makers in an effort to conserve water, improve water quality, and improve habitat. However, there are no current predictive management techniques that quantify the economic and ecosystem benefits of utilizing native vegetation to conserve water, improve water quality, and restore habitat from high water consuming invasive and non-native vegetation. Extensive restoration efforts in fully-appropriated stream systems suffer from an inability to demonstrate a decrease in depletions resulting from the restoration efforts. This research investigates the use of low water consuming native vegetation and geo-engineering technique to reinvent current storm water conveyance and detention systems in urban settings however it is in its preliminary stage. The following is in progress: i) measurement of evapotranspiration depletion by invasive non-native vegetation (*Tamarix spp*.) and native saltgrass (*distichlis spicata*), ii) monitoring of depth to groundwater table using a network of piezometers, iii) regular measurement of groundwater, river water, and soil quality, iv) testing of riparian restoration using geo-engineering material, and v) monitoring of micro-climate.

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Water Use by Managed Saltcedar Area at the Caballo Reservoir, New Mexico

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Poster Abstract 29

Evapotranspiration (ET) of saltcedar managed by mowing at a riparian region near Caballo Reservoir in New Mexico was measured during the peak of the growing season in June and July of 2012. Saltcedar was mowed in July of 2011 and allowed to grow during the 2012 season. Saltcedar grew vigorously from about 30 cm, when it was mowed, to about 183 cm. Using the energy budget method and utilizing eddy covariance technique, net radiation (Q), soil heat flux (G) and sensible heat (H) were measured. Latent heat (LE) was determined as a residual. Then LE was converted to equivalent depth of water (or ET) using the latent heat of vaporization of water (2.45 MJ/kg). ET measured from June 21 through July 19, 2012 (29 days) was 150 mm (LE = 367 MJ/m^2). The groundwater table was about 1.83 m deep from ground surface. The electrical conductivity (EC) and Total Dissolved Solids (TDS) of saturated soil paste extract (1 soil: 5 distilled water) measured at the site varied with depth. The highest EC of 4,523 μS/cm and TDS of 2,426 mg/L were observed at 15.2 cm depth. The average ambient temperature was 27°C with the highest temperature reaching 39°C. The average relative humidity was 38% during the 29 days with lowest observed humidity of 6% and a maximum of 93%.

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RO / NF Applications in Brackish Water Desalination: Membrane Characterization and Hybridization with EDR

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Poster Abstract 30

The fresh water supply is a source of great concern due to the increase in earth's population and maybe the cause of future conflicts over the rights to bodies of water. Water shortage and scarcity pose significant threats for developing countries since desalination technologies are expensive. As a result, there is much interest in reducing the costs of water desalination. In all around the world, waters sources include oceans, brackish waters, and wastewaters. But, brackish water is used as the most common source in New Mexico. The most common brackish water quality problems are caused by suspended solids and hardness. Both problems respond to inexpensive treatment methods.

Reverse osmosis (RO) is one of the technologies used for desalinating brackish and saline waters to provide drinking water. RO treatment plants use semipermeable membranes and pressure to separate salts from water. With the progress of membrane science, RO overtook multi stage distillation as the leading desalination technology. In the last two decades, RO processes had significant progress, allowing new brackish groundwater desalination facilities to use RO technology much more economically than distillation. These systems typically use less energy than thermal distillation, leading to a reduction in overall desalination costs.

The focus of this study is in two parts. First is, studying the characterization of different types of membranes used in RO systems. The objectives are accomplished by utilizing pilot plant experiments. The experiments are designed to test the effect of Recovery, Permeate Flow, Inlet pH, and Inlet Conductivity on Permeate and Concentrate Conductivity, Primary Pressure, and Bank one Permeate Flow. A huge database collected from a full pilot-scale system, located at the Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, NM, and operated by New Mexico State University, are going to be analyzed.

Second part is to combine pressure driven systems, like RO/NF, with electric driven ones, like EDR, find out the stability of hybrid systems, and try to develop a cost model for them. In order to get to this approach we are running such systems in a pilot plant for about 300 hrs. Then, to model the hybrid system, we use WinFlows for RO and WATSYS for EDR. At the end of modeling, applying mass balance, we can get to the product and concentrate blowdown streams specifications. Of course, there are different scenarios of hybridization. We choose couple of these scenarios worthwhile to examine to do the experiments.

This study improves the benefits of using RO by reducing the cost, time, and energy spending to find the best approach for different conditions.

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