Colorado Water Institute

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Activities and Impact Report

November 1, 2010 through October 31, 2011

Colorado State University

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CWI Advisory Committee Agenda
Denver Water Board Room

November 4, 2011
9:30 AM – 1:00 PM

Denver Water
1600 West 12th Avenue
Denver, Colorado 80204
303-628-6000

9:30 AM	Welcome & Introductions
9:40 AM	Update on CSU Water Initiative – Lou Swanson (CSU Vice President for Engagement)
10:00 AM	Research Report – Brian Bledsoe (Colorado State University)
10:20 AM	Research Report – Douglas Kenney (University of Colorado)
10:40 AM	Research Report – Balaji Rajagopalan, Jeffrey Lukas and Lisa Wade (University of Colorado)
11:00 AM	Discussion Items • Select Student Research Project • Current Research Portfolio • Rocky Ford Lysimeter • Water Science Day
12:00 PM	Working Lunch – Advisory Committee Input on CWI Activities and Programs
1:00 PM	Adjourn

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On the cover: Colorado State University Civil and Environmental Engineering Professor Timothy Gates and undergraduate student Justin Kattnig collect a water sample from Clear Creek, July 5, 2011 as a part of as a part of Gates's Arkansas River basin monitoring and modeling project.

Photo By Bill Cotton

Current Research (Active Projects During 11/1/2010 - 10/31/2011)

Investigator	FY	Org	Type	Project Title	Total
	FY09				
Sommers, Lee		CSU	Faculty	Determination of Consumptive Water Use by Alfalfa in Arkansas Valley	$ 300,000
Waskom, Reagan		CSU	Faculty	CWCB/CWI Cooperative Intern Program	$ 100,000
Neupauer, Roseanna		CU	Faculty	Adjoint Modeling to Quantify Stream Flow Changes Due to Aquifer Pumping	$ 117,847
	FY10				
	FY11				
Alia Khan *(McKnight)*		CU	Student	Novel Technique for Evaluation of Dissolved Organic Material (DOM); research methodology and lab protocol developmer	$ 4,500
Victor Sam *(Omus-Ozbek)*		CSU	Student	The Efficacy of the Use of Moringa Oleifera Seeds to Remove Metabolites of Cyanobacteria from Drinking Water	$ 4,980
Cheryl Holling *(Heuvel)*		CSU	Student	Wastewater Treatment Plant End Products Deliver Xenobiotics to Colorado Reclamation Sites: The Effect of Arbuscular My	$ 5,000
Evan Rambikur *(Chavez)*		CSU	Student	Large Aperture Scintillometers for Evapotranspiration (ET) evaluation	$ 4,740
William Christman *(Lehmpuhl)*		CSU	Student	Development and Validation of a Sediment Signature Approach Using ICP-MS in the Fountain Creek Watershed	$ 4,950
Meagan Smith *(Arabi)*		CSU	Student	Environmental Impacts of Ag-to-Urban Water Rights Transfers in the South Platte River	$ 5,000
Umit Duru *(Wohl)*		CSU	Student	Variables Controlling Reservoir Sedimentation in the Colorado Front Range	$ 5,000
Anne Maurer *(Sale)*		CSU	Student	Aquifer Storage and Recovery Optimization	$ 5,000
Balaji, Rajagopalan		CU	Faculty	Paleohydrology of the Lower Colorado River Basin Yr.2	$ 29,964
	FY12				
Jeremy Sueltenfuss *(Knight)*		CSU	Student	Ecosystem Services, Biodiversity, and Irrigation Inefficiencies Year2	$ 25,000
				Total	**$ 611,981**

Adjoint Modeling to Quantify Stream Flow Changes Due to Pumping

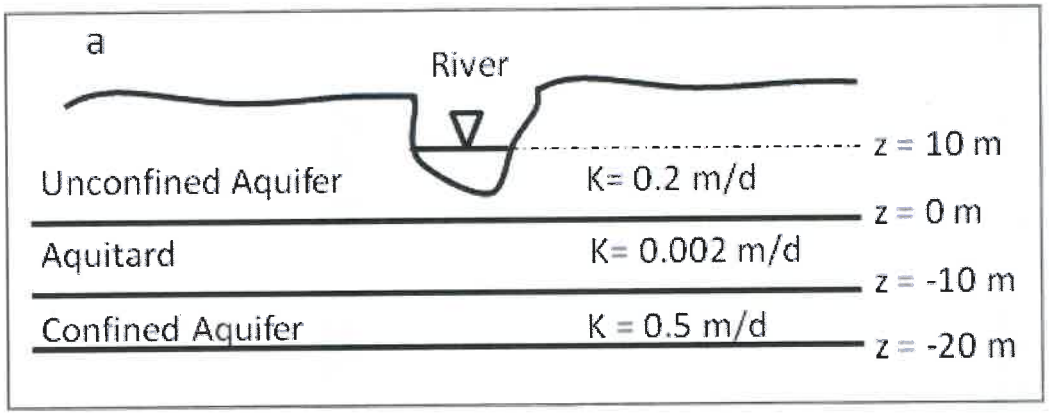
Roseanna M. Neupauer, Associate Professor, University of Colorado

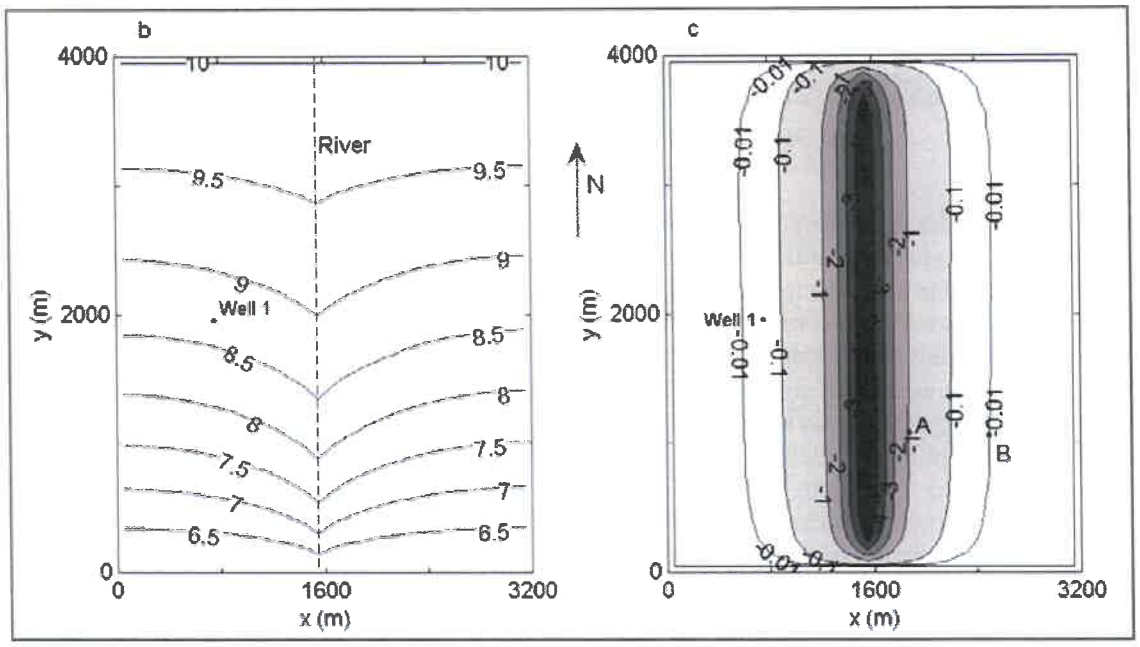
In Colorado, groundwater that is extracted from pumping wells is subject to water rights unless demonstrated to be non-tributary groundwater, which is defined as groundwater that, if extracted, will not deplete a stream by more than 1/10 of one percent of the annual withdrawal rate in any one year period within one hundred years. Groundwater modeling is typically used to determine whether or not groundwater can be considered as non-tributary. The approach is to first simulate conditions in the stream-aquifer system in the absence of pumping to quantify the stream flow rate under natural conditions, and then to simulate conditions with pumping for a 100-year period to quantify the stream flow rate when the well is pumped. If the depletion in the stream flow rate never exceeds 1/10 of one percent of the pumping rate, the groundwater that is withdrawn from the well is demonstrated to be non-tributary groundwater.

The approach described above is applicable if the pumping well under consideration is already in place or if the well location is already chosen. If the well location has not yet been chosen, it may be desirable to install the well where it will have little impact on stream flow, i.e., where it will pump non-tributary groundwater. For this situation, the modeling approach described above is inefficient, because one simulation must be run for each potential well location. We are developing a new modeling approach that solves directly for the change in stream flow or stream volume due to pumping from a well at any location in an aquifer. With this approach, the model results will identify locations where a well can be installed to ensure that pumping has minimal impact on stream flow.

The model development is being conducted by Scott Griebling, a graduate student in the Civil, Environmental, and Architectural Engineering Department at the University of Colorado, under the supervision of Roseanna Neupauer. Using adjoint theory on the governing equation for groundwater flow, we have developed the adjoint equations that describe changes in stream volume or stream flow rate as a function of time due to pumping at a well at any location in the aquifer. We have identified several scenarios for which these adjoint equations have the same form as the groundwater flow equations, and therefore can be solved with standard groundwater flow models, such as MODFLOW. We have also identified several scenarios for which these adjoint equations are similar but different from the groundwater flow equations, so we are developing approaches to use standard groundwater flow models to solve these adjoint equations.

Figure 1. Aquifer system used in the example. (a) Cross-sectional view. (b) Plan view. The northern and southern boundaries are constant head boundaries, and the east and west boundaries are no flow boundaries. The river stage and bottom elevation are 10 m and 5 m, respectively, along the entire river length. The contour lines represent head (in m) in the unconfined aquifer in the absence of pumping. (c) Stream depletion as a percentage of the pumping rate for a well installed at any location in the aquifer. Units are dimensionless.





Here we provide an example of the former scenario. We use the hypothetical aquifer system shown in Figure 1. The system is comprised of an unconfined aquifer, an aquitard (a bed of low permeability adjacent to an aquifer), and a confined aquifer, with a river running from north to south in the unconfined aquifer. The aquifers and aquitard are assumed to be homogeneous (hydraulic conductivity values shown in Figure 1a). Flow in this system was simulated using MODFLOW with the RIV package to simulate interaction between the river and the aquifer. The results show that in the absence of pumping, the flow rate of water from the river into the unconfined aquifer is approximately 4200 m^3/yr. Using standard simulation methods, we also simulated flow in the system when Well 1 is pumped at a rate of 3650 m^3/yr in the confined aquifer. When a well is pumped, head is lowered in the aquifers, and additional water is drawn out of the river. For example, results of the standard simulation show that after five years of pumping at Well 1, stream flow in the river is depleted by 1.24 m^3/yr, or about 0.034% of the withdrawal rate.

We have found that we can use MODFLOW with the RIV package to solve directly for the stream depletion caused by pumping at any location in the aquifer. The only new assumption that must be made is that the change in head in the unconfined aquifer is small relative to the saturated thickness. Figure 1c shows a plot of stream depletion as a percentage of pumping rate for any location in the confined aquifer. The results are shown after five years of pumping. For example, if a well is installed at Point A in Figure 1c, approximately 1% of the water that is pumped in Year 5 will come from depletion of the river. This exceeds the criterion for non-tributary groundwater, so if a well were installed at Point A, it would pump tributary groundwater that would be subject to water rights. Similarly, if a well were installed at Point B in Figure 1c, approximately 0.01% of the water that is pumped in Year 5 would come from depletion of the river; making this a candidate well location. As a verification of these results, note that the stream depletion due to pumping at Well 1 is approximately 0.034% of the pumping rate, which is equal to the value obtained from the standard simulation method.

A well installed near the river will cause more stream depletion than a well is installed farther away. For example, at (x,y)=(1600m, 2000m) in Figure 1c, which is near the river, stream depletion is approximately 5% of the pumping rate; however, at Well 1, which is farther away from the river, stream depletion is much lower.

The model results show essentially no stream depletion for a well near the northern or southern boundary. In the model, these boundaries are simulated as constant head boundaries, so they can provide an unlimited supply of water to the aquifer; therefore, a well near these boundaries will draw most of its water from outside of the model domain and relatively little from the river. If the constant head boundary is not physically realistic, the model results may not meaningful near the boundary.

This example demonstrates that with a single simulation of MODFLOW, we can determine stream depletion for pumping at any location in the aquifer. The model results can be used to choose a well location that will minimize the impact of the well on surface water flows. The method has been developed and demonstrated for a single well in a confined aquifer. Additional work is being conducted to address other scenarios.

Balaji Rajagopalan — Paleohydrology of the Lower Colorado River — $29,964

Environmental and Architectural Engineering
University of Colorado

The State of Colorado draws a substantial portion of its water supply from the Colorado River. The reliability of this supply is a function of natural hydrologic variability, upon which anticipated changes in future climate will be superimposed. Thus, it is extremely important to understand the range of this natural variability in the basin streamflows so as to obtain a robust estimate of the water supply risk and consequently, devise effective management and planning strategies. Observed flow data that are limited in time (~100 years) cannot provide the full range of variability, even with stochastic models built on them. Paleohydrologic reconstructions of annual flow using tree rings, however, provide much longer (500-1000+ years) records of past natural variability, and thus a much richer sampling of potential flow sequences, including severe and sustained droughts of greatest concern to water resource managers. Such reconstructions are available for the combined Upper Colorado River basin flows, but there is no equivalent dataset for the Lower Basin. In this research we propose to develop a paleohydrologic reconstruction of the total Lower Basin streamflow. We will use all the existing tree-ring data and naturalized streamflow records, with a suite of statistical methods. The reconstructions from the different methods will be combined to provide an ensemble of flows in each year, thus providing an effective characterization of the uncertainty. A rich variety of streamflow ensembles will be generated for the entire basin using this and existing reconstructions for the Upper Basin to explore the basin-wide water supply risk, focusing on implications for the water resources of the State of Colorado.

Statement of the results or benefits: The principal dataset generated by this study will be time-series of annual flows, extending back at least 500 years before ~2002, for gage locations which in sum represent the runoff for the Colorado River between Lees Ferry and the Northern International Boundary. These annual flows can then be used, either alone or in combination with the equivalent datasets for the Upper Basin, in further analyses and as inputs to water system models (e.g., Reclamation's CRSS model), to assess water supply vulnerability and risk for the Colorado River Basin and the State of Colorado's share of basin water supply. In fact, the third objective of this project (see below) is to use the reconstructed flows in exploratory analyses for risk assessment. We anticipate that the new flow reconstructions would also be used by other investigators for further modeling and analyses, as with previous paleo-reconstructions for the Colorado River Basin.

Nature, scope and objectives of the project: The natural flow of the Colorado River at the NIB is effectively the sum of three components: (1)The Upper Basin natural flows: the Colorado River at Lees Ferry, AZ (2) Intervening natural flows on the mainstem between Lees Ferry and Imperial Dam (including tributary flows from the Little Colorado R., Bill Williams R., Virgin R., and others) (3) The natural flows of the Gila River at its confluence with the Colorado between Imperial Dam and the NIB.

Component (1) has already been reconstructed using paleohydrologic methods (Woodhouse et al. 2006, Meko et al. 2007). Components (2) and (3), which constitute the Lower Basin flows, have been partially addressed with previous paleohydrologic work (see Related Research, below), but have not reconstructed in their entireties so as to allow the summation of paleo-flows for the Lower Basin and the entire Basin. Thus, the scope of this project is the generation of paleohydrologic reconstructions of annual flows for the intervening flow between Lees Ferry and Imperial Dam (2) and the Gila at its mouth (3). The climatological and hydrologic characteristics of the basins that contribute to (2) and (3) are sufficiently different that they will be reconstructed separately. The main objectives of this proposal are (i) to develop paleo-reconstructed annual streamflows of the Lower Basin (2 and 3) using all available tree ring chronologies using a suite of statistical techniques, (ii) disaggregate these flows to other locations on the river in the lower basin and (iii) demonstrate the utility of the reconstructed flows in water resources management and system risk estimation in the entire basin.

Budget: $29,964

John E. McCray — Water Quality Impacts of the Mountain Pine Beetle Infestation in the Rocky Mountain West: Heavy Metals and Disinfection Byproducts— $140,162

Hydrologic Science and Engineering Program
Colorado School of Mines

Abstract: The Mountain Pine Beetle (MPB) is the primary cause of insect-induced mortality in pine forests in western North America. The MPB's range encompasses most of western North America, from the Mexico to British Columbia, and from the Pacific Coast to South Dakota. The Rocky Mountains are the source-water region for more than 60 million people. The current epidemic is severe: lodgepole forests are expected to experience more than 90% tree mortality. Two important potential watershed impacts are changes in the hydrologic cycle and water quality. While impacts on the hydrologic cycle have received considerable attention; the impacts of this phenomenon on water quality are not well understood.

This proposal addresses two potential MPB impacts on water quality: increased metal concentrations with ecotoxicological and human health ramifications and the potential formation of disinfection byproducts (DBPs) in downstream drinking water supplies.

Dissolved organic carbon (DOC) increases in waters below impacted pines forests are expected based on fundamental biogeochemical mechanisms resulting from sources such as tree stress, litter fall, and decay. This increased DOC can result in enhanced metal transport to natural waters as well as increased potential for the formation of DBPs (e.g., trihalomethanes and nitrosamines) during disinfection of natural waters used for drinking water supplies. Municipal water suppliers are concerned about the impact of MPB infestation on drinking water quality and the potential need for costly treatment process modifications to meet public health mandates. These concerns persist over the entire Rocky Mountain West, but are currently based on anecdotal evidence that has not been sufficiently analyzed and documented using systematic and mechanistic studies.

The proposed research strongly addresses the NIWR research priority regarding vulnerability and resilience assessment of public water supplies. Specifically, results from this project will enable water managers to better understand the vulnerability of their water supplies to MPB outbreaks and implement a plan to ensure current and future resilience of the water supplies.

The proposed research aims to answer 3 primary questions with an integrated approach that includes synthesis and analysis of data collected by municipal water suppliers over the past fifteen years, a field investigation, and supporting laboratory experiments. These questions are as follows: (1) can DBP formation potential and metal loading be estimated based on forest, hydrologic, geographic or geologic factors that represent the watershed's vulnerability (or resiliency) to MPB impacts; (2) will surface waters associated with MPB impacted lodgepole pines will see an increase in TOC and DBP formation potential that corresponds with the degree of infestation and tree mortality; (3) do soils associated with MPB-impacted trees have an increased potential for metal leaching and release of DOC than will soils associated with healthy lodgepole pines?

This research proposal represents a strong collaboration with an existing USGS study in Rocky Mountain

National Park (RMNP) related to hydrologic and water quality impacts (primarily nutrients) associated with MPB infestation. If funded, the research will provide training for a PhD graduate student, an early-career professor, 6 non-thesis MS students, and approximately 60 undergraduates. A well-rounded plan is provided for transferring results to the science community, water managers, and the public, including K-12.

Budget: $140,162 from 104G Competitive Grants

Rick Knight — Ecosystem Services, Biodiversity and Irrigation Inefficiencies (Year 2) — $25,000

Human Dimensions of Natural Resources
Colorado State University

Abstract: In order for agriculture to be successful in northern Colorado's semi-arid environment, irrigation canals have been in place for over 100 years to deliver a limited supply of water to water deficit lands. Due to the high amount of water that is lost through seepage, canals are often blamed for being "inefficient." These seepages are the center of debate between economists, managers, regulators, irrigators and environmentalists who argue that leakage results in wasted water which could be put to better use. As cities along the Front Range continue to increase in population, water transfers from agriculture to urban areas are expected to rise dramatically, consequently drying up many irrigation canals. I set out to challenge the notion that canal seepage leads to water that is truly lost by looking at the role of these seepages in creating wetlands. Wetlands are a supply of many important ecosystem services and are a limiting factor for many species in the west. Over the 2011 irrigation season, I mapped all the wetlands and characterized their vegetation within the boundary of the North Poudre Irrigation Company (NPIC) located in Larimer County, Colorado. To look for possible hydrologic connections between wetlands and irrigation canals, I installed 72 groundwater monitoring wells and six further pressure transducers in 21 wetlands across the NPIC area to monitor fluctuations in groundwater. These fluctuations in wetland groundwater were compared to daily records of adjacent canal flow. To provide further evidence of a hydrologic connection between wetlands and adjacent irrigation canals, water samples from 40 wetlands and each associated canal were collected and analyzed for their stable oxygen isotope ratio of $\delta 18O/ \delta 16O$. Ten of these samples were further analyzed for total ion and cation makeup. A total of 182 wetlands with a total area of 1,300 acres were mapped across the NPIC area. Preliminary results from groundwater wells show that the groundwater in many of the study wetlands respond to fluctuations in canal flow. Wetland groundwater levels showed a dramatic rise once the canals started transporting water at the beginning of the irrigation season. If wetlands across the NPIC area are hydrologically connected to irrigation canals, it can be argued that many wetlands across the irrigated regions of Colorado may show a similar trend. If this is the case, future water transfer locations should be carefully thought out to mitigate wetland loss due to the drying of irrigation canals.

Budget: $25,000

Scott Nissen — New Methods for Sago Pondweed Management — $10,000

Bioagricultural Sciences and Pest Management
Colorado State University

Sago pondweed (*Stuckenia pectinata*) is a submerged, perennial aquatic species that is native to Colorado. When present in standing water, sago pondweed is not usually problematic; however, irrigation canals across Colorado provide optimal growing conditions for sago pondweed. When sago pondweed is present the efficiency of water delivery can be severely impacted. Sago pondweed reaches maximum growth in July and August when water demand is highest.

Common control methods in Colorado include acrolein (Magnacide) applications and canal dredging. These methods are expensive and in the case of acrolein, very dangerous for applicators. Since current methods are limited, alternative control strategies are needed to provide water districts with additional tools for sago pondweed management in irrigation canals.

Previous studies have indicated that several aquatic herbicides have synergistic effects when applied to submerged aquatic plants. When copper sulfate pentahydrate (CSP) was combined with endothall or diquat there appeared to be a synergist interaction with respect to hydrilla (*Hydrilla verticillata*) control. Diquat and several copper formulations are currently registered for the sago pondweed control in irrigation canals, and endothall will be registered by spring 2010. While these compounds are registered for sago pondweed control, they provide only marginal control much of the time. The objective of this study will be to determine if combinations of diquat and endothall with copper formulations will provide better control compared to the herbicides applied individually.

Greenhouse studies will be conducted to evaluate control using combinations of endothall, diquat, copper sulfate pentahydrate, and four chelated copper formulations. Sago pondweed tubers will be planted in topsoil and allowed to produce approximately six inches of top growth. Plants will then be transferred to simulated irrigation canals (Shown in Figure 1) to simulate the forces of flowing water, and treated with these herbicides applied alone and combination. Plants will exposed to the herbicides for 2, 4, 6, and 8 hours. Following herbicide treatment plants will be rinsed in clean water and then place in clean water in the simulated canals. This will be followed by a 30 day grow-out period. After the grow-out period, plants will be harvested, dried, and biomass will be recorded. Data will then be analyzed and the effectiveness of herbicide combinations compared.

If any of the herbicide treatments appear synergistic they may provide a new alternative for the sago pondweed control in irrigation canals. In addition to providing better control, the combinations may reduce the required exposure time and may also provide lower cost alternatives compared to the current control methods.

Budget: $10,000

Student Funded Projects

This program is intended to encourage and support graduate and undergraduate research in disciplines related to water resources and to assist Colorado institutions of higher education in developing student research expertise. The purpose of the funding is to help students initiate new research projects or to supplement existing student projects focused on water resources research. The FY 11 funded projects and funding recipients are listed below:

Alia Khan — Novel Technique for Evaluation of Dissolved Organic Material (DOM): research methodology and lab protocol development using a FluidImages Flowcam on lake water samples across the state of Colorado — $4,500

Civil and Environmental Engineering
University of Colorado (Boulder)

Abstract: Previous research suggests that production of nonhumic DOM can be related to chlorophyll-a concentrations. In recent years, increases in dissolved organic carbon (DOC) concentrations in surface waters have been documented in many northern temperate regions and the underlying processes of the affects of increasing DOC on aquatic ecosystems and drinking water quality are not yet fully understood. Furthermore, DOC has been directly correlated to the formation of potentially carcinogenic, chlorinated disinfection by-products (DBP's). Characterization of the relationship between varying DOC qualities (such as terrestrial versus humic, or certain types of algal species) to DBP formation is not yet fully understood. Part of this reason is due to the complexity and time consumption for source identification of DOC quality.

Budget: $4,500

Victor Sam — The Efficacy of the Use of Moringa Oleifera Seeds to Remove Metabolites of Cyanobacteria from Drinking Water — $4,980

Civil and Environmental Engineering
Colorado State University

Abstract: The proposed work aims to study the occurrence and removal of the cyanobacterial metabolites microcystin-LR, geosmin and 2-MIB in source waters (1,2). Microcystins are potent hepatoxins which can cause severe cases of gastro-enteritis and hepato-enteritis (i.e. liver damage) (3,1). Geosmin (trans-1,10-dimethyl-trans-9-decalol) and 2-MIB (2-methylisoborneol) are odorous compounds that causes earthy and musty odors in drinking water, respectively (2). Recently it was shown that microcystins usually co-occur with such taste-and-odor compounds (4). Since geosmin and 2-MIB can be detected by the human nose at very low concentrations (2), the surveillance of harmful toxins may be easily performed due to the co-occurrences of the metabolites.

Currently, there is not a cost-effective and sustainable method to treat source water for these detrimental metabolites. That is why the moringa oleifera tree seed will be studied in this project for its ability to treat water. The moringa oleifera seed has already been used for many purposes in third world countries, serving as a source of food, medicine, and more recently an effective coagulant for water treatment. The seed, which is grown in most parts of the world, eliminates the addition of synthetic chemicals (5).

Budget: $4,980

Cheryl Holling — Wastewater Treatment Plant End Products Deliver Xenobiotics to Colorado Reclamation Sites: The Effect of Arbuscular Mycorrhizae on Native Plant Uptake of Human Pharmaceuticals— $5,000

Environmental Biology
Colorado State University (Pueblo)

Abstract: Waste water treatment plants (WWTPs) produce enormous quantities of treated waste water and solid phase end products. Finding beneficial uses for the waste water and biosolids formed from sewage sludge is a high priority for WWTPs, government agencies and communities. In southeast Colorado, WWTP biosolids have been applied to rangeland, sand dunes and croplands to enhance vegetative growth.

WWTP effluent and biosolids harbor many persistent anthropogenic organic contaminants, one class of which includes human prescription drugs excreted or directly flushed into the waste water system. Studies have demonstrated antidepressants, mood-altering drugs, and antibiotics taken up into plant tissues when food plants are grown in contaminated soil. Biosolids from WWTP with their inherent contaminant load are applied at reclamation sites such as mines or burn areas to increase vegetation cover quickly in order to begin ecosystem recovery, stabilize soils, and prevent erosion into nearby surface water.

Most native Colorado plants that grow on rangelands and in reclamation areas have beneficial fungal infections in their roots. The mycorrhizae extend the rhizosphere of native plants growing in minimal soils and enhance nutrient and water uptake. We want to investigate the differential uptake, by Colorado native plants, of the human pharmaceutical carbamazepine (CBZ), commonly found in WWTP biosolids and heavily applied in reclamation areas.

Budget: $5,000

Evan Rambikur — Large Aperture Scintillometers for Evapotranspiration (ET) Evaluation— $4,740

Civil and Environmental Engineering
Colorado State University

Abstract: Irrigation water management can be more effective and accurate when the crop consumptive use (CU), or ET, is known. This allows for more intelligent application of water by irrigators in arid and semi-arid regions. This is one reason for much needed research on different methods of evaluating ET. Local estimates of ET can be made directly by precision-weighing lysimeters. In addition, through measurement of the structure parameter of the refractive index of air (turbulence), the sensible heat flux, and subsequently ET, can be determined using a Large Aperture Scintillometer (LAS, Kipp and Zonen, The

Netherlands) and the land surface energy balance (EB) equation. This LAS-EB method allows for spatially averaged estimates of crop or vegetation ET over a range of approximately 100m to 4.5km.

Therefore, the instrumentation can potentially be validated by point estimates of ET (e.g. Lysimeter) and used to validate regional estimates of ET (e.g. Remote Sensing (RS) based). Further validation of LASEB ET estimates could be conducted using a soil water budget, where moisture deficit (soil moisture) and precipitation parameters can both be sensor monitored.

Budget: $4,740

William Christman — Development and Validation of a Sediment Signature Approach Using ICP-MS in the Fountain Creek Watershed — $4,950

Chemistry and Biology
Colorado State University (Pueblo)

Abstract: Sediments in rivers and lakes can adversely affect aquatic habitats as well as serve as a mechanism to transport inorganic and organic contaminants. Suspended sediment tracking approaches have for decades relied upon the use radioactive tracers such as 7Be, 210Pb and 137Cs to study erosion, transport, deposition and resuspension of sediments. The use of radionuclides can limit accessibility for such analysis due to costs and time constraints. The purpose of this study is to validate the use of inductively coupled plasma mass spectrometry (ICP-MS) as a technique to characterize sediment for the purposes of source tracking as a cheaper, more useful technique than radioactivity analysis. To accomplish this, the Fountain Creek Watershed (2407 km2) will be selected as the test system for validation and application of the developed model. The Fountain Creek Watershed was selected because of its close proximity to CSU-Pueblo, longstanding issues over sediment translocation, and concerns over the presence of inorganic and organic contaminants, such as mercury (Hg).

Budget: $4,950

Meagan Smith — Environmental Impacts of Ag-to-Urban Water Rights Transfers in the South Platte River Basin — $5,000

Civil Engineering
Colorado State University

Abstract: Colorado's population is projected to increase nearly 40% by the year 2030; resulting in an estimated increase in water demand between 300,000 and 600,000 acre-feet (CWCB, 2004). While conservation will be heavily relied upon, transfers of water out of irrigated agriculture are anticipated to meet the majority of new demands. The South Platte River Basin is projected to lose as many as 226,000 irrigated acres by 2030 (CWCB, 2005). In recent years, however, there has been a greater push to keep water in agriculture whenever possible. This stems from the growing awareness of the public benefits of agriculture beyond its economic output; including the values associated with access to locally produced foods, open space, and wildlife habitat.

Budget: $5,000

Umit Duru — Variables Controlling Reservoir Sedimentation in the Colorado Front Range — $5,000

Geosciences
Colorado State University

Abstract: Sediment deposition can alter the storage capacity and operation of a reservoir. Numerous studies have been done on reservoir sedimentation, but site- and region-specific characteristics of sediment yield limit extrapolation of results between sites. One challenge in understanding reservoir sedimentation is that sediment yield to a reservoir varies spatially and temporally as sediment supply, storage, and mobilization from the contributing watershed change. This variability partly reflects regional characteristics such as lithology, rate of sediment generation, and mechanisms of sediment movement. The objective of this research is to evaluate the relative importance of parameters influencing sedimentation rate within and between reservoirs in the Front Range. The null hypothesis is that reservoir sedimentation correlates most strongly with the magnitude (spatial extent, frequency) of disturbance that alters land cover (e.g., forest fire) because disturbance can mobilize large volumes of sediment from the watershed. Increased disturbance by forest fire results in enhanced sedimentation in numerous sites across the Front Range. The alternate hypothesis is that reservoir sedimentation correlates most strongly with drainage area, relief, or elevation. The research will develop a GIS-based statistical model to determine the factors most important for reservoir sedimentation in the Front Range.

Budget: $5,000

Anne Maurer — Aquifer Storage and Recovery Optimization — $5,000

Civil and Environmental Engineering
Colorado State University

Abstract: Increasing demands for water and finite resources are driving a need for more efficient water storage systems. An emerging strategy is aquifer storage and recovery (ASR). With ASR seepage and evaporation losses can be minimized. Furthermore, peak capacities of key infrastructure elements such as surface water storage, water treatment plants, and pipelines can be reduced. Unfortunately, resolving necessary infrastructure, timing of aquifer storage and recovery is a complex process. Key factors governing infrastructure and operations include timing of water delivery, water quality, and timing of demands.

Budget: $5,000

Internships

USGS - Internship in Water Resources Research

The Watershed Modeling project of the U.S. Geological Survey (USGS) National Research Program (NRP) is seeking a currently enrolled graduate student to work on development of simulation models and modeling tools across environmental and computer-science disciplines. The intern would be employed by the Colorado Water Institute.

PROJECT DESCRIPTION: Due to the increasing complexity of environmental and water-resource problems and ad hoc development of effective simulation models and modeling tools, policy and management decisions regarding natural and engineered systems are often made without considering the interaction between atmospheric, surface, and subsurface processes. The common theme among these problems is the need for integration: integration of computer science and environmental science, integration of different types of GIS and water resources data, integration of processes across spatial and temporal scales, and integration of science and management objectives. The Integrated Watershed Modeling project builds upon a solid foundation of watershed modeling to investigate, formalize, and document integration methods.

ACCEPTED INTERN

Amir Kashipazha

STATEMENT OF WORK: Software development and research to integrate USGS watershed models and data preparation and analysis tools with the Object Modeling System (OMS) and other environmental models and modeling tools. The OMS, using a modular programming strategy, facilitates integration, evaluation, and deployment of simulation models and other natural-resource technology from various disciplines, provides interfaces to geo-spatial tools, linkages to data bases, and analysis and visualization tools for parameter estimation, delineations, and uncertainty. The OMS is being developed by the Agricultural Research Service (ARS) and Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture in cooperation with the USGS, the EPA, and Friedrich-Schiller-University Jena, Germany.

SKILLS: Interns at all degree levels are considered. Applicants should already have attained undergraduate core technical skills, with interest in multidisciplinary study. Object-oriented programming experience using Java and an integrated development environment (IDE), such as, the NetBeans IDE, is required. Experience in one or more of the following is desired: a Geographic Information System (GIS), simulation models, optimization and sensitivity tools, and data base design and management.

LOCATION: U.S. Department of Agriculture building, Fort Collins, Colorado with oversight from the USGS Modeling of Watershed Systems project located at the Denver Federal Center in Lakewood, Colorado.

CWCB - Internship in Water Resources Research

ACCEPTED INTERNS

Computer Information Systems in the Environmental Sciences Interns

Andrew Baessler

Matthew Baessler

Jessie Hickey

Intern for Basin Needs Decision Support System (BNDSS)

Craig Godbout

Instream Flow and Natural Lake Level Program archiving Intern

Annie Sligh

Future Research Priorities

Colorado Water Research Priorities

Water Agency Research Needs and Priorities
June 23, 2010
University Memorial Center, CU-Boulder

Colorado Water Conservation Board

- The impact of HB 08-1141 ("Concerning Sufficient Water Supply for Land Use Approval") on sufficient water supply for new development. This could involve a survey of water providers and land use planners to analyze if and how the new legislation has changed their practices in permitting new development.
- Further development of remote sensing technology for use in water rights administration in Colorado.
- Analysis of the environmental effects of large-scale agricultural dry-up.
- How to define marginal vs. productive agricultural lands, locations of these lands in Colorado, and how that information could be used for state water planning. (The thinking behind this one is that if irrigated agricultural lands were to be dried up to supply future M&I demands, it should be done in a thoughtful way. Maybe there could be a way to maintain the most productive agricultural lands and sacrifice the marginal lands. However, we realize this could be a touchy subject.)
- What percentage of habitat and level of connectivity is needed for important water-dependent species to have viable populations?
- A study that examines river gaging, well monitoring, diversion and return flow measurements using remote technologies for the South Platte and Arkansas basins. This would provide an analysis of data gaps and recommendations for a coordinated system of measurement devices.
- What motivates people to relocate to Colorado (economic aspects, quality of life related to water)?
- How representative the water needs of cottonwoods are of overall riparian habitat needs on Colorado streams.
- Additional studies on flow needs of willow species that appear to be dependent on flushing flows.

Colorado Department of Agriculture

- Agricultural adaptation to Climate Change
    - Stream, salinity, temperature
- Salt tolerant crops
- Impacts of efficiency rules and dynamics of center pivots on return flows.
- Biotechnology approaches to water efficiency
- Opportunities for water storage and non-traditional storage
- Economic scenarios on cropping systems and best return on water for Ag producers.

Colorado Department of Public Health and Environment

- Need selenium fish toxicology work on CO fish species
- Stream impacts from CBM produced water discharge
- Determine methods to incentivize farmers to use nutrients more efficiently
- Selenium effects on endangered species

Division of Wildlife

- DOW holdings in RG, L. S. Platte, Ark could benefit from system analysis to optimize for wildlife benefits and ways to use DOW water as commodity to achieve species benefits
- Effects of drought, flood, climate change on DOW facilities and how tomanage DOW facilities and water in changing climate
- Climate change impacts on wildlife and DOW holdings
- Ways to better use and collect water quality data for protecting sensitive species, reintroduce species, developing in stream flow tools specifically for sensitive and endangered species.
- Dolores River could benefit from neutral scientific evaluation of physical, social, institutional context and data.
- How to finesse water supplies to meet specie flow needs. How optimize flow management
- Return flow changes as land use changes
- Oil and gas impacts on aquatic species
    - Connectivity between fracing and private wells.
    - Importance of spring flows or surface stream flows. Possible energy develop impacts on springs.
- CaCO3 level relationship to quagga and zebra mussel survival to adulthood
- Numeric nutrient criteria – identify source areas
- Developing in-stream flow tools for sensitive species

Colorado State Forest Service

- Forested watershed needs – identification and prioritization of forested watersheds most vulnerable to wildfire or bugs to help focus CSFS resources

Northern Colorado Water Conservancy District

- Effect of bettlekill on water quality especially TOC.
- Nutrient standards potential impact on transbasin diversions
- Stream temp standards – impact on water project operations
- Irrigation canals – algae control mechanisms
- Water conservation – sustainability of landscapes and trees as drought restrictions imposed. Can IBCC projected conservation levels be achieved and sustained
- Climate change – What should water managers do to address?
- Socially how do you engineer multiple-use projects and who pays? When should society pay?
- Economic impacts of dry-up

Department of Natural Resources

- Independent view of what water conservation data needs to be collected by municipalities

FY12 Student Water Research Grant Program

Request for Proposals

The Colorado Water Institute announces a request for proposals for the FY12 Student Water Research Program.

Program Description

This program is intended to encourage and support graduate and undergraduate student research in disciplines relevant to water resources issues and to assist Colorado institutions of higher education in developing student research expertise and capabilities. It is intended to help students initiate research projects or to supplement existing student projects in water resources research. Proposals must have a faculty sponsor and students must be enrolled fulltime in a degree program at one of Colorado's public 4-year Universities.

Funding

Budgets may include, but are not limited to, expenditures for student salaries, fringe benefits, supplies, services, travel, and other direct costs. Funds will **not** be approved for faculty salaries, student tuition, or equipment*. All awards are limited to a maximum of $5,000. Research projects should begin March 1, 2012 and be completed by February 28, 2013. Only direct costs are allowed for these research grants. Facilities & Administrative (F&A) costs may be shown as institutional cost share. Institutions are encouraged to participate in project costs although cost sharing is not required.

Eligibility

Students must be enrolled full-time in a degree program at one of the nine Colorado public universities. Proposals must have a faculty sponsor from the applicant's institution. The faculty sponsor is responsible for ensuring that the proposal has been processed according to their university's proposal submission policies and procedures.

Submission Process

All proposals must be submitted online by 10/17/2011. Please visit http://cwi.colostate.edu for submission site.

Announcement of Awards

The student applicant and faculty sponsor will be notified as to the status of their application by January 2012 vi a email, pending availability of federal funds.

Deliverables

Upon completion of the research project, recipients will be required to submit a final project report, which will include:
Narrative on research activities
Project results
High-quality photos of students and faculty advisor conducting research of the project
Financial accounting of all expenditures
Final project reports may be published in the *Colorado Water* newsletter
Students may be asked to present an oral report on their work to the CWI Advisory Board
Projects must be completed by February 28, 2013. The final project report will be due no later than March 31, 2013.

Proposal Deadline

Monday, October 17, 2011 at 5:00 PM (MST)
Expected Award/Start Date
Start Date: March 1, 2012
End Date: February 28, 2013

Program Contact Information

Dr. Reagan Waskom, Director
reagan.waskom@colostate.edu
Nancy Grice, Assistant to the Director
nancy.grice@colostate.edu
Phone: 970-491-6308
Web: http://cwi.colostate.edu

* Equipment: Non-expendable property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit.

FY 12 CWI Student Research Proposals List

Student Department University	Faculty Sponsor	Proposal Title
Davis, Jennifer Geosciences CSU	Michael Ronayne	Quantifying Snowmelt Derived Groundwater Recharge in a Climate-Sensitive Alpine Watershed
Dunbar, Matthew Chemistry CSU (Pueblo)	Chad Kinny	The Influence of High Molecular Weight Polymers in Biosolids on the Presence and Fate of Anthropogenic Organic Compounds and Nutrients
Fox, Brian Civil Engineering CSU	Brian Bledsoe	3D Modeling of Fish Passage in Colorado Whitewater Parks (CWCB)
Gage, Edward Ecology CSU	David Cooper	Structural and Functional Controls of Tree Transpiration in Front Range Urban Forests
Garber, Jonathan Geosciences CSU	Ellen Wohl	Using 10Be Geochrology to Constrain Background Denudation Rates on the Colorado Front Range
Garland, Deena Civ., Env. & Arch. Engineering CU (Boulder)	Diane McKnight	Using FlowCAM® Technology to Support Lake Algae Data Acquisition and Understanding of Climate Change Impacts on Water Resources
Hans, Liesel Economics CSU	Chris Goemans	A Survey to Improve Understanding as to How Residential Consumers Make Water Use Decisions
Herdrich, Adam Fish, Wildlife, and Cons. Biology CSU	Chris Myrick	Thermal Preferences of Ago-0 Stonecats (Noturus Flavus): Are Thermal Water Quality Standards Protective for This Species
Huber-Stearns, Heidi Forest and Rangeland Stewardship CSU	Tony Cheng	Assessing the Benefits and Drawbacks of Different Institutional Arrangements to Enhancing Forest and Water Ecosystem Services Markets in Colorado
Irrer, Adam Ag and Resource Economics CSU	Troy Bauder	Developing a Tool for Estimating the Amount Spent on Nutrient BMPs Among Colorado Producers
Kolden, Nell Civ & Env Engineering CSU	Brian Bledsoe	3D Modeling of Fish Passage in Colorado Whitewater Parks (CWCB)
Kulkarni, Harshad Civ & Env Engineering, CSU	Pinar Omur-Ozbek	Removal of Cyclic Siloxanes from Activated Sludge for High Quality Biogas Production
Marsh, Andria Chemistry CSU	Thomas Borch	Impact of Subalpine Wetlands on Colorado Drinking Water Quality
Motallebi, Marzieh Ag and Resource Economics CSU	Dana Hoag	Shadow Prices of Conservation Practices in Boxelder Watershed
Muniz, Andrew Earth Science, UNC	Nolan Doesken	Winter Precipitation Variability in the Colorado Rocky Mountains
Nelson, Ron Ag and Resource Economics CSU	Chris Goemans	The Short and Long-Term Impacts of Drought on the Structure of Regional Economics: Investigating the Farm Supply Chain (CWCB)
Roudebush, Jason Ecosystem Science and Substainability CSU	John Stednick	Using Water Chemistry to Characterize the Connection Between Alluvial Groundwater and Stream Flow Water Under Augmentation at the Tamarack Ranch State Wildlife Area, Colorado
Serbina, Larisa Ag. and Natural Res. Economics CSU	Chris Goemans	Quantifying Risks Producers Face when Entering Agricultural Water Lease Contracts (CWCB)
Venable, Niah Geoscience CSU	Steven Fassnacht	Reconstructing a Water Balance for the San Luis Valley: Stream Flow Variability, Change, and Extremes in a Snowmelt Dominated Internal Drainage Basin
Venkatapathi, Keerthivasan Civ & Env Engineering CSU	Pinar Omur-Ozbek	Biowin Simulation to Assess Alternative Treatment Units for a Local Wastewater Treatment Plant to Meet the New Effluent Nutrient Regulations

CWI Activities

Mission

CWI Mission Defined

Federal Water Resources Research Act (42 USC Sec. 10301 et. seq.) - last amended on January 11, 2007, President Bush signed this act into law (by PL 106-374) (114 STAT. 1434 and the Water Resources Research Act Amendments of 2007) (PL 109-471) - a five-year authorization extension (fiscal years 2007 through 2011)

- Colorado Legislature
  - SB06-183
  - HB07-1096
  - HB08-1026
    - Bill changed name to Colorado Water Institute and expanded the mission.
  - HB08-1405

CWI Mission Statement

Connect all of Colorado's higher education expertiese to the research and education needs of Colorado water managers and users.

Reporting

CWI Reports to

1. Vice President of Engagement, Lou Swanson
2. CWI's Advisory Committee on Water Research Policy (per SB06-183)
3. USGS External Research Officer (Per Federal Water Resources Research Act - annual proposal and report required)
4. National Institutes for Water Resources Annual Report

CWI Activities Required to Implement both Federal and State Legislation

1. Organized Interdisciplinary faculty to prepare proposals for national competitions
2. Organized an annual, graduate level, water resources seminar (GRAD592)
3. Administrated graduate and undergraduate 'water' scholarships funded by private donors and through federal competitions
4. Administered internships for USGS and CWCB
5. Provided a venue for education, discussion and exposure of regional and global water re source issues through Spring Interdisciplinary Water Resources Seminars on CSU campus
6. Promoted CSU's annual Hydrology Days symposium that brings national and international hydrological scientists to CSU
7. Prepared nominations of outstanding CSU 'water' faculty for state and national awards
8. Supported the CSU Water Archives via collection, identification, and promotion
9. Graduate students funded through grants
10. Conducted annual state-based water research competition

Personnel

Current Water Center and Colorado Water Institute Faculty

The CWI office is located in Room E-102 of the Engineering Building on the campus of Colorado State Univserity. The CWI staff consists of:

- Director: Dr. Reagan Waskom
- Assistant to the Director: Nancy Grice
- Nonpoint Source Outreach Coordinator: Loretta Lohman
- Research Associates: Faith Sternlieb and Julie Kallenberger
- Water Resources Specialists: Perry Cabot, Denis Reich and Joel Schneekloth
- Policy & Collaboration Specialist: MaryLou Smith
- Technical Writing: Lindsey Knebel
- Office Support: Jan Wright
- Student Support: Six to seven students


Reagan Waskom


Nancy Grice


Amanda Barngrover


Perry Cabot


Joe Collins


Doug Davis


Gio DiDomenico


Craig Godbout


Justin Hachemeister


Kevin Hackett


Zach Hittle


Julie Kallenberger


Lindsey Knebel


Loretta Lohman


Elmahdi Omar


Denis Reich


Paul Rhine


MaryLou Smith


Joel Schneekloth


Faith Sternlieb


Annie Sligh

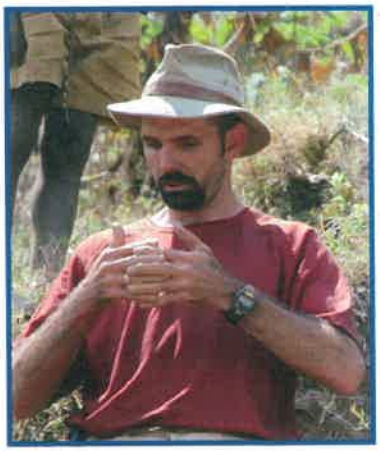

Jena Thompson


Lloyd Walker


Jan Wright

Water Outreach Team

Perry Cabot



Dr. Cabot is an Extension Specialist and Faculty Affiliate of the Department of Civil and Environmental Engineering at Colorado State University. He received his Ph.D. in Agricultural Engineering and Land Resources from the University of Wisconsin at Madison, his M.S. in Environmental Engineering from the University of Illinois, and his B.S. in Civil Engineering from Colorado State University. He has authored several academic papers on subjects related to agricultural practices and their environmental impacts. He is also licensed professional engineer, and a member of Chi Epsilon and Gamma Sigma Delta Honor Societies. He has conducted international work pertaining to water supply and purification project in Rwanda through Engineers Without Borders. Dr. Cabot is also a Fulbright Scholar (2009) in collaboration with the University of Zambia on research related to soil sustainability, irrigation practices, and bioenergy cropping.

Denis Reich

Denis graduated from the University of Sydney, Australia with a Bachelors in Chemical Engineering in 1996. He worked for seven years in water and waste-water treatment in Australasia, Europe and North America, specializing in membrane filtration. Most Recently he graduated from Iowa State University with a Masters in Science co-majoring in Economics and Sustainable Agriculture where he researched federal conservation programs and biofuels. He is currently responsible for the Western Region of Colorado with CSU Extension as a Water Resource Specialist.

Joel Schneekloth

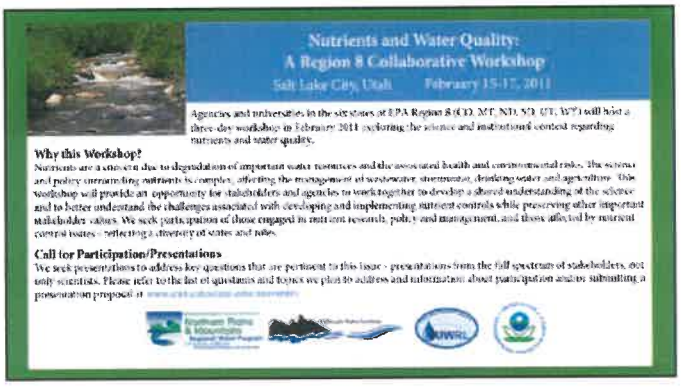
Joel Schneekloth is the Regional Water Resource Specialist for Colorado State University. He has a B.S. and M.S. in Mechanized Agriculture with an emphasis upon water resources from the University of Nebraska-Lincoln. Joel has been with Colorado State University since 2000. Prior to that, he held a Water Resource Extension Educator and Water Resources Coordinator positions with the University of Nebraska. Joel conducts research and educational programs relating to irrigation and crop production with a primary emphasis upon limited water supplies, system management and design, and alternative crops. Prior research projects have included irrigated forage production, irrigation response of sunflowers, water response of oilseeds, and skip-row sunflower production. His current research and demonstration projects include a large scale limited irrigation and crop systems projects in the Republican and South Platte Basin and fertility management of irrigated sunflowers.

Technology Transfer

Research Reports and Publications

Research reports are prepared for each CWI water research project and for those with high public interest, a 'Water in the Balance', short and concise, research summary is published and distributed widely. Recent reports and publications include:

1. CR222 — **Hydrologic Analysis and Process-Based Modeling for the Upper Cache La Poudre Basin** Authors: Stephanie K. Kampf and Eric E. Richer
2. CR221 — **Irrigation Practices, Water Consumption & Return Flows in Colorado's Lower Arkansas River Valley** Author: Timothy Gates
3. CR220 — **Direct Determination of Crop Evapotranspiration in the Arkansas Valley with a Weighing Lysimeter** Author: Abdel Berrada
4. CR219 — **Simultaneous Water Quality Monitoring and Fecal Pollution Source Tracking in the Colorado Big Thompson Water Project** Authors: Lawrence Goodridge, Claudia Gentry-Weeks and Douglas Rice
5. IS112 — **Proceedings, South Platte Forum, 21st Annual, "Making River Music"** Author: Jennifer Brown, Ed
6. IS111 — **Nutrients and Water Quality: A Region 8 Collaborative Workshop -- Workshop Summary and Recommendations** Authors: James W. Bauder and MaryLou Smith
7. SR22 — **Agricultural/Urban/Environmental Water Sharing: Innovative Strategies for the Colorado River Basin and the West** Authors: MaryLou Smith and James Pritchett
8. SR21 — **Quantification Task: A Description of Agriculture Production and Water Transfers in the Colorado River Basin** Author: James Pritchett
9. SR20 — **Meeting Colorado's Future Water Supply Needs: Opportunities and Challenges Associated with Potential Agricultural Water Conservation Measures** Authors: Kelly DiNatale, Todd Doherty, Reagan Waskom and Rick Brown



Meetings

Actively sponsored or supported water meetings in Colorado:

22nd Annual South Platte Forum
October 19-20, 2011

UCOWR/NIWR Annual Conference 2011
July 12 – 14, 2011

Arkansas River Basin Water Forum
April 27-28, 2011

Hydrology Days
March 21-23, 2011

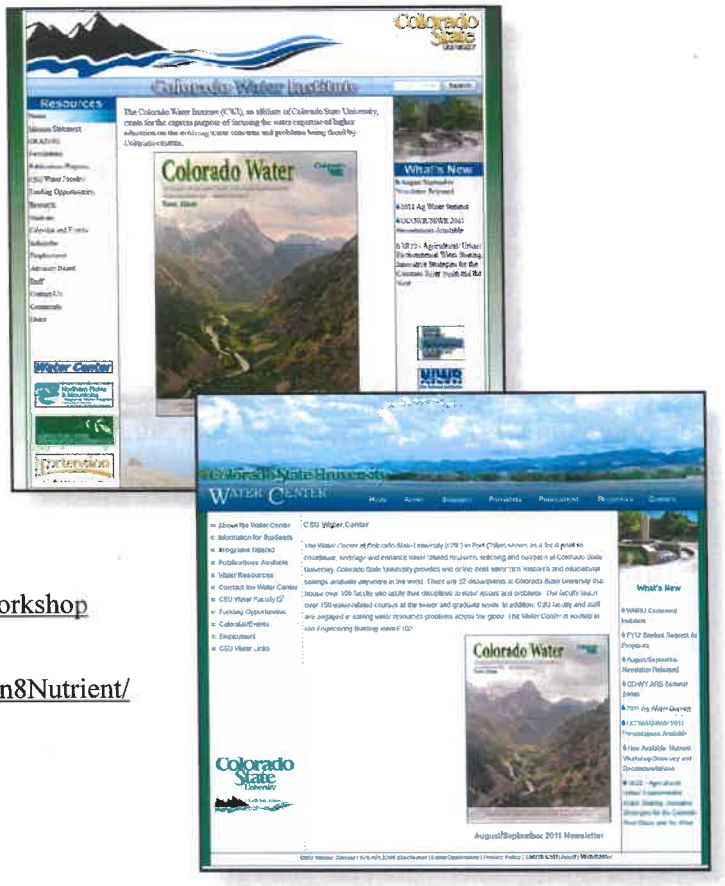
Water Tables
February 19, 2011

Nutrients and Water Quality Workshop
February 15-17, 2011

Ag Water Summit
November 30, 2010

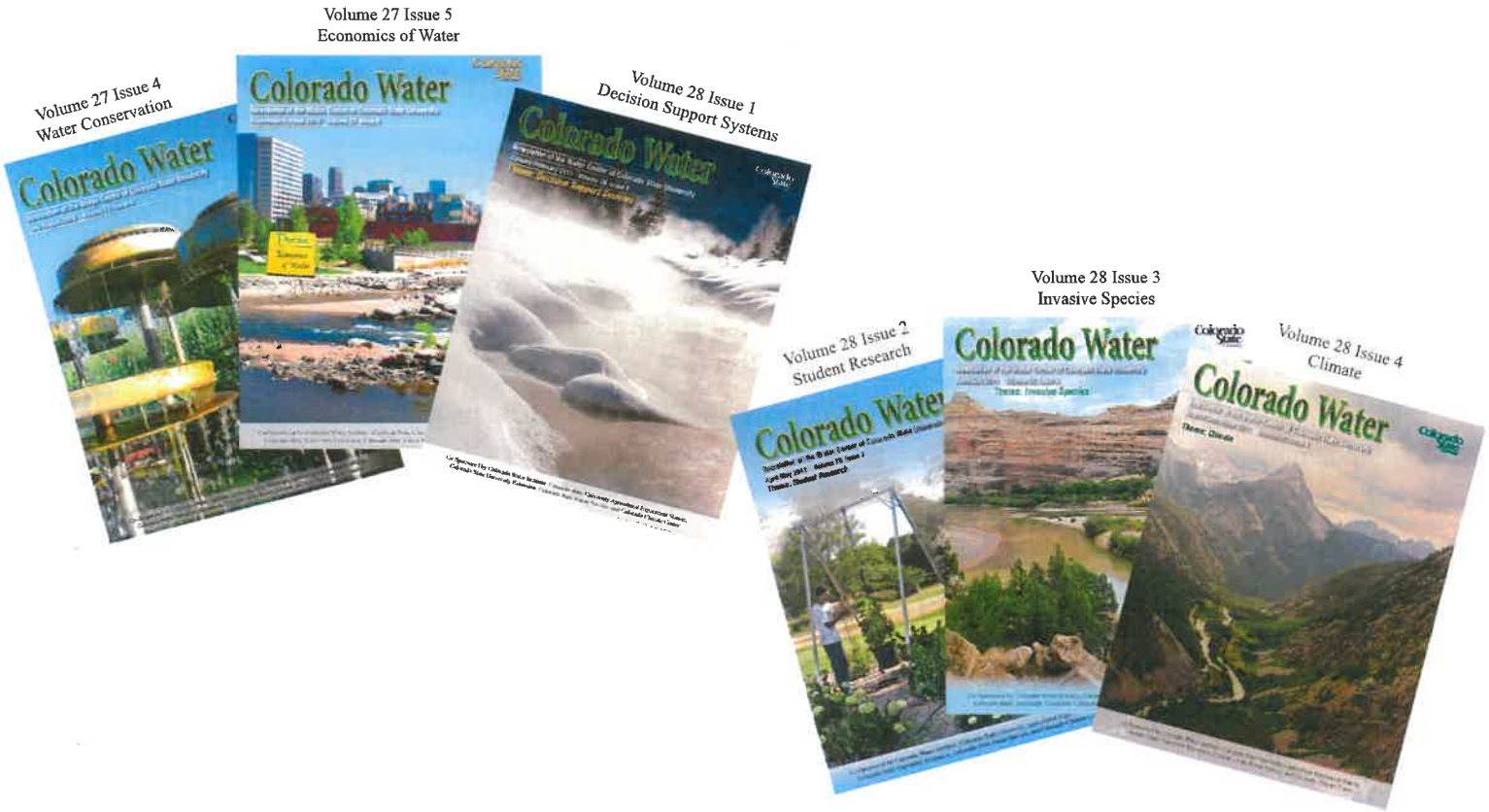
Websites

- **Colorado Water Institute**
  http://www.cwi.colostate.edu
- **Colorado State University Water Center**
  http://www.watercenter.colostate.edu
- **Northern Plains & Mountain Region Water**
  http://www.region8water.org
- **Ag Water Conservation Clearinghouse**
  http://agwatconservation.colostate.edu
- **CSU Water Faculty Expertise**
  http://www.cwi.colostate.edu/CSUWaterFaculty/
- **Nonstationarity Workshop**
  http://www.cwi.colostate.edu/NonstationarityWorkshop
- **Nutrients and Water Quality**
  http://www.cwi.colostate.edu/Workshops/Region8Nutrient/



Newsletter

Colorado Water newsletter, which was revamped in 2007, is sent to over 2000 Colorado water managers and users, including all members of the Colorado Legislature and Colorado Congressional delegation.



Scholarships

Upper Yampa Water Conservancy District

The Upper Yampa Water Conservancy District (UYWCD) funds an annual scholarship named in honor of John Fetcher in support of CSU students preparing for careers in water-related fields. The scholarship program is administered by the CSU Water Center and provides financial assistance to committed and talented students who are pursuing water-related careers at CSU. The UYWCD $3,000 scholarship is open to any major at CSU. Criteria require that the recipient must be a full-time student enrolled in a water-related major at a public university within the state of Colorado and with a minimum GPA of 3.0. The scholarship duration is one year.

The UYWCD John Fetcher Scholarship recipient for the 2011-12 academic year is Eric Gardunio.

Eric Gardunio is a graduate student in the Department of Fish, Wildlife and Conservation Biology at Colorado State University who is studying invasive burbot and white suckers. Eric is specifically focused on describing the swimming and jumping capabilities of these fishes to limit their spread in the Upper Colorado River Basin. His work will define guidelines for creating barriers to the dispersal of these invaders in the Upper Colorado River Basin. This work is highly relevant to the Yampa River, as both burbot and white suckers pose threats to the endangered fishes of the Yampa River basin through predation, competition and hybridization.

Eric is a young professional focused on creating a career in fisheries biology which will give me the opportunity to positively impact the fisheries resources of the western United States. He has had an extensive amount of experience in this field, and has had the opportunity to learn a great deal about fisheries management as a result. He hopes to further his opportunities to positively impact native biota, while providing sport fisheries opportunities as a full time fish biologist following the completion on my graduate thesis.

Eric was born in Grand Junction, Colorado, and as a child was lucky to get to experience the natural wonders of western Colorado. This experience as a child is a large part of what encouraged his pursuance of a natural resources related profession. Growing up fishing in western Colorado provided him the interest to pursue fisheries as a career. He hopes in the future to facilitate work with kids to expose them to the wonders of the natural world, and to hopefully instill an interest in its preservation. He has worked with the Boys and Girls Club of Larimer County to put on Kids Fishing Days with our American Fisheries Society CSU Sub-unit, and hopes to continue his involvement with kids and natural resources. This work along with his dedication to his Sub-unit resulted in his receiving of the Outstanding Service Award from the CSU Sub-unit of AFS in 2008.

He is the first individual from his father's side of the family to receive an undergraduate degree, and also is pursuing a graduate education. His parents raised him to value education, and in that they encouraged him to spend time outside, which facilitated his involvement in an education path that he loves.

The CSU Water Center and Colorado Water Institute congratulate Eric and wish him success in his future academic studies and career. The ongoing support of CSU students by the UYWCD is acknowledged and greatly appreciated.

Water Education

Spring Interdisciplinary Water Resources Seminar — Spring 2011

Spring 2011
Interdisciplinary Water Resources Seminar

Sponsored by: CSU Water Center, USDA-ARS, Civil and Environmental Engineering, and Forest, Rangeland, and Watershed Stewardship

Thursdays from 12:00 to 1:00 PM

January 27 **LSC Room 208**	**Mazdak Arabi & Jorge Ramirez** **Joint Lecture: Building a Better Water Future in Education, Research, and Economic Development**
February 2 **LSC Room 224-226**	**Steve Silliman** **Darcy Lecture- Characterization of a Complex, Sole-Source Aquifer System in Benin, West Africa**
February 10 **LSC Room 208**	**Robert Ward & Mark Fiege** **Joint Lecture: History of the Poudre River**
February 17 **LSC Room 208**	**Steven Fassnacht & Mike Gillespie** **Operational Measurements of Snowpack Properties across the Cache la Poudre Watershed: Monitoring and Research to Increase Our Understanding of the Basin**
February 24 **LSC Room 228**	**Dennis Ojima & Brad Udall** **Climate, Water, and Ecosystems: The Changing Socio-Ecological Systems of the West**
March 3 **LSC Room 208**	**Deborah Entwistle, Carl Chambers & John Stednick** **Watershed Analysis on National Forest Lands**
March 10 **LSC Room 208**	**Stephanie Kampf & Jeffrey Niemann** **Basin and Catchment-Scale Hydrologic Regimes in the Cache la Poudre**
March 17	**No Seminar** **Spring Break**
March 24	**No Seminar** **Hydrology Days Mar. 21-23; www.hydrologydays.colostate.edu**
March 31 **LSC Room 208**	**John Bartholow & Brian Bledsoe** **Crafting a Flow Recommendation for the Cache la Poudre River through Fort Collins**
April 7 **LSC Room 208**	**George Varra** **Water Management on the Poudre River**
April 14 **LSC Room 208**	**Ken Carlson & Keith Elmund** **The Built Environment of the Cache la Poudre River**
April 21 **LSC Room 208**	**Ellen Wohl** **Geomorphology of the Poudre River**
April 28 **LSC Room 220-222**	**Boris Kondratieff & Ashley Ficke** **Biomonitoring of the Poudre River**
May 5 **LSC Room 228**	**Panel: Reagan Waskom, Mazdak Arabi, Jorge Ramirez, & Colorado Water Innovation Cluster** **Discussion of Poudre Watershed Monitoring Plan**

* Room may be changed if needed. Check weekly announcements.

All interested faculty, students, and off-campus water professionals are encouraged to attend.

For more information, contact Reagan Waskom at reagan.waskom@colostate.edu or visit the CWI web site.

GRAD592
Interdisciplinary Water Resources Seminar

Fall 2011 Theme: **Exploring Jobs, Careers and Leadership in Water Resources**
Mondays at 4:00 PM, NATRS 109

Course Description

The purpose of the 2011 Interdisciplinary Water Resources Seminar (GRAD592) is to expose students to the broad gamut of opportunities and trends within the field of water resources through guest lectures by prominent Colorado water practitioners.

More specifically, the seminar will:

- Examine jobs and careers in the international, government, private and NGO sectors
- Discuss how students can best prepare for water jobs and careers
- Examine the trends and future of various sectors of the industry
- Discuss leadership in the water resources professions

Students interested in taking the one-credit seminar should sign up for GRAD592, Water Resources Seminar, CRN 67067. Grading will be on a pass/fail basis with student participation and written assignments comprising the grade requirement. The seminar will be held at 4:00 PM Monday afternoons in NATRS 109. (Students who have enrolled in GRAD592 in the past, can also enroll for this offering.)

Grading Policy / Attendance

For students taking the 2011 Interdisciplinary Water Resources Seminar (GRAD592), the course will be graded as pass/fail. To receive a passing grade, students will be asked to prepare responses to 8 of the lectures.

Aug 22	Purpose, overview, and expectations
Aug 29	Barbara Richardson, CSU Career Center
Sept 5	**Labor Day - No Class**
Sept 12	Russell Young, Hach Co.
Sept 19	Jonathan Bartsch, CDR Associates
Sept 26	Jerry Pena, MWH Global
Oct 3	Jim Finley, Telesto Solutions
Oct 10	Dale Gabel, International Water Association and CH2M Hill
Oct 17	Jim Kircher, U.S. Geological Survey
Oct 24	Chuck Hennig, U.S. Bureau of Reclamation
Oct 31	Wayne Vanderschuere, Colorado Springs Utilities
Nov 7	Marc Waage, Denver Water
Nov 14	Sue Morea, CDM
Nov 21	**Thanksgiving Break - No Class**
Nov 28	Jennifer Gimbel, Colorado Water Conservation Board
Dec 5	Student discussion and participation

All interested faculty, students, and off-campus water professionals are encouraged to attend.
For more information, contact Reagan Waskom at reagan.waskom@colostate.edu or visit the CWI web site at http://www.cwi.colostate.edu

Other Outreach

- Administer undergraduate Water Minor - for any CSU major
- Hydrology Days Annual Meeting on CSU Campus
- Information for new water graduate students at CSU (for recruiting high quality water students to CSU)
- Lists of CSU water faculty and courses on CWI webpage
- Administer water scholarships sponsored by Colorado water organizations

COLORADO WATER INSTITUTE

About CWI

Colorado water managers and users must contend with the fickle nature of weather and climate, the allocation of limited water among competing sectors of Colorado's economy and environment, and the demands of thirsty downstream states. CWI works closely with Colorado water managers and users to develop sound science to assist water managers in reducing conflict among water users. CWI facilitates the transfer of new water knowledge to water managers and assists in educating the next generation of Colorado water managers by working with all Colorado institutions of higher education.

Training

One of CWI's primary missions is to facilitate the training and education of university students. To this end, CWI works with the U.S. Geological Survey to place student interns in positions, funds student research grants, and manages scholarships on behalf of students.

Research

CWI, an affiliate of Colorado State University (CSU), exists for the express purpose of focusing the water expertise of higher education on the evolving water concerns and problems being faced by Colorado citizens. We are housed on the campus of CSU but work closely with all institutions of higher education in Colorado. CWI coordinates research efforts with local, state, and national agencies and organizations. Recent state funding allowed CWI to fund research projects at CSU, the University of Colorado, and Colorado School of Mines. (See "Current Research Projects").

Outreach/Information Transfer

CWI publications include research reports and *Colorado Water*, a bimonthly newsletter containing information on research, faculty, conferences and other events with a water focus. Outreach activities are conducted in conjunction with CSU Extension, the U.S. Department of Agriculture, the Colorado Department of Agriculture, the Environmental Protection Agency, and The Colorado Department of Public Health and Environment.

CWI works with CSU Extension to coordinate outreach with three Water Resources Specialists: Perry Cabot, Denis Reich, and Joel Schneekloth. The specialists focus on water resource-related research and outreach, as well as statewide collaboration. Their research and outreach topics include meeting water demand, agriculture, and water quality assurance.

Highlights
Response to State Needs

Agricultural Water Conservation

The Agricultural Water Conservation Clearinghouse Project is a joint collaboration between CWI, CWCB, CSREES, Western Regional Water Program, and CSU Libraries. The project's goals are to increase access to information that will help build collaborative relationships between and among regional and national agencies, provide technical expertise regarding agricultural water conservation, and offer detailed information on the management, policies, and laws regarding ag water conservation. www.agwaterconservation.colostate.edu.

Lysimeter

State of Colorado, USDA/ARS, and Colorado State University are working together to install and instrument two scientifically sound large weighing lysimeters in the Arkansas Valley in support of the Arkansas River Compact settlement.

Colorado River

The Colorado River is subject to significant natural hydrologic variability, yet water managers have limited flow data that may not represent the full array of hydrologic futures and risk. This research employs paleohydrologic reconstructions of annual flow using tree rings to provide much longer (500-1000+ years) records of past natural variability, and thus a much richer sampling of potential flow sequences, including severe and sustained droughts of greatest concern to water resource managers.

Mussels in Colorado

Zebra and Quagga mussels are non-native freshwater bivalves which reproduce rapidly and have the ability to form thick mats that clog pipes and cause millions of dollars in damage to water-delivery systems. An adaptive management model is under development which estimates costs and benefits (in terms of economic, ecological, and wildlife impacts) associated with various treatments, along with other available mussel management and mitigation strategies that focus primarily on prevention or infestation control.

Colorado State University

Current Faculty Research Projects

Adaptive Management of Zebra and Quagga Mussels in Colorado
Craig Bond, Colorado State University

Adjoint Modeling to Quantify Stream Flow Changes Due to Aquifer Pumping
Roseanna Neupauer, University of Colorado

Assessing the Relative Costs/ Values of New Water Supply Options
Doug Kenney, University of Colorado

Data Analysis and Final Report of the Nature and Implications of Irrigation Practices in Colorado's Lower Arkansas River Valley
Tim Gates, Colorado State University

Determination of Consumptive Water Use by Alfalfa in Arkansas Valley
Lee Sommers, Colorado State University

Estimating the Cost Effectiveness of Water Conservation Programs
Chris Goemans, Colorado State University

New Methods for Sago Pondweed Management
Scott Nissen, Colorado State University

Paleohydrology of the Lower Colorado River Basin
Balaji Rajagopalan, University of Colorado

Current Student Research Projects

Aquifer Storage and Recovery Optimization
Anne Maurer, Colorado State University

The Efficacy of the Use of Moringa Oleifera Seeds to Remove Metabolites of Cyanobacteria from Drinking Water
Victor Sam, Colorado State University

Environmental Impacts of Ag-to-Urban Water Rights Transfers in the South Platte River Basin
Meagan Smith, Colorado State University

Large Aperture Scintillometers for Evapotranspiration (ET) Evaluation
Evan Rambikur, Colorado State University

Novel Technique for Evaluation of Dissolved Organic Material (DOM); Research Methodology and Lab Protocol Development Using a FluidImages FlowCam on Lake Water Samples Across the State of Colorado
Alia Khan, University of Colorado (Boulder)

Variables Controlling Reservoir Sedimentation in the Colorado Front Range
Umit Duru, Colorado State University

Ecosystem Services, Biodiversity, and Irrigation Inefficiences
Jeremy Sueltenfuss, Colorado State University

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06/27/20

Evan Vlachos Receives Honorary Doctorate

Lindsey A. Knebel, Editor, Colorado Water Institute

In March, Evan Vlachos, who has been a lawyer, professor, researcher, and consultant in urban planning, water resource planning and management, forecasting and futurism, technology assessment and demography, and other areas for over 40 years, was presented with an honorary doctorate in Civil Engineering from the Aristotle University of Thessaloniki (AUTH) in Greece. Following the award, Vlachos and CSU President Tony Frank attended and signed an international memorandum of understanding (IMOU) that called for a partnership between the universities on certain water-related projects. Vlachos emphasized that the event signifies an emphasis on integrated, interdisciplinary, and transnational research and communication between the universities.

Vlachos was born in Greece, and he earned a law degree there before coming to the U.S. and earning a Master's and Ph.D. in Sociology as well as a Certificate of Russian Studies. In his career, Vlachos' work included directing the Environmental Resources Center, acting as Associate Director of the International School for Water Resources, and serving as member and chairman of the Environmental Advisory Board, the U.S. Army Corps of Engineers, and the Advisory Panel on Environmental and Earth S&T in NATO, Brussels, to name a few, and he has authored many books and articles. Vlachos' interests when he first came to the U.S. were sociology and the environment, which quickly grew into studying and learning about water and other related issues. He explains that receiving an honorary doctorate in Civil Engineering is a tremendous honor for someone who studied as a lawyer and sociologist.

The IMOU signing took place during a Water Day meeting, during which President Frank made a speech, and the two universities discussed water issues. The IMOU included the following as tentative joint projects between CSU and AUTH:

- Transboundary hydrodiplomacy (with focus on the Balkans and Circum-Mediterranean areas) and special attention to transboundary aquifers;
- Water Resources Planning and Management, with emphasis on new techniques, as well as, methodological advances and models;
- The increasing number of extreme hydrological events and their consequences for water-scarce and water-stressed hydrological regimes;
- The use of scenarios for outlining options in comprehensive planning and management;
- Exchanges of students and faculty for improving ties with the Unesco ICIWaRM program at CSU and AUTH; and
- Comparative drought and desertification studies affecting the agricultural economies of Colorado and Greece.

Vlachos explains that CSU has experience in agriculture and a reputation in the water field, and AUTH has a central location in Europe with many similar agreements with around 200 European universities. The agreement would also bring more international students to each university, strengthening international ties and increasing knowledge.

Vlachos discusses growing up in Greece, saying that especially in the islands, fresh water was scarce. "Water is a sacred thing," he says, and it's important for historians and anthropologists, who understand older, traditional ways of dealing with water scarcity, to be involved. Such an integrated approach is necessary for water resources.

ICIWaRM, the International Center for Integrated Water Resources Management, where CSU participates as a founding member, is an example of an integrated and international approach to water. ICIWaRM was established in 2007 by organizations "sharing an interest in the advancement of the science and practice of integrated water resources management around the globe," according to its website.

Vlachos expresses his hope that this international approach to water issues will continue with CSU, which has been known for its involvement in water. "We're engineering the planet," he says.

Evan Vlachos, center, is pictured with CSU President Tony Frank, AUTH President Ioannis Mylopoulos, and surrounded by members of the Department of Civil Engineering of AUTH.

Cathy Thomas Wins Master Thesis Award

Cathy Thomas, a master's student in Agricultural and Resource Economics has just been awarded the Western Agricultural Economics Association Master's Thesis Award. They will present her award at their annual meeting in Banff, Alberta, Canada. The thesis is entitled "A Cost-Benefit Analysis of Preventative Management for Zebra and Quagga Mussels in the Colorado-Big Thompson System."

CSU Student Joseph D. Vassios Receives Award

Colorado State University Ph.D. candidate Joe Vassios was recently honored with the annual Outstanding Graduate Student Award from Aquatic Plant Management Society. Vassios says the graduate work he was recognized for has focused on "examining the absorption and translocation of the aquatic herbicides triclopyr, fluridone, and penoxsulam in two aquatic plant species, hydrilla and Eurasian watermilfoil." In addition to this research, Vassios has been active in CSU Professor Scott Nissen's aquatic plant management research program. He's also been "evaluating current and new methods for control of sago pondweed in irrigation canals and new control methods for Eurasian watermilfoil in lakes, ponds, and irrigation canals."

Vassios plans to graduate in fall 2011, and says he hopes to pursue an industry career in the aquatic plant management field. He holds a Bachelor of Science in Soil and Crop Sciences and a Master of Science in Bioagricultural Sciences and Pest Management, both from CSU.

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