Colorado Water

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Highlights:

In Every Issue:

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Cover Photo: Phantom Creek near Cripple Creek, CO. (Image courtesy of Kenneth Wyatt / www.wyattphoto.com)

Editorial

by Reagan Waskom, Director, Colorado Water Institute

You might think that a bi-monthly newsletter dedicated only to water-related activities at one Colorado institution of higher education would run out of new stories in short order, but the Colorado Water Institute has been publishing water research results for 44 years now and there is no end of material in sight. CSU's eight colleges, the Ag Experiment Station, CSU Extension, Colorado State Forest Service, and Colorado Climate Center team with the CSU Water Center and Institute every other month to provide what seems like a never-ending array of water research, teaching, outreach, and service activities that we bring to our readers. As soon as we develop an area of expertise, new problems like zebra and quagga mussels crop up, requiring new solutions.

This issue of *Colorado Water* is bittersweet for us, as we mark the passing of Maury Albertson, legendary civil engineer with a fantastic array of global accomplishments while here at CSU, not the least of which was his role in the establishment of the Peace Corps. His legacy sets the bar for what a determined academic can accomplish; but what I recall most about Professor Albertson was his optimism, energy, and his dedication to creating a better world.

While the loss of Professor Albertson marks another changing of the guard, readers should note the continued development of new water leaders here at CSU, like our Upper Yampa Water Conservancy District scholarship winner, Mike Macklin, and our new faculty members Stephan Kroll and Stephanie Kampf, featured in this issue. The opportunity to address Colorado's water challenges and to train the next generation of leaders is just as compelling today as it was for Dr. Albertson and his peers following World War II. What has changed are the methods and technologies, but the basic issues of water supply, demand, and water quality continue to engage and challenge our best thinking and problem solving skills. What is still required of us is creativity, curiosity, hard work, and intellectual integrity. Fortunately, these requirements bring their own rewards.

By now, *Colorado Water* readers are well aware of the budget difficulties facing the State and, in particular, higher education. These times may temporarily diminish our ability to deliver on all of the pressing water issues that faculty and our students are eager to tackle, but they do not have to diminish our passion for the work we do here in Colorado. The challenge and the opportunity is to work smarter, be accountable, and focus on our key mission—training students and serving as the land-grant university for the people of this great state.

We have been fortunate in recent years to attract and hire a number of outstanding new faculty members in each of CSU's colleges who will dedicate themselves to water-related work for years to come. Now, it seems we will return to the not unfamiliar state of budget scarcity where once again we run lean, which seems to be the Colorado way. The competition for scarce resources compels us to a higher level of cooperation, and yes, of competition as well. The issues related to water stress and scarcity are no different—they can bring out the best of our creativity and cooperative spirit, or they can thrust us towards conflict and competitiveness. While it is in good humor that we often propagate Mark Twain's aphorism that "water is for fighting," our history reveals something different: cooperation and community are often found in scarcity. In these lean budget times, CSU looks forward to forging new collaborations with private and public entities committed to solving water problems in Colorado.

Stream Rehabilitation Engineering at Colorado State University

by Chester C. Watson, Professor; and
Christopher I. Thornton, Assistant Professor; Department of Civil and Environmental Engineering

The engineering community is faced with the task of designing streams that must satisfy a broad range of uses, including ecology, recreation, water supply, flood insurance, irrigation, and many others. In addition, stream restoration implies that the stream can be returned to some former state and function, which may be difficult to achieve considering changes in land use that continuously occur. Mitsch and Jorgensen (2003) emphasize that ecological engineering is based on the self-design capacity of ecosystem, meaning—let the ecosystem function and design the project. In our combined experience, we have witnessed that most projects must function across a broader range of goals than solely ecosystem function. Therefore, while ecosystem function is a worthy goal and necessary component, stream rehabilitation implies that ecosystem function as well as infrastructure-related goals be identified and balanced.

Stream rehabilitation engineering at Colorado State University (CSU) seeks to be inclusive in the approach toward design projects that satisfy the public need. A critical element in the design of a stream rehabilitation project is a team that is composed of the technical personnel required for the project, which may include an ecologist, a biologist, a geomorphologist, and a registered professional engineer to ensure that public safety is preserved. For example, changing a stream may affect flood protection and flood insurance zoning. A very high percentage of civil engineering undergraduate students at CSU pass the State of Colorado preliminary examination for professional registration.

While undergraduate studies include the basic courses in hydrology and hydraulics, the graduate curriculum in the Department of Civil and Environmental Engineering offers a suite of opportunities. Hydrology (CIVE 522,), open channel hydraulics (CIVE 612), sediment transport (CIVE 716), river engineering (CIVE 717), stream rehabilitation (CIVE 613), field methods for stream investigations (521), geotechnical engineering (CIVE 450), geographic information systems (GIS) (CIVE 577), applied hydraulic design (CIVE 510), and water quality studies (CIVE 538) are all included in the course offerings each year.

One of the courses fundamental to understanding streams is fluvial geomorphology, which is offered each year in the Department of Geosciences. Typically, a well-rounded plan of study includes at least one course from partnering departments. For instance, a course in fundamental aquatic ecology is recommended if the student has a suitable background and interest. Many students are pursuing double majors combining the engineering coursework with programs in fishery and wildlife biology, Earth resources, and chemistry. Figure 1 illustrates this mix of courses for the engineer who has selected a career with an emphasis in stream rehabilitation and restoration.

For those who choose to invest their time in river hydraulics and rehabilitation, we suggest some of the history of hydraulics at CSU and the bountiful literature pertaining to rivers and the study of rivers. Dr. Hunter Rouse edited a history titled *Hydraulics, Fluid Mechanics and Hydrology at Colorado State University* (1980), in which he traced the

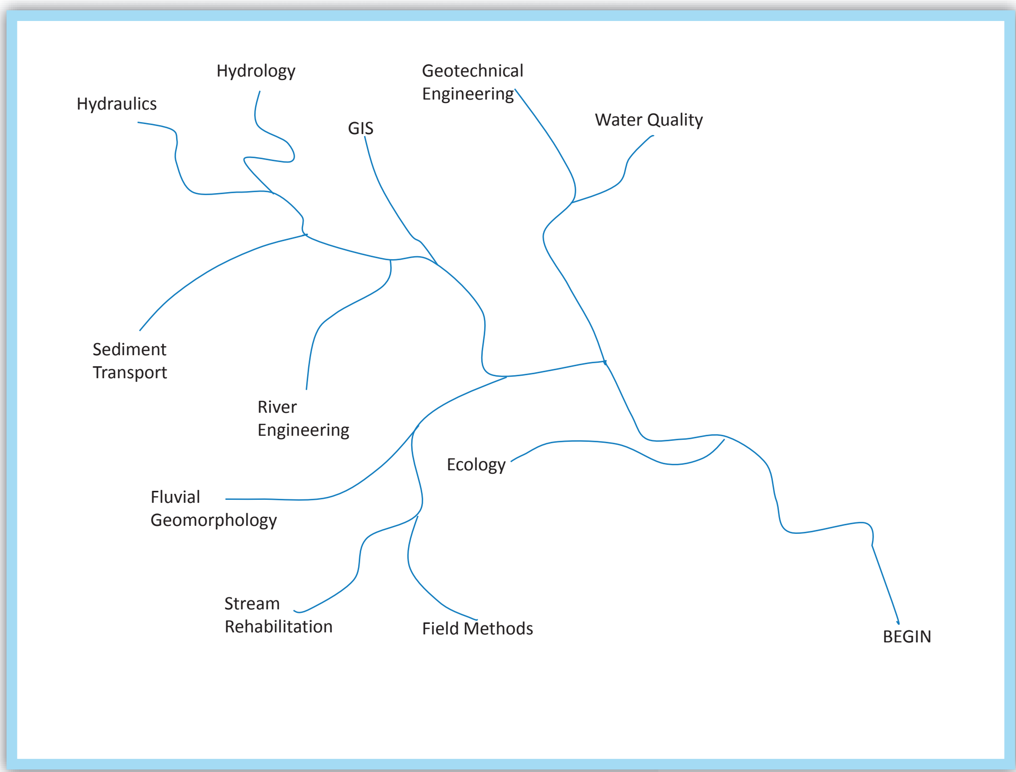


Figure 1. This chart illustrates the mix of courses for engineers who plan to focus on stream rehabilitation.

beginning of hydraulics back to two courses in irrigation taught by Elwood Mead in 1883. The Civil and Irrigation Engineering building was begun in 1904, and a graduate of that class was Ralph Parshall. Today, it is difficult to imagine irrigation without the Parshall flume to measure flow. This history continues to record some of the accomplishments of notable alumni and professors, including Emory Lane, Maurice Albertson, Daryl Simons, Everett Richardson, Vujica Yevjevich, Hsieh-Wen Shen, Lionel Baldwin, and Ray Chamberlain. Their accomplishments marked great strides in hydrology and hydraulics through the twentieth century and beyond.

Today, faculty and research scientists at CSU are conducting field and laboratory research programs designed to bring together practitioners from diverse disciplines in an effort to meet the engineering challenges of the future. Multi-disciplinary teams are actively working on in-stream flow control structures, habitat enhancement, environmental monitoring, and improved field methods. Tools, methods, and training that are developed today will be paramount to bridging the void between form and function as we continue to work in and impact river and stream environments.

Robert Newbury (1995), an engineer who excels in stream rehabilitation and lives in Canada, captured an important emphasis for those of us who work with streams:

"Water flowing in rivers has a structure and pattern that are too complex to analyze completely. To restore and enhance habitats in uniformly channelized rivers, the founding observations of Chezy must be re-interpreted using natural river characteristics and the eye of an angler. Even then, some mystery will remain in just how the water flows."

Newbury acknowledges the mystery and the haunting nature of rivers that lingers in the flow and sediments as we try to understand how to restore. Our challenge in rehabilitation is not to conquer the stream, but to acknowledge that mystery and our shortcomings, then to proceed with our limited knowledge of the stream to achieve the worthy task set before us.

All of the engineering courses and related studies will do little to dispel the wonderful excitement and mystery of working with rivers, but it will give the student a framework in which to study and to design stream rehabilitation. Theory, experience, and appreciation for the complexity of a stream are the main ingredients of successful rehabilitation design; these can develop by continuing study. Colorado State University is a good place to begin, to refresh, or to augment the skills necessary to participate in the exciting and challenging field of stream restoration.

DARCA

Ditch and Reservoir Company Alliance

The Seventh Annual Convention of the Ditch & Reservoir Company Alliance (DARCA)

Ag to Urban Transfers of Water: Can Ditch Companies Come Out Ahead? - February 18-20, 2008; Pueblo Convention Center, Pueblo, Colorado.

For information regarding convention registration as well as sponsorship or exhibitor opportunities please visit www.darca.org or contact DARCA at (970) 412-1960 or john.mckenzie@darca.org.

The convention will provide a wealth of information relevant to Colorado's water providers on the innovative developments in the state regarding ag to urban transfers of water. Don Ament, Former Colorado Commissioner of Agriculture, will be the keynote speaker on the first day of the convention. During the two-day conference, a wide variety of speakers will discuss transfer mechanisms for alternatives to buy-and-dry, including the on-going efforts of the Super Ditch in the Arkansas Valley and the Colorado Water Conservation Board's efforts to facilitate alternatives to buy-and-dry arrangements. Farmers, ranchers, agricultural groups, engineers, lawyers, and municipalities will present their views on this timely subject.

On the second day, Justice Greg Hobbs of the Colorado Supreme Court will deliver his presentation titled "How Drought Has Shaped Colorado Water Law." The annual meeting of the Ditch and Reservoir Company Alliance will be held on Friday morning. DARCA has board member terms expiring this year and invites you to submit names of qualified individuals who might choose to help lead DARCA.

DARCA will present "Owners' Guide to Dam Safety, Operation, and Maintenance," the pre-convention workshop on Wednesday, February 18, from 9:00 a.m. to 5:00 p.m., also at the Pueblo Convention Center.

Snowmelt Runoff in the Upper Cache la Poudre River Basin, Northern Colorado

by Stephanie Kampf, Assistant Professor, and
Eric Richer, M.S. Student, Watershed Science;
Department of Forest, Rangeland, and Watershed Stewardship

From its headwaters in Rocky Mountain National Park, the Cache la Poudre River travels approximately 80 miles down through the Poudre Canyon, eventually passing through Fort Collins and Greeley before reaching its confluence with the South Platte River (Figure 1). The basin covers an area of 1,890 square miles, with elevations ranging from over 13,000 feet above the headwaters to 4,600 feet at the outlet. The river has a long history of water use extending back to early settlements in the 1850s, and water is now used to support multiple agricultural, municipal, and industrial demands. In March 2008, we began a project funded by the Colorado Water Institute to explore runoff generation in the upper Cache la Poudre Basin and develop a model to predict flow in the basin under varying climate conditions. The objective of the first phase of this research is to determine which parts of the basin contribute runoff to the river during the snowmelt season.

Methods

To determine sources and timing of snowmelt runoff in the Cache la Poudre Basin, we compiled a hydrometric database combining climate and discharge data. This database includes point measurements of temperature and precipitation from National Climatic Data Center COOP stations, temperature and snow water equivalent from Natural Resources Conservation Service SNOTEL stations (Figure 1), and snow water equivalents from snow course surveys. These point measurements are located primarily in the highest elevations of the watershed. To estimate the spatial variability in precipitation and temperature, we used PRISM (Parameter-elevation Regressions on Independent Slopes Model; http://www.prismclimate.org), which predicts spatial distributions of precipitation and temperature at monthly time steps. To track the spatial distribution of snow in the basin, we compiled Snow-Covered Area (SCA) data from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite sensor. SCA data used in our analyses represent the 8-day maximum snow cover extent during each snowmelt season (late March to early June) from 2000-2006.

We compare time series and spatial patterns of these climate variables to discharge at the Canyon Mouth Gauge (Figure 1), which is the flow forecasting point for the Cache la Poudre. Because we are interested in sources and timing of snowmelt runoff in the basin, our analyses are conducted using 'naturalized' flow records in which the effects of diversions and impoundments have been removed. These naturalized flow rates are estimated using a basic accounting method: adding or subtracting diversions and changes in reservoir storage.

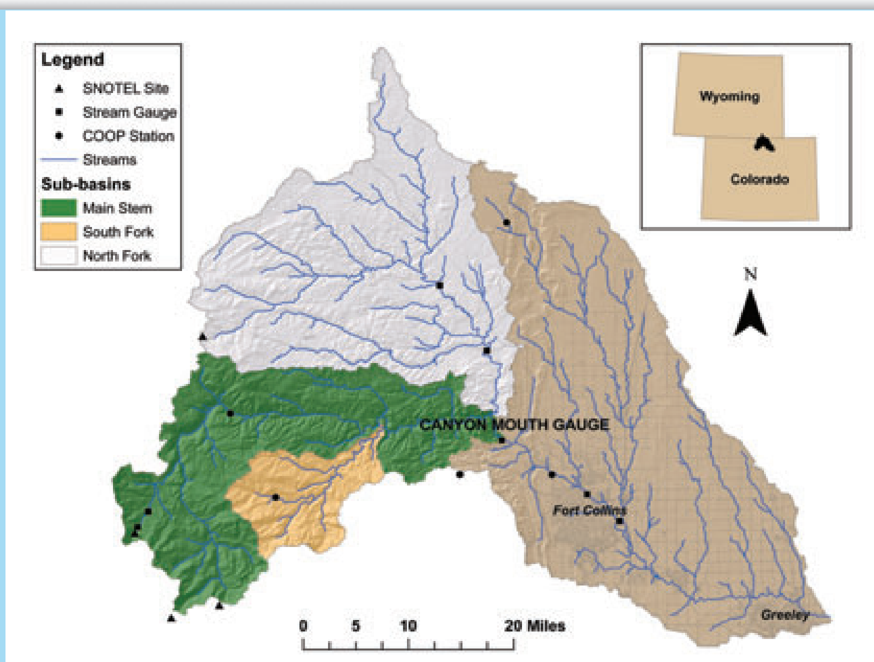


Figure 1. The Cache la Poudre watershed, including measurement locations and sub-basins.

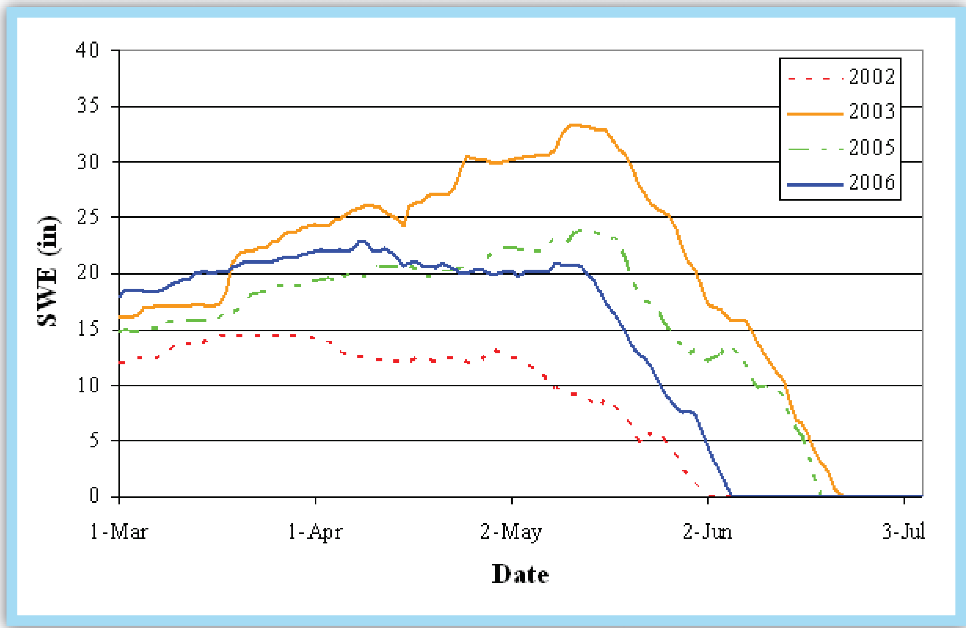


Figure 2. Spring-summer snow water equivalent at the Joe Wright SNOTEL site (10,120 feet). (Data source: Natural Resources Conservation Service)

the basin, but the additional snow cover typically melted within a week after each event.

These precipitation and snowmelt patterns affect the magnitude and timing of snowmelt runoff in the basin. River flow at the Canyon Mouth Gauge shows a gradual rise during early spring snowmelt, which begins from late March to late April (Figure 4). In most years, a gradual rise in discharge during early spring is followed by a rapid increase in discharge around mid-May. This rapid flow increase corresponds to the time when high elevation snowpack begins to melt (Figure 2). Peak flow occurs in late May to early June, and the river then recedes to baseflow conditions by mid-August.

Results

The upper Cache la Poudre Basin exhibits high spatial variability in temperature and precipitation. According to the PRISM model, average annual precipitation ranges from 13 inches at lower elevations to 53 inches near the headwaters, with a distinct increase in precipitation occurring above 10,000 feet. PRISM-derived average annual temperatures decrease from 50˚F at the lowest elevations to 25˚F at the headwaters. Temperature in the basin follows a seasonal cycle, with minimum temperatures in December and maximum temperatures in July. Average precipitation for the basin is lowest during the winter months and then increases during the spring, with maximum monthly average precipitation occurring in May.

Snow water equivalents measured at SNOTEL sites highlight the importance of spring precipitation. Figure 2 shows example snow water equivalent time series for the Joe Wright SNOTEL site (10,120 feet). During two of the years shown in Figure 2 (2003 and 2005), snow accumulation continued until mid-May. In all years, melt at this high-elevation site began in early to mid-May. In contrast, snow-covered area data show rapid snow melt over much of the basin area in late March (Figure 3), with the snow line gradually rising in elevation throughout the spring. Spring snow storms are evident in the snow cover data for all years except 2006. These spring storms caused abrupt rises in snow cover over

Discussion

The spatial distribution of precipitation and temperature in the Cache la Poudre Basin implies a moisture surplus in the upper elevations of the basin and a moisture deficit in the lower elevation zones. Analyses of spring snow cover depletion and discharge data indicate that snow melt below around 8,000 feet does not typically result in increased river discharge. As the snow line rises above 8,000 feet, discharge begins to rise gradually, followed by a more rapid increase in flow as the snow line rises above around 9,500 feet elevation. Although each year exhibits a somewhat different relationship between snow cover depletion and discharge, the strong coupling between high elevation melt

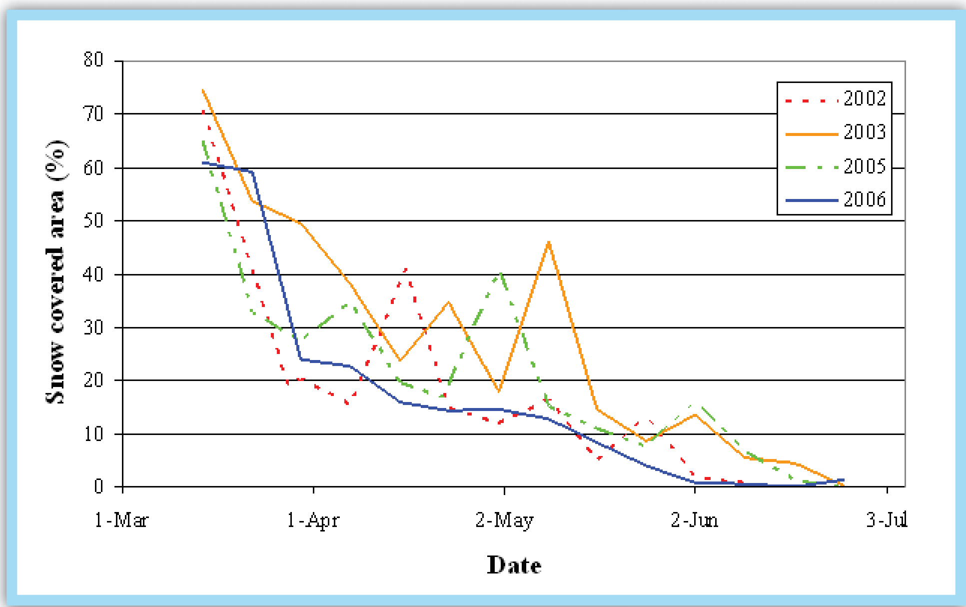


Figure 3. Spring-summer snow covered area depletion for the Cache la Poudre Basin. (Data source: MODIS 8-day composite snow cover, National Snow and Ice Data Center)

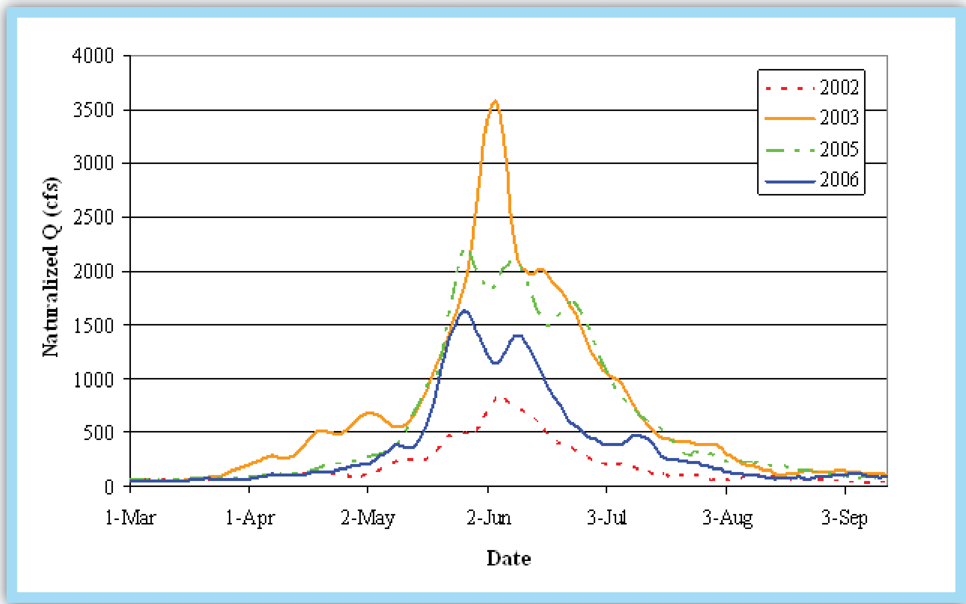


Figure 4. Naturalized discharge at the Cache la Poudre Canyon Mouth gauge. Discharge values represent a 7-day moving average. (Data sources: U.S. Geological Survey, Colorado Division of Water Resources, and water accounting by G. Varra)

and rapid increase in discharge suggests that high elevation zones contribute much of the snowmelt runoff to the river during high flows.

Under average conditions, the high-elevation moisture surplus is most significant in spring months, when precipitation is high but temperatures are still relatively low. Because precipitation in the basin is highest on average in the spring months, spring precipitation can contribute a significant portion of the annual water yield for the basin. The years 2005 and 2006 highlight the importance of spring conditions for river discharge. These years had similar high-elevation snow water equivalents on April 1 and May 1 (Figure 2), the dates when spring flow forecasts are issued, but the river flow was much higher in 2005 (Figure 4). During 2005, spring precipitation contributed to an increase in the high-elevation snowpack (Figure 2) and additional moisture input at lower elevations (Figure 3). With both high spring precipitation and cool spring temperatures, the 2005 snowpack persisted longer in the spring, and the river had a sustained high flow period lasting from mid-May through late June. In contrast, 2006 had low spring precipitation and warmer spring temperatures. The 2006 snowpack depleted rapidly throughout the basin (Figures 2 and 3), and the river had both lower peak flow and a shorter duration of high flows. With these warmer, drier spring conditions, the recession of the snowmelt hydrograph was already underway by mid-June.

Conclusions and Future Work

The timing and spatial distribution of precipitation in the Cache la Poudre Basin are both important controls on the amount of snowmelt runoff that occurs. Our preliminary results show that snowmelt from around 8,000-9,500 feet elevation tends to result in a gradual rise in Cache la Poudre river flow during April and early May. A rapid rise in the hydrograph occurs around mid-May, when the high elevation snowpack (above ~9,500 feet) begins to melt. Spring months have the highest average precipitation in this basin, and temperatures and precipitation during April and May can have a significant effect on river discharge.

MODIS snow cover data and the PRISM model have been useful for characterizing how and when different elevation zones in the basin contribute runoff to the Cache la Poudre during recent years (since 2000). We are working on quantifying these relationships and expanding the analysis to earlier years by using shape and timing characteristics of the hydrograph. Future work will incorporate snow cover, snow water equivalent, and temperature into a low-parameter model for predicting ensembles of snowmelt hydrographs under varying spring temperature and moisture conditions.

Acknowledgements

This project is funded by the Colorado Water Institute. We acknowledge the support and helpful contributions of Bill Fischer and Shawn Hoff from Cache la Poudre Water Users Association; Andy Pineda, Katie Melander, and Drew Linch of Northern Water; Tom Perkins and Mike Gillespie of the Natural Resources Conservation Service; and George Varra and Mark Simpson of the Colorado Division of Water Resources.

The Cache la Poudre River descends eastward in northwestern Colorado through Roosevelt National Forest in Poudre Canyon. (Image courtesy of Stephanie Kampf)

New Book by CSU Faculty Explores Ten of the World's Largest Rivers

by Ellen Wohl, Department of Geosciences, Colorado State University

A World of Rivers, currently in press at University of Chicago Press, explores the environmental history of ten of the world's large rivers. The book begins with an overview of the environmental services provided by functional rivers and the importance of river health. Each major chapter then explores the natural and human history of ten profiled rivers: the Amazon, Ob-Irtysh, Nile, Danube, Ganges, Mississippi, Murray-Darling, Congo, Chang Jiang, and Mackenzie. These rivers encompass the diversity of the world's large rivers: less altered tropical rivers (the Amazon and Congo), desert rivers that now have little flow by the time they reach the ocean (the Nile and Murray-Darling), highly engineered and regulated rivers of the temperate zones (the Danube and Mississippi), and boreal rivers (the highly polluted Ob-Irtysh and the relatively pristine Mackenzie).

Individual river chapters also highlight particular aspects of river form and process, different types of river engineering, and historical alteration of rivers. For example, the Amazon serves as the model for understanding the importance of the seasonal flood-pulse in large rivers; the Danube exemplifies simplification of complexly branching channel networks into single, relatively uniform channels for navigation and flood control; and the Nile and Murray-Darling illustrate some of the unforeseen consequences of water engineering in drylands, such as salinization). Interlude chapters between each major river chapter trace the journey of a hypothetical water droplet as it follows pathways of oceanic and atmospheric transport to the headwaters of the next river basin. This device emphasizes the interconnectedness of seemingly disparate regions of the planet and illustrates how water, airborne sediment and contaminants, and organisms move between discrete river drainages. A concluding chapter synthesizes patterns of environmental change and river alteration that appear when comparing all of the rivers and highlights the importance of river protection and restoration.

Recent synthesis papers in *Science* and *Nature* emphasize the global scale of human effects on rivers. Worldwide, an estimated 40,000 large dams (greater than 15 meters in height) and more than 800,000 smaller dams store approximately 9,000 cubic kilometers of water. This is equal to five times the volume of water in all the world's rivers. Dams also store 25-30% of sediment that formerly was carried to the oceans.

Human activities that cause soil erosion have increased the transport of sediment by the world's rivers by approximately 2.3 billion tons per year, but the storage in reservoirs has more than compensated for this increase, reducing sediment flux to the oceans by 1.4 billion tons per year. Over 100 billion tons of sediment and one to three billion tons of carbon are now stored in reservoirs built mostly within the past 50 years. These massive changes in the global cycling of water, sediment, and nutrients have created equally massive side effects, including depletion of dissolved oxygen and enhanced release of nutrients, heavy metals, and toxic compounds; collapse of inland fisheries and riverine and coastal ecosystems; and widespread coastal erosion and eutrophication. Flow regulation and development of floodplains is particularly widespread in Europe and North America, where up to 90% of historical floodplains are functionally extinct as a result of channelization, levees, and consumptive uses of river bottomlands. Although small in area, freshwater habitats are disproportionately rich in species; 12% of all animal species live on the less than 1% of the Earth's freshwater surface. As freshwater habitat has been lost over the past few decades, at least 35% of all freshwater fish species have become extinct, threatened, or endangered. Projected future declines in aquatic biodiversity are five times greater than the rate for terrestrial fauna and three times the rate for coastal marine areas.

Although the details vary, five alterations appear consistently among most of the rivers profiled in *A World of Rivers*: loss of longitudinal connectivity, flow variability, lateral connectivity, and complexity; and contamination of water and stream sediments. As we recognize the scale of these losses and the importance of healthy river ecosystems, river restoration projects that are local and regional in scale are gaining momentum.

Although dams exist on some tributaries, and mining and deforestation have altered some parts of the Amazon Basin, many physical and ecological processes remain relatively natural on the world's largest river.

Tamarisk Control Efforts in the Colorado River Basin

by Tim Carlson, Executive Director, Tamarisk Coalition

As we are all aware, the water budget in the western United States is rather like the current American economy—there is nothing to spare. To increase yields, western water authorities are considering the water-saving potential of controlling the invasive species tamarisk, a plant known for its alleged thirst. However, as with any complex issue, there are many aspects to consider.

Tamarisk (*Tamarix sp.*), or salt cedar, is a shrub or small tree that was introduced to the western U.S. from Eurasia in the early nineteenth century. A facultative phreatophyte, it has an extensive root system suited to the hot, arid climates and alkaline soils common in the West. Its adaptations allow it to dominate many low-elevation (under 6,500 feet) river, lake, and stream banks, covering an estimated 1 to 1.5 million acres in the western U.S.

This tamarisk infestation has many negative impacts. The deep root systems that allow tamarisk to exploit valuable water resources also enable it to out-compete and displace native riparian and adjacent dryland vegetation, increase the risk of wildfire, and increase surface soil salinity. Tamarisk's tolerance for the conditions it augments results in dense monocultures that provide poor habitat and forage for most wildlife species, and that will dominate an ecosystem until actively removed by humans.

Mechanical, chemical, and manual tamarisk removal is expensive, and potential benefits must be shown to justify costs. Retaining water in western rivers is one benefit that would validate significant expenditures. However, it is unclear how much, if any, water would be recovered by removing tamarisk, especially considering that removal sites must be revegetated with native plants to ensure that tamarisk or other invasive species do not simply reinvade the area. Just how much water can be saved if native species are restored is a question that many scientists and land managers are very interested in answering.

Water recovery is estimated using evapotranspiration (ET) rates for a given species, which represents the loss of water to the atmosphere through soil evaporation and plant transpiration, and the percent cover of that species. While generalizations can be made, estimates of potential water savings are difficult to obtain. Water consumption estimations vary a great deal depending on location, maturity, density of infestation, water quality, and groundwater depth. Thus, even experts have difficulty predicting the water savings that will result from tamarisk control efforts.

Clear indications of this issue's importance are the Colorado River Watershed Tamarisk Impact Assessment reports being prepared by both the Bureau of Reclamation and the Tamarisk Coalition. Both documents will address the issue of tamarisk water use and are expected to be completed early in 2009. To tackle the water use issue in the report, the Tamarisk Coalition convened a panel of experts to discuss evapotranspiration and to draft a state of the science report. The results of these efforts will help scientists assess current knowledge and research needs and will help managers create useful action plans.

Another factor that affects tamarisk water budget studies is the biological control agent, the tamarisk leaf beetle or *Diorhabda elongata*. Identified as a control agent in 1987, *D. elongata* was released in the wild in 2001 after rigorous testing. Released in California, Colorado, Nevada, Utah, Texas, and Wyoming the several beetle populations are well established and rapidly defoliating tamarisk, a process that can kill the plants if repeated sequentially for several years. Research is underway to document the reduction of water use due to defoliation, and initial results look promising.

Tamarisk dominates the banks of the Colorado River near Grand Junction, Colorado.

However, water savings are not the only ecosystem shift expected to result from bio-control.

This brings us to another interesting twist in the tamarisk story. Although tamarisk monocultures support fewer birds than do native habitats, mixed tamarisk/native habitats appear to be good bird habitat. One species that makes use of tamarisk is the endangered southwestern willow flycatcher; many populations of this species are presently dependent on tamarisk-invaded habitat that has replaced native willow stands. It is possible that control of tamarisk by *D. elongata* may negatively impact the flycatcher. This concern was taken into consideration when the beetle was released. Release sites are not permitted within 200 miles of the flycatcher's habitat, and the initial beetle ecotypes released were not adapted to conditions in the flycatcher's range and thus not expected to spread there. However, the beetle populations are adapting to more southerly latitudes and are beginning to encroach on flycatcher habitat. One response to this development would be to plant native vegetation, namely willows, in areas directly adjacent to current flycatcher habitat. Such work could be completed immediately on a small scale to great benefit. However, there is some resistance to replacing tamarisk with native species on a large-scale, particularly in the lower Colorado River Basin.

Volunteers remove tamarisk near Fruita, Colorado.

Members of the Tamarisk Coalition monitor tamarisk leaf beetles along the Colorado River.

Some scientists and land managers do not believe that tamarisk control is cost effective, especially in the highly saline soils and altered flow regimes of the lower Colorado River Basin. This position hinges on the opinion that native vegetation can no longer be sustained in the highly altered environment and that tamarisk should be left as default vegetation. While it is true that these highly altered systems pose real challenges to revegetation and restoration efforts, successful projects such as the Yuma East Wetlands project in Arizona suggest that difficulties do not equal impossibilities. They do equal high prices, however, and just as Americans are carefully weighing every expenditure, the benefits of restoring a healthy ecosystem must balance the costs. Clearly, tamarisk removal is a complicated issue, particularly in the lower basin states, that will greatly benefit from continued research.

State Zebra and Quagga Mussel Program Update

by Elizabeth Brown, Invasive Species Coordinator, Colorado Division of Wildlife

Zebra and quagga mussels are two highly invasive aquatic species that were first identified in Colorado in January 2008. They get their name from the black- (or dark brown) and white-striped markings that appear on their shells. Native to the Dneiper River and the Caspian, Black, and Azov Seas of Eastern Europe, these exotic mussels were first discovered in the United States in Lake Saint Clair, Michigan, in 1988 and are believed to have been introduced in 1986 through ballast water discharge from ocean-going ships. Since their initial discovery, zebra mussels have spread rapidly throughout the Great Lakes and Mississippi River Basin states and other watersheds throughout the eastern and central United States.

Primarily plankton grazers, the mussels feed by filtering up to a liter of water per day through a siphon, consuming large portions of the microscopic plants and animals that form the base of the food web. Removal of significant amounts of plankton from the water by mussels can cause a shift in native species and a disruption of the ecological balance of a lake or other waterway.

The mussels can attach to hard surfaces and settle in massive colonies that may block water intake and affect municipal water supply, agricultural irrigation, and power plant operation. In the United States, Congressional researchers estimated that zebra mussels alone cost the power industry $3.1 billion from 1993-1999, with impacts to industries, businesses, and communities estimated at more than $5 billion.

The Colorado Division of Wildlife (DOW) coordinates the State Aquatic Nuisance Species (ANS) Program, which has recently completed the State Zebra and Quagga Mussel Management Plan (ZQM Plan). The ZQM Plan describes the collaborative approach to detecting, containing, and substantially reducing the risk of the spread and further infestation by zebra/quagga mussels in Colorado. The Plan's primary components are early detection, containment, prevention, education/outreach, and research.

The foundation of the ZQM Plan is a mandatory watercraft inspection and decontamination program to prevent the spread of mussels overland on recreational watercraft. Beginning in 2009, all trailered watercraft must submit to an inspection prior to leaving an infested reservoir, prior to entering a high risk reservoir, and prior to launching in any waters of the state if the watercraft has been out of state waters in the previous 30 days. Inspection stations will be located adjacent to infested and high-risk waters, at state parks, and at select DOW offices.

The primary method of overland dispersal of the mussels is through human-related activities. Given their ability to attach to hard surfaces and survive out of water, many infestations have occurred when adult mussels "hitch" rides on watercraft. Therefore, it is critical for all watercraft to be cleaned, drained, and dried between water launchings. Boaters should remove all visible plants and mud from the boat and trailer and drain all water from the boat. Because juvenile mussels are microscopic, they can be transported in water that is carried from one reservoir to another. Mussels can live in mud and on plants that boats move to new waters.

In addition to the ZQM Plan, regulations have been drafted as required by the State ANS Act and will be presented to

Colorado Governor Bill Ritter signs the Aquatic Nuisance Species Act (Colorado Senate Bill 08-226) on May 29, 2008. (Image courtesy of Jerry Neal, Colorado Division of Wildlife)

The state education campaign about aquatic nuisance species includes billboards, brochures, and signs at boat access points. (Image courtesy of Elizabeth Brown, CO Division of Wildlife)

the Parks Board in February. These regulations define ANS (plant and animal) and set the standard requirements for scientific collection, sampling, identification, watercraft inspection, decontamination, impoundment, training, and reporting. The draft regulations mirror requirements of the ZQM plan (i.e., mandatory watercraft inspections).

The Colorado ANS Management Plan (CANS Plan) is the final piece of the strategic puzzle. The CANS Plan was drafted by the Colorado ANS Steering Committee, which includes 15 members from state, federal, and local governments; private industry; and non-governmental organizations (NGOs). The Plan, which details the recommended programmatic approach for managing ANS (plant, animal, and pathogen) in Colorado, is currently awaiting approval by both the Federal ANS Task Force and the Colorado Governor. Upon approval, Colorado will be eligible for funding through the National Invasive Species Act of 1996.

Statewide monitoring will continue for zebra and quagga mussels beginning in spring 2009. In addition, the DOW plans to resume statewide sampling for over 25 species of aquatic weeds and over 20 animal species, while collecting baseline data on native species. The DOW conducts visual and molecular identification for aquatic species at the Aquatic Animal Health Lab.

The statewide education program is being increased this year. Key elements include expanding the billboard campaign, developing an invasive species webpage, increasing signage at waters, and distributing print information. The DOW is also developing curriculum for grade school, junior high, and high school on invasive species using zebra mussels as the poster species. The curriculum will teach math, geography, and biology concepts by exploring invasive species.

Several Front Range municipalities implemented preventative inspection programs in 2008, and the DOW hopes that more will follow. The boating public was especially helpful and cooperative with the response program in 2008, and the DOW is asking for public assistance again. All managers, recreational users, and partners have the ability to protect Colorado waters by ensuring that watercraft are clean, drained, and dry before launching.

For more information, please visit www.colorado.gov/wildlife or call (303) 291-7362.

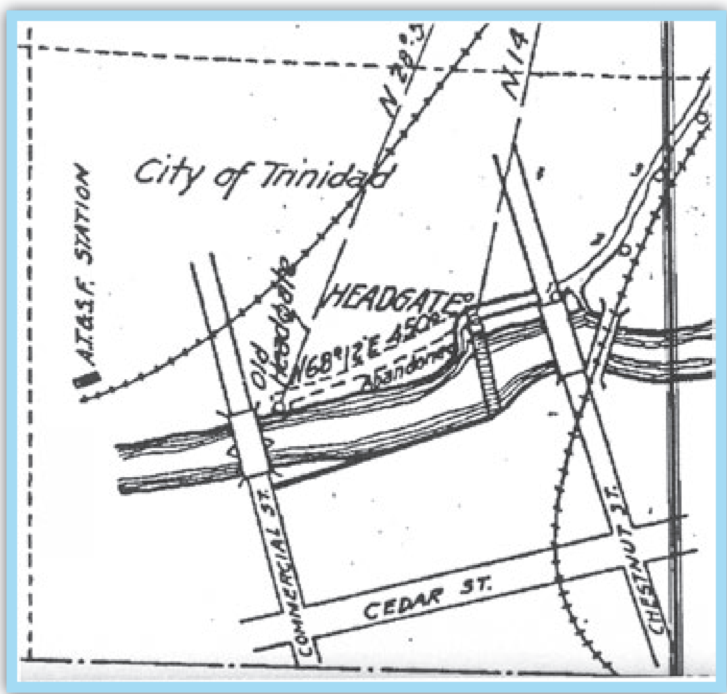
A boat is washed during a watercraft decontamination day held in 2008 at Grand Lake and Lake Granby, Colorado. Colorado Division of Wildlife staff have implemented a watercraft inspection and decontamination program to prevent the spread of mussels overland on recreational watercraft. (Image courtesy of Elizabeth Brown, CO Division of Wildlife)

Early History of the Baca Ditch

by Virginia Sanchez, Independent Historian, New Mexico and Southern Colorado History

When Spanish colonists first entered the southwestern part of the United States, they brought with them the knowledge of acequia (irrigation ditch) water engineering. Acequias are engineered canals that carry water from a river or stream to distant farmlands. Based on gravity flow, they move the water in a snake-like pattern following the contour of the land, turning slightly up a hill or around large trees and boulders to control the flow of water. The early Hispano farmers of present-day southern Colorado learned how to use gravity to control water flow from long-standing customs established by their ancestors from New Mexico. Anglo settlers, farmers, and entrepreneurs migrating from the east into southern Colorado found fertile fields irrigated by acequias. In fact, the acequia system is the oldest water management system in the United States and has historical ties to the water systems of medieval Europe and northern Africa.

About 1860, Felipe de Jesús Baca and his family settled the Town of Trinidad, Colorado, and began constructing an acequia to irrigate their crops. This acequia became known as the Baca Ditch. Because it was a major stop along the Mountain Branch of the Santa Fe Trail, the Town of Trinidad became a major center for people and freight arriving from the east, and Felipe Baca became an influential leader of the community. In 1870, he served in the Colorado Territorial Legislature and was personally, socially, and politically connected with Colorado statesmen Casimiro Barela and Jesús María Garcia. The Baca Ditch is still in operation today and takes its water from a river that was called Río de Las Ánimas Perdidas en Purgatorio. Today, it is known as the Purgatoire or Picketwire River (Picketwire evolved from a mispronunciation of the French word purgatoire, which means purgatory).



This illustration shows the location of the main headgate of the Baca Ditch in Trinidad, Colorado.

Like most early acequias, the Baca Ditch was dug by hand using wooden tools. Dirt and rock were loaded onto large pieces of rawhide and hauled to a dump site by mule or oxen. On sloping ground, contents were dumped on the downhill side to build up the embankment. After a large section of the ditch had been dug, its engineering was tested by channeling water into the ditch through a dam and inlet works positioned at a point on the river. Logs, rocks, and brush were used to construct a dam to contain the water spilling into the main headgate at the inlet, and a wooden headgate at the inlet regulated the water flowing into the acequia. Over time, silt sealed the ditch and the ground absorbed less water.

Only parciantes (irrigators) associated with the Baca Ditch were allowed water from the ditch. Each parciante had a wooden headgate at the opening of his sangría (individual outlet or lateral ditch) to control the flow of water onto his field. Insufficient water flow resulted in sinkholes and less water getting to the crops; too much water flow could erode fertile topsoil and wash away seeds and growing shoots. To administer a ditch and resolve disputes, an acequia association (membership) established a form of governance incorporated from long-standing rules and customs. Each year, parciantes elected a mayordomo (ditch boss) to enforce their agreements and manage their ditch affairs. Because acequia administration was so deeply rooted in Hispano precedence, custom, and oral tradition, mayordomos and parciantes worked together without a need to keep written records. The mayordomo was authorized to fine transgressors for misuse of the water, and when water conflicts arose among parciantes, he stepped in to intervene.

To assure the continued operation of their ditch, every parciante worked and shared labor responsibilities to maintain and keep it free flowing throughout the irrigation season. The spring cleaning—clearing the acequia of debris collected during the non-irrigation seasons, burning and cutting weeds, and repairing and reinforcing ditch banks—engaged the participation of multiple generations and perhaps served as a child's rite of passage. The gathering was a celebration of community, and when parciantes

Historic photo of Felipe de Jesús Baca. (Image © Colorado Historical Society)

were not in attendance, associations imposed fines.

Rules for water sharing during times of drought or water scarcity were based on which uses were of most benefit to the community—distribute first to those in greatest need, take water only when it is your turn, and take no more than the amount you need. If a parciante did not need or want the water during an irrigation season, he notified the mayordomo so the water could be used by those who needed it. In times of shortage, the mayordomo partitioned the available water equitably among parciantes by limiting the amount of time each could irrigate. Every parciante who needed water got at least some water, a concept that is quite different from the Colorado Law of Prior Appropriation where allotments are based on priority number and quantity.

Colorado became a Territory in 1861, and by 1872 new state water laws enacted for Costilla (rib) and Conejos (rabbit) counties included Huérfano (orphan) and Las Ánimas (the souls) counties, two other Hispano-populated counties in southern Colorado. This law established duties of the mayordomos and rules for their elections, regulated the use of acequia water by mills or other industry, and gave elected acequia officials power to order compulsory labor from parciantes who used the water. In compliance with the 1872 amended Colorado water law, all acequia associations and ditch companies held annual meetings and elected new officers. These ideals and important norms were not new to Hispanos, as they had practiced these concepts for centuries.

During times of economic strife, some parciantes sold off parts of their land and water rights, resulting in the reduction of available irrigation water. As some parciantes periodically or permanently left to work away from home in the mines or on the railroad, those remaining were left to either maintain the ditch themselves or hire contract labor. Contributions to acequia dues and expenses stretched family budgets, and sons and grandsons who now lived farther away were called upon for their much-needed labor. Over time, the annual spring cleaning became a chore rather than a celebration of community.

The main headgate of the Baca Ditch was originally located on the north bank of the Purgatoire River east of present day Commercial Street in Trinidad. On an unknown date, the ditch was abandoned when commercial property replaced farm land. When crop land was brought under cultivation outside Trinidad, the Baca Ditch was put back into use. In fact, its headgate was moved several times and the ditch was enlarged to irrigate additional land.

By the 1870s, some Colorado farmers began developing ditch corporations to manage their water. The larger irrigation systems chose to incorporate, so as to enter into contracts and legal obligations as corporate entities. In 1884, five years after Felipe Baca's death, Edward F. Mitchell, Theodore Hamlan, and Edward J. Hubbard established and incorporated The Baca Irrigating Ditch Company. The first enlargement of the Baca Ditch occurred that same year; however, no additional water was apportioned. Casimiro Barela and Jesús María Garcia became stockholders of company but were likely associated with the Baca Ditch prior to that time. From 1896 to 1898, Garcia served as Secretary-Treasurer of its board of directors.

On September 9, 1886, stockholders of The Baca Irrigating Ditch Company proposed to enlarge the Baca Ditch and extend it to Powell Canyon (Powell Arroyo)—a distance of approximately seven miles. The following year, they extended the length of the ditch by 10 feet and enlarged the main headgate and the bottom width of the ditch. To accommodate the growing needs of the community, the headgate of the Baca Ditch was subsequently moved several times and the ditch was again enlarged to irrigate land farther away. By 1898, the Baca Ditch fed three other ditches to irrigate 800 acres (North Side, Lujan, and Chicosa Ditches), carrying all appropriated water for or acquired by these ditches. By 1903, the headgate of the Baca Ditch was moved to its present location west of Chestnut Street.

Today, water in the Baca Ditch moves through a concrete diversion structure toward the farming community of El Moro. Although it is not the oldest acequia in Colorado, it is an important part of southern Colorado's historical landscape. Little did Felipe de Jesús Baca realize that nearly 150 years later, his Baca Ditch would continue to divert a significant amount of water.

For further information about the history of acequias in the southwestern U.S., contact Virginia Sanchez at virginia.sanchez@comcast.net.

The Fort Collins Weather Station–120 years

by Nolan Doesken, Colorado State Climatologist, Colorado Climate Center

December 31, 2008, marked the completion of 120 years of uninterrupted weather data collection at the historic weather station on the campus of Colorado State University. The station occupies a prominent location northwest of the Lory Student Center. Thousands of students and campus visitors pass by on their way to and from classes and events; yet, few people even notice or are aware of this important campus landmark and the role it plays.

The Fort Collins weather station is one of only a handful across the country that has been maintained for so long in the same approximate location. The Rocky Ford weather station at CSU's Arkansas Valley Research Center also dates back to 1889. The oldest continuously operated weather station in Colorado is Denver, with records beginning in 1871. However, that weather station has been moved many times and many miles, initially occupying several locations in downtown Denver, then several locations at the old Stapleton Airport, and now at Denver International Airport.

The Fort Collins weather station belongs to a network of over 200 National Weather Service Cooperative weather stations in Colorado and is part of an important nationwide network of over 8,000 stations. Data from these stations are considered "official" and are archived by NOAA's National Climatic Data Center in Asheville, North Carolina, and are used daily to monitor and track our nation's weather conditions and climate resources. There is no reimbursement from the National Weather Service to CSU for the facility or the human resources required. That support has been provided continuously since 1889 by the Colorado Agricultural Experiment Station, a key element of the Land Grant University system.

What Do We Measure?

The Fort Collins weather station has measured the basic elements of temperature and precipitation since 1889. Even before that, sporadic data were gathered in the 1870s and 1880s in the earliest years of the college. In addition, morning and evening measurements of humidity, snowfall, snow depth, snow water equivalent, wind speed and direction, barometric pressure, cloudiness, visibility, sunshine, solar energy, soil temperatures, and hail stone size and intensity are collected. Few weather stations across the country measure evaporation, but this has always been a priority measurement here. Evaporation data were used extensively in early research by the former Department of Irrigation Engineering. Maxwell Parshall, son of Ralph Parshall of the Parshall flume fame, was in charge of the weather station from the 1930s until the formation of CSU's Department of Atmospheric Science in 1962.

The Fort Collins weather station on the CSU campus.

Climate Highlights of the Past 120 Years

Since 1889, annual precipitation has averaged 15 inches; however, precipitation varies greatly from year to year. Individual years have seen as little as 7.39 inches in 1966 to a high of 28.30 inches in 1961. The driest recent year was 2002 with 9.22 inches. Despite these wild fluctuations, no obvious long-term trends are evident. The largest rain storms on record were 6.07 inches on August 3-4, 1951, and 6.17 inches on July 28-29, 1997. Snow is also highly variable—prior to 1940, there were some years with less than 15 inches of seasonal snowfall. The snowiest winter in Fort Collins history was the winter of 1979-80 with 114.2 inches. Other memorable snowstorms occurred in early December 1913 and, more recently, in March 2003 when so much heavy, wet snow dropped that many buildings were damaged and roofs collapsed under the weight of the snow.

Temperatures have ranged from a low of -41°F on February 1, 1951, to a high of 103°F on July 21, 2005. The mean annual temperature is approximately 49.2°F and typically varies a few degrees from year to year. Long-term data show a noticeable upward trend at the Fort Collins station. Some of this warming is associated with a widespread warming trend observed over portions of the southwest and north central U.S. However, a closer inspection of the station history shows the profound change in the environment around the station since the 1880s. What used to be wide open fields and grassland near the station has gradually been replaced by buildings and pavement, especially during the time when the campus grew rapidly in the 1950s and 1960s. Much of the observed warming trend of over 4°F in the past century is a result of the change in the local environment and the "urban heat island" effect that has developed.

Benefits of Long-term Data

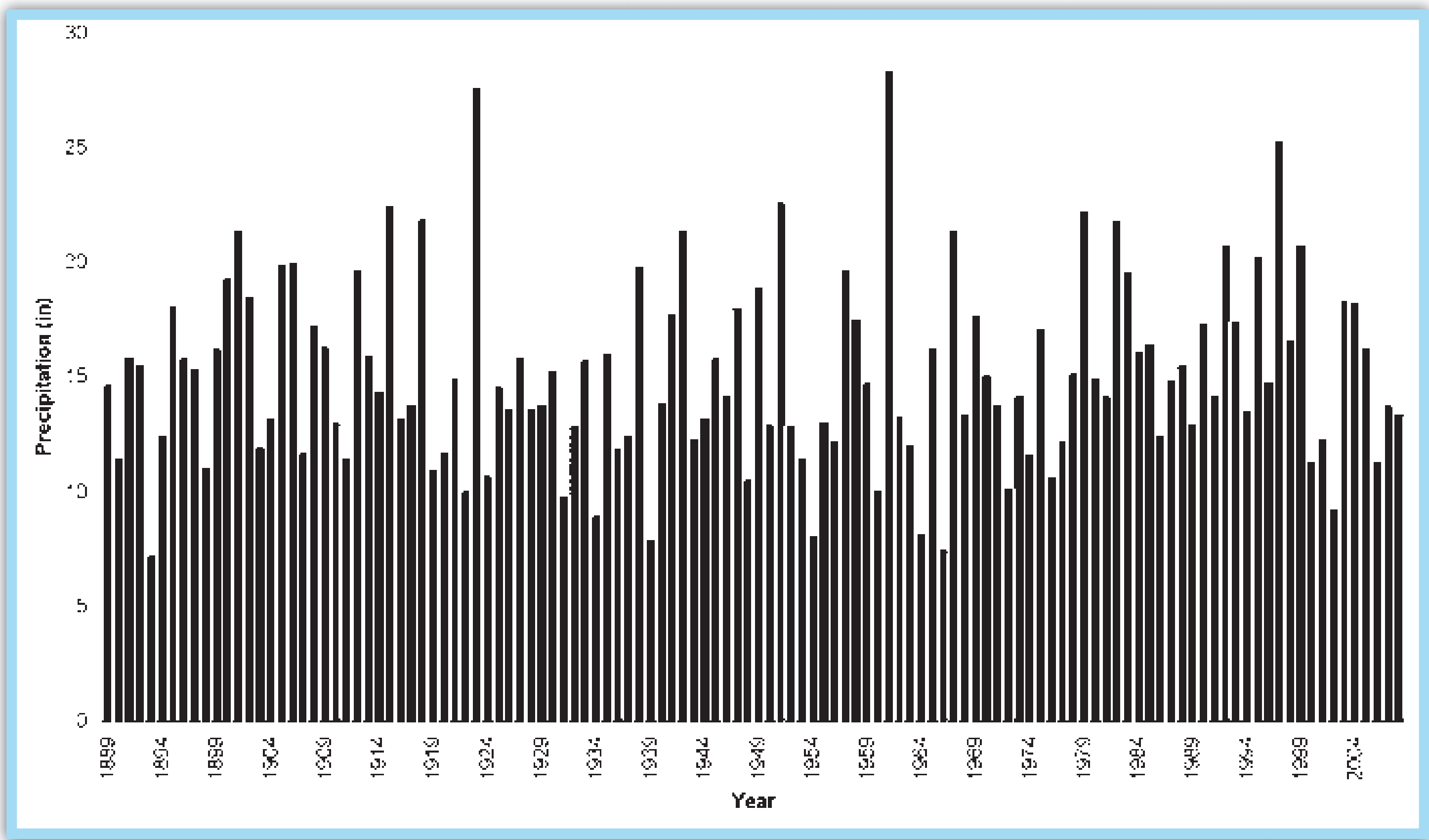
From weather forecasting and transportation safety, to support of agricultural and business decision making, many individuals and organizations rely on accurate and timely weather data. Weather data in Colorado continue to be essential for tracking water supplies and water use as well as administrating surface water resources. The engineering community is a big user of recent and historic data. For example, rainfall data help civil engineers assess flood frequencies. After the Fort Collins flash flood of July 28, 1997, (which also flooded the weather station and many parts of the CSU campus) detailed data analyses were performed to determine if engineering design criteria for flooding and storm water runoff were adequate. Heavy snows in 2003 prompted a review of building codes associated with snow loads and engineering requirements for roofs. By maintaining comprehensive weather data collection, we can determine our basic climate resources, the range of variations and extremes to expect, and long-term variations and trends.

The weather station is also used to test and compare various weather instruments, including thermometers, rain gauges, instruments for estimating evaporation, and new sensors for tracking the accumulation of snow.

Accessing Data

There are several ways to access Fort Collins weather station data. Current and recent data can be viewed or downloaded from the Colorado Climate Center website at http://ccc.atmos.colostate.edu. Graphs and tabular data of 1889-current temperature and precipitation data will soon be available on the new Colorado Climate Trends website that will be posted this spring. Digital data for some of the observed elements can be downloaded from the National Climatic Data Center or the Western Regional Climate Center. Hardcopy hand-written records are still maintained at CSU.

Annual Precipitation for Fort Collins, Colorado, 1889-2004



(data courtesy of Colorado Climate Center)

Protecting Critical Watersheds in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization

by Brad Piehl, Partner, JW Associates, Inc.; and
Katherine Timm, Outreach Division Supervisor, Colorado State Forest Service

The seven major Front Range water providers—Aurora, Boulder, Colorado Springs, Denver Water, Fort Collins, Northern Colorado, and Westminster—draw their water supplies from 10 watersheds in the mountains that collectively provide more than two-thirds of Colorado's population with drinking water. Many cities, towns, and villages in the mountains also depend on these watersheds for drinking water.

The Front Range of Colorado experienced major impacts on municipal water supplies as a result of flooding, erosion, and sediment deposition after the 1996 Buffalo Creek Fire, 2000 Bobcat Fire, and 2002 Hayman and Schoonover fires. In July 2007, the Pinchot Institute for Conservation released an assessment report titled *Protecting Front Range Forest Watersheds from High-Severity Wildfires*, which was funded by the Front Range Fuels Treatment Partnership. The study concluded that climate factors and forest conditions place Front Range source watersheds at high risk from severe wildfires that threaten water supplies and the integrity of reservoirs due to erosion and flood damage. General areas of wildfire hazards and water supplies at risk were identified through the study.

In August 2007, the Colorado State Forest Service and U.S. Forest Service hosted a meeting with Front Range water providers to discuss the report's findings and explore opportunities for joint action. In September 2007, the agencies and water providers met again and crafted the structural outlines of a partnership effort to protect Front Range watersheds from severe wildfires. As a result, the Front Range Watershed Wildfire Protection Working Group was formed to develop and implement a strategy to protect critical Front Range Watersheds from damage due to high-intensity wildfires. Three work groups were formed to carry out the actions of the strategy. The Work Group coordinated its efforts with the Front Range Fuels Treatment Partnership Roundtable, which is composed of members from more than 40 participating organizations.

In June 2002, the Hayman Fire burned areas around Cheesman Reservoir in Colorado.

Front Range Watershed Protection Assessment Process

The Front Range Watershed Protection Data Refinement Work Group (Work Group) is one of three sub-groups that evolved from the Front Range Watershed Wildfire Protection Working Group. The purpose of this Work Group is to adapt and refine the methods used by the Pinchot Institute for Conservation to assess individual watersheds within the 10-county area served by the Front Range Fuels Treatment Partnership and Roundtable.

Building on the work of the Pinchot Institute for Conservation, the Work Group reviewed additional information and created a template for watershed assessments to identify critical watersheds that supply municipal water. The purpose of the watershed assessments is to identify and prioritize hazard reduction treatments in watersheds that provide or convey critical community water supplies. The Work Group envisions that the template can be used in any 5th-level watershed in Colorado and throughout the western United States.

Goals

The primary goal of the Data Refinement Work Group was to develop and adopt a clear and common methodology to identify 6th-level watersheds (defined below) that are critical for water supplies; to develop criteria and processes and recommend data that can be used to determine hazards/effects associated with fire and treatment potential for 6th-level watersheds; and make the methodology and data available for use in determining priorities.

A second goal was to apply the watershed assessment approach to a test case to help adapt and refine the approach.

Analysis Units

Existing delineated watersheds were used to designate the areas drained by surface water. The Work Group chose to analyze and prioritize 6th-level/12-digit watersheds, typically 16-63 square miles or 10,000-40,000 acres, because a wide range of data are generally available at this scale and it is a good size for landscape-level fuels treatment planning. Sixth-level watersheds are the standard analysis unit recommended for the watershed assessments.

The Work Group chose the Upper South Platte Watershed as its test case because it is well known and studied; a previous prioritization exists to which results can be compared; and acquiring soils data for the area is challenging in the Upper South Platte Watershed—a 5th-level watershed that is approximately 649,694 acres in area and contains 22 6th-level watersheds.

This image shows the after-effects of the 2002 Hayman Fire on the area around Cheesman Reservoir.

Watershed Assessment Components

A watershed's potential to deliver sediments following catastrophic wildfire depends on forest and soil conditions and the physical configuration of those watersheds. High-severity fires can cause changes in watershed components that can dramatically alter runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is affected by fire.

This watershed assessment considers four components that are defined as most critical when evaluating hazardous watershed conditions: **wildfire hazard**, **flooding or debris flow risk**, **soil erodibility**, and **water uses ranking**.

Wildfire Hazard

In 2007, the Pinchot Institute for Conservation evaluated the wildfire hazard for the 10 Front Range counties. The results of this analysis were used for the wildfire hazard assessment for the Upper South Platte Watershed test case.

Flooding or Debris Flow Risk

Watershed steepness or ruggedness is an indicator of the relative sensitivity to debris flows following wildfires. The more rugged the watershed, the more likely it is to generate debris flows following wildfire. A combination of slope, road density in miles of road per square mile of watershed area, and other data were used as inputs to the flooding or debris flow risk portion of the analysis.

Soil Erodibility

The soil analysis used a combination of two standard erodibility indicators: the inherent susceptibility of soil to erosion (K factor) and land slope derived from U.S. Geological Survey 30-meter digital elevation models. The K factor data were combined with the slope grid using Natural Resources Conservation Service slope-soil relationships to create a classification of slight, moderate, severe, and very severe erosion hazard rating.

(**Note**: Soils scientists have observed that K factor in the Upper South Platte Watershed test area does not adequately identify soil erodibility on granitic soils. Therefore, a geology layer was used to identify areas of granitic soils, and the erodibility rating was increased for those soils. The soils erodibility analysis was extracted from the 1999 Upper South Platte Landscape Assessment.)

Water Uses Ranking

Water intakes, diversions and storage reservoirs, and streams that are used as conveyances are susceptible to the effects of wildfires. These structures have been identified for the Colorado Source Water Assessment completed by the Colorado Department of Public Health and Environment. These data were used to define which 6th-level watersheds contain critical water supply infrastructure as part of the water use ranking.

Overall Watershed Ranking

Overall watershed ranking will be determined by creating a Composite Hazard Ranking; creating a Final Watershed Prioritization map by adding the Water Uses Ranking to the Composite Hazard Ranking map; deciding on what approach to take for the Zones of Concern (described below), and adding them to the Final Watershed Prioritization map.

Composite Hazard Ranking

The Composite Hazard Ranking is the combination of the rankings of the first three components (Wildfire Hazard, Flooding/Debris Flow Risk, and Soil Conditions). These are combined by averaging the rankings of the Wildfire Hazard, Flooding or Debris Flow Risk, and Soil Erodibility for each 6th-level watershed. A Composite Hazard Ranking map of the results is then created using the following scheme:

- Category 1 – Low
- Category 2 – Moderate
- Category 3 – Moderate-High
- Category 4 – High
- Category 5 – Very High

The Work Group believed it valuable to create this Composite Hazard Ranking map to compare relative watershed hazards based solely on the physical inputs.

Final Watershed Prioritization

The Final Watershed Prioritization involves combining the Composite Hazard Ranking map and the Water Uses Ranking.

Zones of Concern

The Work Group identified an important risk factor for water uses related to transport of debris and sediment from upstream sources. The area upstream from important water supply reservoirs or diversions that have a higher potential for contributing significant sediment or debris is called the Zone of Concern. These zones also could be used to define project areas on which stakeholders can focus watershed protection actions. The 6th-level watersheds that are within that distance are considered to be within the Zone of Concern. The boundaries for the Zones of Concern will be drawn and overlaid on the Final Watershed Prioritization map.

The Next Step—Using the Watershed Assessment to Identify and Develop Critical Community Watershed Wildfire Protection Plans

Each reservoir, water intake, or other water infrastructure element has a set of stakeholders interested and involved in its operation and maintenance. In some cases, this may be a single water provider or community. In other cases, multiple communities and water providers may have an interest.

In addition, existing Community Wildfire Protection Plans (CWPPs) may cover portions of the watershed(s) in which planning will occur. These existing plans should be inventoried and the stakeholders involved in those planning efforts should be invited to participate in this expanded watershed planning effort. Specific treatment areas and priorities of existing plans also should be reviewed for their contribution to the watershed protection effort and incorporated into the expanded plan.

In a similar manner, there may be other existing land and vegetation management plans, fuels treatment plans, or prescribed fire or fire use plans that cover portions of the watersheds in which planning will occur. The stakeholders in these other efforts also should be invited to participate. After the stakeholder list is complete and existing treatment plans are inventoried, the planning effort may begin in earnest.

The Front Range Watershed Protection Data Refinement Work Group

- Brian Banks, U.S. Forest Service
- Dana Butler, U.S. Forest Service
- Carl Chambers, U.S. Forest Service
- Chuck Dennis, Colorado State Forest Service
- John Duggan, Colorado Department of Public Health and Environment
- Hal Gibbs, U.S. Forest Service
- Steve Gregonis, U.S. Forest Service
- Dave Hessel, Colorado State Forest Service
- Eric Howell, Colorado Spring Utilities
- Don Kennedy, Denver Water
- Jeff Kitchens, Bureau of Land Management
- Deb Martin, U.S. Geological Survey
- Jim Maxwell, U.S. Forest Service
- Mike McHugh, City of Aurora
- Chris Mueller, U.S. Natural Resources Conservation Service
- Brad Piehl, JW Associates
- Eric Schroder, U.S. Forest Service
- Ed Spence, U.S. Natural Resources Conservation Service

FY09 Student Water Research Grant Program Request for Proposals

The Colorado Water Institute is pleased to announce a request for proposals for the FY09 Student Water Research Program.

All proposals must be submitted online by February 27, 2009.
Please visit http://www.cwi.colostate.edu for submission site.

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 nine public universities (ASC, CSM, CSU, CU, FLC, MSC, MSCD, UNC, or WSC).

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.

Water Tables 2009 to Focus on Water Conflicts

by Jane Barber, Assistant Director of Communications Development and
Patricia J. Rettig, Head Archivist, Water Resources Archive, CSU Libraries

On Saturday, February 21, 2009, the Colorado State University (CSU) Libraries will once again host Water Tables, its annual fundraiser for the Water Resources Archive. The theme of this year's event is "Compact Issues and Conflict Resolution." Nineteen water experts will host tables discussing relevant topics while a gourmet meal is served. The evening will begin with a reception and open house for the Water Resources Archive in CSU's Morgan Library.

In February 2008, the third annual Water Tables attracted nearly 200 guests from across the state and raised more than $30,000 for the Water Resources Archive, which preserves materials critical for documenting the state's water history. "The evening was enjoyable, and it was a credit to CSU and its library system," said Ken Wright of Wright Water Engineers, event sponsor and Archive donor. "The 19 or so tables all had good discussion moderators who had been thoughtfully selected. We are already looking forward to the 2009 Water Tables."

Table hosts and topic discussions for Water Tables 2009 will focus on various aspects of interstate water compacts or other ways of resolving water conflicts. Archival materials on display during the open house will illuminate the history behind these topics. This year's table hosts and topics are:

Jim Broderick, Director of the Southeastern Colorado Water Conservancy District
Topic: Colorado's Fryingpan-Arkansas Project: conflicts past, present and future

Nolan Doesken, Colorado State Climatologist
Topic: Climate variations in Colorado and their role in water conflicts

John Eckhardt, Executive Program Manager for the Imperial Irrigation District
Topic: Compact requirements and third party impacts of the world's largest ag to urban water transfer

JOIN US FOR
Water Tables 2009

COMPACT ISSUES AND CONFLICT RESOLUTION
A benefit for the Water Resources Archive at
Colorado State University
Libraries

SAVE THE DATE:
Saturday, February 21, 2009
Morgan Library, CSU Campus
5 p.m., Reception and Archive Tours
7 p.m., Dinner and Conversation

Tickets: $125 per person
Reservations: accepted through February 16, 2009

By phone: (970) 491-1833, or online at:
lib.colostate.edu/watertables09

David Freeman, CSU Professor
Topic: Twelve years' negotiating for habitat within the confines of the 1923 South Platte Compact

Neil Grigg, CSU Professor
Topic: Pecos River Master asks "How will we resolve water conflict in a world with seven billion people?"

John R. Hill, Jr., Lawyer
Topic: Federal reserved rights in Colorado—an historical perspective

Greg Hobbs, Colorado Supreme Court Justice
Topic: Colorado River Compact entitlements—clearing up misconceptions

Dan Keppen, Executive Director of the Family Farm Alliance
Topic: Comparing the conflicts irrigated agriculture faces now compared to those faced historically

Ken Knox, Water Resources Engineer
Topic: Republican River Compact—challenges and opportunities

Jim Lochhead, Water Rights Attorney
Topic: Eighty-five years later: how seven Colorado River states carved out an agreement for sharing the drought

Peggy Montaño, Lawyer
Topic: Reopen the Colorado River Compact? Over how many dead bodies?

Ken Neubecker, President of Colorado Trout Unlimited
Topic: Conflicting philosophies/evolving law and management: Colorado water yesterday and today

Peter Nichols, Lawyer
Topic: Alternatives to the permanent dry up of irrigated land for municipal use: the "Super Ditch Company"

John Porter, Former General Manager, Dolores Water Conservancy District
Topic: In the West, when you touch water you touch everything (Wayne Aspinall)

Harris Sherman, Executive Director; and Alex Davis, Assistant Director; Colorado Department of Natural Resources
Topic: As Colorado's IBCC and the basin roundtables consider our next 50 years from the water perspective, what can we learn from the past to help us better resolve conflict?

Larry Simpson, Former General Manager of the Northern Colorado Water Conservancy District
Topic: How water law and management in Colorado has migrated around the world

Tom Trout, Research Leader of the Water Management Research Unit, USDA Agricultural Research Service
Topic: Evapotranspiration research in support of resolving interstate water compact conflicts

Dick Wolfe, Colorado State Engineer
Topic: The future is not what it used to be—learning from the past how to better manage Colorado's water compacts

Tickets for the event are $125 per person. Proceeds will support the Water Resources Archive, working to preserve, promote, and make available records of Colorado's water history.

Reservations can be made online at http://lib.colostate.edu/watertables09 or by calling (970) 491-1833. Limited seating is available; reservations will be filled on a first-come, first-served basis.

Guests discuss water topics at Water Tables 2008.

Faculty Profile

Stephan Kroll, Assistant Professor, Department of Agricultural and Resource Economics

I am a new assistant professor in the Department of Agricultural and Resource Economics. My family just moved here from California, where I was a tenured associate professor in the Department of Economics at Sacramento State University. Previously I held a position at St. Lawrence University in upstate New York for four years and spent 15 months as research fellow in the Center for Experimental Economics at the University of Innsbruck in Austria. A native of Germany, I am no stranger to the Rocky Mountain area. From 1993 to 1999, I lived in Laramie, Wyoming, where I received my Master's degree and my PhD in economics at UW, and where I also met my wife.

Even though I am an economist, please don't ask me about how to get out of the recession; like most people (and definitely like most economists) I have no clue. My two main research fields are experimental and environmental economics, and my interests lie in generic market institutions, how these institutions impact human behavior, and what happens if markets are missing, flawed, or incomplete.

Economics is about how society and human beings make choices under scarcity, thus "environmental economics" is not as much of a contradiction in terms as it sounds. Many environmental goods, like clean air, clean water, and biodiversity, are scarce. We—as a society or individually—have to make choices that are impacted by this scarcity, while at the same time our choices have an impact on the scarcity itself. Economists often wonder if some kind of market mechanism can help us deal with the scarcity surrounding the environmental problem; for example, the market for tradable SO2 permits in the Northeast had a profound impact on improving water quality in the Adirondacks at relatively low costs to society. This market was so successful that many industrialized countries, including the USA, are now setting up similar markets for greenhouse gases to combat global climate change.

Okay, so environmental economics makes sense. But what is "experimental economics?" Experimental economists use incentives and institutions from the real world and transfer a minimized version of them into a laboratory. What if we do not know whether a proposed market is really going to work as advertised? For example, as we saw in the disaster following the creation of markets for electricity in California, a bad market design can be extremely expensive. Trial-and-error, however, does not work well when it comes to (often irreversible) market designs. This is where experimental economics can be very helpful. In an experiment, subjects—usually but not exclusively college students—make decisions, which in conjunction with the decisions of others and sometimes with a kernel of luck decide how much money they take home from the experiment. One important feature of such an experiment is that different decisions will result in different monetary outcomes, which gives the subjects the incentive to think very carefully about their strategies. Another feature is that the

(Image courtesy of Sam Parsons, CSUS/ATCS)

experimenter can focus on the impact of just one variable by holding everything equal across different treatments, something not easily possible with "real-world" data.

I use the experimental tool in a variety of different settings, several of them water-related. For example, in a paper that was recently submitted to a peer-reviewed journal, my coauthors and I investigate if and how the introduction of an options market could help improve efficiency in a water market (modeled after the Californian water market). We find that it does, particularly in the case of a market with one large buyer, which is the most relevant case for California (thanks to L.A.). I have also started several other water projects since coming to CSU, including investigating the possibility of a water bank for Colorado, the financing of a "peripheral canal" for central California, and the functioning of markets for water quality trading, when point and non-point sources of pollution are involved at the same time.

Other current, non-water related projects include experimental research on "responsive pricing" for parking (we find it can work), on coordination of fire mitigation strategies of homeowners (with the economists at the Rocky Mountain Station of the National Forest Service), on valuation of local and organic food, and on acceptance and efficiency of "green taxes" to combat pollution problems, a project with colleagues in Oslo, for which we received grant money from the Norwegian Research Council.

In addition to juggling all those projects, I enjoy teaching. After a brief hiatus during the fall semester, I am happy to be back in the classroom. Non-economists often do not have a basic understanding of economics, so I believe that one of my prime tasks as an academic economist is to teach fundamental economic literacy. Not all of my colleagues at institutions at which I have worked enjoy teaching Principles of Economics to students who might never take an economics class again as much as I do.

If you cannot find me in the classroom or in my office, look for me and my family on the bicycle trails or in the parks of Fort Collins, or somewhere in the outdoors. If you cannot find me there either, I must be travelling or playing or watching a soccer game.

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2009 Arkansas River Basin Water Forum

The 2009 Arkansas River Basin Water Forum will be held March 31-April 1 at CSU-Pueblo in the Occhiato University Center.

Registration prior to March 16 is $45 for both days, $20 for one day, and no charge for students.
Please visit the Forum website at http://www.arbwf.org/ or contact Dr. Perry E. Cabot at (719) 549-2045 for more information.

Purpose

The Forum has been a focal point for highlighting current water issues in the Arkansas River Basin and in Colorado since its inception in 1995. Planners, presenters, and attendees represent a wide variety of organizations, agencies, and public citizenry working on water resources issues in the basin.

Description

As Colorado charts a course for a new energy economy, the Forum theme this year is "Water to Fuel Our Future." Topics discussed will include water use for energy production, invasive species, and other watershed management topics of interest to the basin. Our keynote speaker this year will be Jennifer Gimbel, Director of the Colorado Water Conservation Board.

Scholarships

The Forum sponsors are pleased to offer a $4000 scholarship to an outstanding graduate student. Applicants must currently be enrolled as a second year graduate student in a field relating to water resources management (e.g., water law, limnology, hydrology, water resources engineering) at a university or college in the state of Colorado. Applicant must have attended high school within the Arkansas River Basin.

CSU Mourns Passing of Legendary Civil Engineer, Maurice L. Albertson

Maurice L. Albertson, civil engineering professor emeritus at Colorado State University who played a critical role in the creation of the Peace Corps, died on January 11, 2009, at age 90. Albertson, a Centennial Emeritus Professor, served CSU as the first director of the Colorado State University Research Foundation (CSURF), director of International Programs, and professor of civil engineering. One of his most recognized contributions was his critical role in the formation of the Peace Corps.

Great Figure in the History of CSU

Albertson arrived at Colorado A&M—now CSU—in August 1947 to help bolster the Department of Civil Engineering's civil engineering and hydraulics programs. By 1958, Albertson had moved from being a professor in the college to overseeing all research projects on campus. In 1960-1961, Albertson was the director of the U.S. Congressional study on the Point 4 Youth Corps, which led to creation of the Peace Corps. Albertson and two colleagues, Pauline Birkey-Kreutzer and Andrew Rice, were co-authors of the book, "New Frontiers for American Youth - Perspective on the Peace Corps," which set up the basic design for the Peace Corps.

"Professor Albertson will be remembered as one of the truly great figures in the history of Colorado State University," said Colorado State's Interim President Tony Frank. "It was primarily because of his work as a professor that CSU attracted and graduated its first doctoral student and assumed its full role and responsibility as a research university. He was an innovative teacher and scholar who dedicated his life to improving the living conditions of people around the world and who helped create, through the Peace Corps, a vehicle through which generations of young people have channeled their compassion and commitment into useful and important work for developing communities. CSU is grateful and honored to have been Professor Albertson's academic home."

World Leader in Water Research

According to Sandra Woods, dean of the College of Engineering, Albertson helped to establish the Department of Civil Engineering as a world leader in water research, and he played a significant role in creating the Department of Atmospheric Science. "He was an amazing individual who, even in his 90s, continued to work for the benefit of humankind," she said.

Albertson served as a consultant to the World Bank, the United Nations Development Programme, the Agency for International Development, UNESCO, and other agencies on projects dealing with water and sanitation, water resource development, village development, small industry development, and research and education. He also directed the CSU project that led to establishment of the Asian Institute of Technology in Bangkok, Thailand, and helped develop CSU's International Institute for Sustainable Development and Village Earth.

Key Figure in Hydrogen Power Movement

As recently as 2004, through the Fulbright Scholars Alumni Initiatives Award Program, Albertson worked with engineering students and faculty at Nepal's Tribhuvan University to develop and install small hydrogen fuel generators throughout the nation's countryside to meet energy needs. The project was led by CSU's Engines and

Energy Conversion Laboratory because of its strong record of hydrogen research and engine development work with the U.S. Department of Energy and private industry. The idea for the project began when Chandra Joshi, engineering professor at Tribhuvan University, completed his Fulbright postdoctoral research at CSU in 2000. Joshi was hosted by Albertson, a key figure in the hydrogen power movement, and the two began discussions about the potential of hydrogen power for Nepal.

> "We need to be motivated by service as well as by profit, we serve best by finding out what people want and helping them work to realize their dreams, not by going into a country and telling villagers what they need." -Maurice Albertson

Albertson was named a Centennial Professor by the College of Engineering in 1970 during CSU's Centennial year; he received emeritus status in 1998. In 2006, the university honored him with an honorary doctoral degree for his humanitarian work.

"Maury was an extraordinary man who truly embodied the best of America," said Peace Corps Director Ronald A. Tschetter. "As one of the primary architects of the Peace Corps, he helped set a course that has allowed more than 195,000 American men and women to serve their country and the agency's mission as Peace Corps Volunteers in 139 countries. His years of service to his community and country are a testament to his dedication, leadership, and generosity of spirit. The many people whose lives Maury touched will always remember him, and for those of us in the Peace Corps family, we will remain forever indebted to him for his vision and commitment to volunteerism and international fellowship."

*This article was adapted from a January 12, 2009, CSU news release.

Water Research Awards

Colorado State University (October 15, 2008 to December 14, 2008)

Cabot, Perry, Lower Arkansas Valley Water Conservancy Dist., Winter Canola Variety Trials for Biodiesel Production in the Lower Arkansas Valley of Colorado, $16,057

Cooper, David, Town of Telluride, Development of a Regional Restoration and Protection Program for Mountain Fens, $10,000

Doesken, Nolan J, University of Colorado, Climate Support to The Western Water Assessment (WWA), $25,000

Garcia, Luis, DOI-Bureau of Reclamation, Multi-Temporal High-Resolution GIS-Based Spatial Evapotranspiration, $63,301

Garcia, Luis, USDA-ARS-Agricultural Research Service, Module Development for OMS (Object Management System), $25,000

Gates, Timothy, DOI-Bureau of Reclamation, Identification, Public Awareness, and Solution of Waterlogging & Salinity in the Arkansas River Valley, $15,000

Koski, Anthony J, National Turfgrass Federation Inc., 2008 National Bentgrass (Fairway/Tee) Test (Saline Irrigation), $10,000

Lyon, Margarette J, USDA-USFS-Forest Research, White River National Forest Fen Inventory, $15,000

Qian, Yaling, Denver Water Department, Real Time Monitoring and Management of Soil Salinity in Recycled Water Irrigated Golf Courses, $22,864

Schorr, Robert, DOI-USFWS-Fish & Wildlife Service, Preble's Meadow Jumping Mice Populations on the US Air Force Academy, Colorado, $44,652

Sommers, Lee E, Colorado State Water Conservation Board, Determination of Consumptive Water Use by Alfalfa in Arkansas Valley, $300,000

University of Colorado

Udall, B, Colorado Water Conservation Board, Climate Change Impacts on Water Resources in Colorado: Report for the Colorado Water Conservation Board, $42,295

Barnes, R, National Science Foundation, Biogeochemistry of Nitrogen Associated with Discharge of Coal Bed Methane Production Water: Transport and Fate in Western Watersheds, $3,000

Upper Yampa Water Conservancy District Scholarship Awarded to CSU Student

The Upper Yampa Water Conservancy District (UYWCD) funds an annual scholarship 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 the recipient to be a full-time student enrolled at CSU with a minimum GPA of 3.0. Financial need may be considered, and preference is given to students from the Yampa Valley area. The scholarship duration is one year.

The Upper Yampa Water Conservancy District Scholarship recipient for the spring semester of 2009 is Michael Macklin. A senior majoring in political science with an interdisciplinary study in water resources, Mike was born in La Junta, Colorado, and raised in Springfield, Colorado. For the past four years, while attending Colorado State University, he has worked at the Colorado State 4-H Office, where he has helped coordinate state and national 4-H youth development events. His studies in water resources and political science led him to Lincoln University in Lincoln, New Zealand, for a semester of study in natural resource and water economics during the spring of 2008. Mike has been active in Alpha Gamma Rho, an agriculturally based fraternity, and has served as an ASCSU Senator for the College of Agriculture for two years. Following graduation, Mike plans to pursue a law degree with an emphasis on water law in the fall of 2009. Mike's love for small towns and rural America has driven his passion to protect the farmers and ranchers of rural America.

The CSU Water Center and Colorado Water Institute congratulate Mike 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.

USGS science for a changing world — Recent Publications

Evaluation of the Acoustic Doppler Velocity Meter for Computation of Discharge Records at Three Sites in Colorado, 2004-2005 by M.R. Stevens, P. Diaz, and D.E. Smits http://pubs.usgs.gov/sir/2007/5236/

An Evaluation of Selected Extraordinary Floods in the United States Reported by the U.S. Geological Survey and Implications for Future Advancement of Flood Science by J.E. Costa, and R.D. Jarrett; http://pubs.er.usgs.gov/usgspubs/sir/sir20085164/

Understanding Contaminants Associated with Mineral Deposits Edited by P.L. Verplanck; http://pubs.er.usgs.gov/usgspubs/cir/cir1328/

Analysis of the Magnitude and Frequency of Peak Discharge and Maximum Observed Peak Discharge in New Mexico and Surrounding Areas by S.D. Waltemeyer; http://pubs.usgs.gov/sir/2008/5119

Radionuclide Data and Calculations and Loss-On-Ignition, X-Ray Fluorescence, and ICP-AES Data from Cores in Catchments of the Animas River, Colorado by S.E. Church, C.A. Rice, and M.E. Marot; http://pubs.usgs.gov/ds/382/

The U.S. Geological Survey Modular Ground-Water Model – PCGN: A Preconditioned Conjugate Gradient Solver with Improved Nonlinear Control by R.L. Naff, and E.R. Banta; http://pubs.usgs.gov/of/2008/1331/

U.S. Geological Survey Colorado Water Science Center: http://co.water.usgs.gov

New IMAX Film Takes Viewers on a River Journey through the Grand Canyon

On Friday, February 13, 2009, a new IMAX film titled *Grand Canyon Adventure: River at Risk* will open at the Denver Museum of Nature and Science. The new film by MacGillivray Freeman Films gives audiences a spectacular tour of the Grand Canyon as few ever see it—from the sometimes wild, sometimes placid waters of the Colorado River as it winds through the colorful depths of the canyon.

Leading the raft trip are world-renowned river advocate Robert F. Kennedy Jr. and author, anthropologist, and National Geographic Explorer-In-Residence Wade Davis. They are guided on the river by Shana Watahomigie, a National Park Service ranger and member of the Havasupai tribe. The film features a soundtrack by the Dave Matthews Band and is narrated by Robert Redford, actor, director, and advocate for the American West.

Dr. Robert Ward, former director of the Colorado Water Institute and Professor Emeritus of Civil and Environmental Engineering, Colorado State University, played a role in the film's development by serving as science advisor to the filmmakers. His work included reviewing two rough cuts of the film, three script drafts, and a number of science facts used in the film script. "We dealt with issues such as water use by tamarisk, conserved water reaching the mouth of the Colorado River, and climate cycles/change," said Ward. "The inability of a film script to fully explain water science and policy complexities was frustrating for me at times, but I appreciated the need to be concise for public audiences."

The filming of the movie represents the largest filmmaking expedition in the canyon's recent history. Shot in four weeks almost entirely on the Colorado River, the challenging production involved the cooperation of three Indian nations, the National Park Service, a team of champion kayakers, and more than a dozen experienced river guides. Due to new protective restrictions on the number of crew members and equipment allowed, this was likely to be the last major film production of its magnitude to be shot in the Grand Canyon.

Other shooting locations included the classic steam locomotive at Williams, Arizona; Glen Canyon Dam, which holds back the Colorado River's water and generates electricity from the river's power; Chaco Canyon in New Mexico, where the Anasazi culture used innovative irrigation techniques and thrived from 900-1250 AD; and the city of Las Vegas, which powers its bright lights and flashy casinos via the Colorado River. Later filming was completed at a place that is a haunting reminder of the water crisis: at the Sea of Cortez, where the Colorado River used to meet the ocean just south of Yuma, Arizona.

For information about ticket prices and specific showing times, call the Denver Museum of Nature and Science at (800) 925-2250, or visit their web site at www.dmns.org.

Dr. Robert Ward experienced the Grand Canyon up close on a rafting trip.

AGU Hydrology Days 2009
March 25–27, 2009

Hydrology Days has been held on the campus of Colorado State University each year since 1981. Hydrology Days is a unique celebration of multi-disciplinary hydrologic science and its closely related disciplines. The Hydrology Days vision is to provide an annual forum for outstanding scientists, professionals, and students involved in basic and applied research on all aspects of water to share ideas, problems, analyses, and solutions.

For information regarding this event and registration please visit www.hydrologydays.colsotate.edu.

Spring 2009
Interdisciplinary Water Resources Seminar

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

Thursdays from Noon to 1:00 PM

All seminars are held in the Lory Student Center on the main campus of Colorado State University.

February 5 LSC 222	**Benedito Braga**, University of Sao Paulo **Managing Water in the 21st Century: Challenges and Opportunities**
February 12 LSC Virginia Dale	**Perry Cabot**, CSU Extension **Water Quality Issues on Fountain Creek**
February 19 LSC Virginia Dale	**James Pritchett**, Agricultural and Natural Resources Economics, CSU **Survey of Water Attitudes and Values of Western Households**
February 26 LSC 226	**Jeff Neimann**, Civil and Environmental Engineering, CSU **Controls on Soil Moisture in a Semiarid Setting and an Associated Method for Soil Moisture Estimation**
March 5 LSC 222	**Scott Miller**, University of Wyoming **LiDAR in Hydrology: Improving Accuracy or Just Cost?**
March 12 LSC 222	**Mazdak Arabi**, Civil and Environmental Engineering, CSU **Non-point Source Web-based Evaluation Tool**
March 19	*Spring Break*
March 26	*Hydrology Days*
April 2 LSC 222	**Ginger Paige**, University of Wyoming **Rangeland Water Resources: Management Opportunities**
April 9 LSC Virginia Dale	**Mike Ronayne**, Geosciences, CSU **Solute Transport in Fluvial Aquifers**
April 16 LSC 222	**Pieter Johnson**, University of Colorado - Boulder *Topic To Be Announced*
April 23 LSC 226	**Jack Morgan**, ARS **Global Change: It's Essentially About Water**
April 30 LSC 222	**Katie Walton-Day**, USGS Denver **Use of Isotopes to Identify Surface-Groundwater Connections**
May 7 LSC 222	**Marie Livingston**, University of Northern Colorado *Topic To Be Announced*

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.

Calendar

February

8-12 **USDA-CSREES National Water Conference; St. Louis, Missouri**
Provides opportunities for water professionals to share knowledge and ideas.
http://www.awwa.org/index.cfm

12-13 **2009 AWWA Research Symposium; Austin, Texas**
Will address the status of contaminants from various perspectives.
http://www.awwa.org/Conferences/

17-20 **The Utility Management Conference; New Orleans, Louisiana**
Will cover the issues facing the water and wastewater profession.
http://www.awwa.org/Conferences/

18 **Owner's Guide to Dam Safety, Operation, and Maintenance; Pueblo, Colorado**
Pre-convention workshop before the 7th Annual Ditch and Reservoir Alliance Convention.
http://www.darca.org

18-19 **Tamarisk and Russian Olive Research Conference; Reno, Nevada**
The symposium series connects researchers and facilitates opportunities to use science.
http://www.tamariskcoalition.org/tamariskcoalition/index.html

19-20 **DARCA 2009 Convention; Pueblo, Colorado**
Will cover strategies and alternatives to buy and dry arrangements.
http://www.darca.org

21 **Water Tables 2009; Fort Collins, Colorado**
Dinner to benefit the Water Resources Archive at Colorado State University.
http://www.cwi.colostate.edu/other_files/teaserpostcard_color_10-15-08.pdf

26-27 **International Water Conservation Conference; Albuquerque, New Mexico**
Will feature the world's most renowned water experts.
http://waterconservationconference.org

March

1-4 **AWWA/WEF Information Management & Technology Conference and Exposition; Charlotte, North Carolina**
Provides the most current information for management and technology information.
http://www.awwa.org/Conferences/

9-12 **19th Annual AEHS Meeting & West Coast Conference on Soils, Sediments, and Water; San Diego, California**
Presentations and debate related to soil and water contamination.
http://www.aehs.com/conferences.htm

11 **Lower South Platte Water Symposium; Sterling, Colorado**
Symposium theme is "Today's Issues Impacting Tomorrow's Livelihood."

22-26 **2009 International Master Gardener Conference; Las Vegas, Nevada**
Water conservation, proper plant selection, soil enrichment, and pest control.
http://www.unce.unr.edu/imgc/

25-27 **Hydrology Days; Fort Collins, Colorado**
http://hydrologydays.colostate.edu

27-29 **Watershed Science 50th Anniversary Celebration; Fort Collins, Colorado**
Three day celebration of science, reflection, and looking to the future.
http://cfwe.org/Events/calendar.asp?id=3

30-1 **NWRA Federal Water Seminar; Washington, D.C.**
http://www.nwra.org/index.cfm

30-2 **WaterEC International Water Efficiency Conference & Exposition; Newport Beach, California**
The first annual International Water Efficiency Conference.
http://www.waterec.net/wec.html

31-1 **Arkansas River Basin Water Forum; Pueblo, Colorado**
This year's theme is "Water to Fuel Our Future."
http://www.arbwf.org

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http://www.waterknowledge.colostate.edu

Helen Hunt Falls near Colorado Springs, CO. (Image courtesy of Kenneth Wyatt / www.wyattphoto.com)