Rocky Mountain Hydrologic Research Center
67th Annual Meeting
hosted by the University of Colorado Denver

We are meeting in the Science Building (SI), Room 1117, 1151 Arapahoe St., Denver, CO 80204. Allow about 15 minutes to park and walk to the meeting room.

Parking rates vary by lots: map of parking lots can be found here (www.ahec.edu/parking/ParkingMap2009.pdf) and driving directions and road map can be found here (http://g.co/maps/ba7fp).

Registration fees: $20 for professionals, $10 for students, payable at the meeting. This is also a good time to renew your RMHRC membership for $20 per year!

Presenters: Please bring your presentation on a jump drive or CD-ROM as a PowerPoint presentation.

SCHEDULE:

9:00am Registration and Beverages

9:30 President's welcome

Session 1. Physical, hydrological, and climatic processes

9:40 Bed mobility and critical dimensionless shear stress in coarse mountain streams. Kristin Bunte, Steve Abt, Kurt Swingle, and John Potyondy

10:00 Climatic Impacts on Sediment Yield and Geomorphology in the Rocky Mountain Streams. Joel Sholtes, Civil and Env. Engr. Colorado State University

10:20 When is an Archeological Depression not a Reservoir? Eleanor Griffin, Larry Benson, John Stein, and Rich Friedman

10:40 Storm Centering Technique for Flood Predictions from Large Mountain Watersheds. James C.Y. Guo, PE, Professor and Director, CU Denver

11:00 Review of the 2011 Water Year in Colorado. Wendy Ryan and Nolan Doesken Colorado Climate Center. Dept of Atmospheric Science. Colorado State University

Lunch Break. The Tivoli has a food court and there are numerous restaurants downtown within walking distance.

Session 2. Biological and ecological processes

1:00 pm Aquatic Measurements and the STREON Experiment at the National Ecological Observatory Network (NEON). Glenn Patterson and Heather Powell

1:20 Endocrine Disruption Responses to Long-Term Wastewater Treatment Facility Infrastructure Modifications. Alan M. Vajda, Larry B. Barber, Jeffery H. Writer, and Chris Douville.

1:40 Aquaponics: Recommended area for research. Greg Cronin, CU Denver

2:00-4:00pm Annual Meeting of the Board of Trustees with special guest Robert Kerr.

Bed mobility and critical dimensionless shear stress in coarse mountain streams

Kristin Bunte, Steve Abt, Kurt Swingle, John Potyondy

Critical dimensionless shear stress values τ^*_c (Shields 1936) (also called Shields values) are often applied to solve a wide range of incipient motion questions in natural streams. A common application for Shields values is the computation of the bankfull mobile particle size in coarse gravel-bed streams. However, the original Shields values were obtained from experiments conducted on beds with similar-sized particles, without bed forms and without obvervable particle structure such as imbrication or wedging. Therefore, Shields values can often not accurately predict incipient motion in natural streams. This study investigated Shields values for mountain streams. Bedload data measured at 13 mountain streams were used to compare the largest bedload particles sizes sampled at bankfull flow ($D_{max\ bf}$) to the bankfull mobile particle size (D_{cbf}) computed from bankfull flow conditions using τ^*_c. The study then backcalculated critical bankfull Shields values τ^*_{cbf} from the measured $D_{max\ bf}$ sizes and compared them to the original Shields values τ^*_c.

$D_{max\ bf}$ and D_{cbf} were similar for the most mobile mountain streams with the lowest gradient, but D_{cbf} exceeded $D_{max\ bf}$ by an order of magnitude in the coarsest and steepest channels. Similarly, τ^*_{cbf} increased steeply with stream gradient and bed coarseness, ranging within 0.03 – 0.085 for mixed plane-bed/pool-riffle coarse gravel-bed streams, within 0.05 to 0.36 for plane-bed streams that have occasional pool-riffle sequences forced by sharp channel bends, and within 0.17 – 0.67 for cobble-bed step-pool streams. These results indicate that Shields values τ^*_c of 0.03 – 0.06 can be appropriate to predict the bankfull mobile particle size in mobile gravel- and cobble-bed streams with high sediment supply (such as alternate bars, braided, pool-riffle morphology as well as in torrents). However, Shields value of 0.03 – 0.06 overpredict D_{cbf} by a factor of approximately 5 in steep and poorly mobile plane-bed streams and by a factor of approximately 10 for step-pool streams.

Climatic Impacts on Sediment Yield and Geomorphology in the Rocky Mountain Streams

Joel Sholtes PhD Candidate, Civil and Env. Engr. Colorado State University

Since the inception of global circulation models and the subsequent downscaling of future predictions of global temperature and precipitation regimes, numerous hydrological applications of these predictions have followed. The questions asked are often pragmatic: How will climate change affect water yields or impact flood recurrence intervals? An additional practical question that has received relatively little attention thus far is how will climate change impact sediment yield and channel morphology? This question is inevitably more complex because sediment yield and channel morphology is, in part, a function of not only precipitation and runoff regimes, but also of vegetation cover and local topographic and soil properties. Layered on top of these relationships are vegetation disturbance regimes, such as drought, fire, and pathogenic impacts (i.e. Grosmannia clavigera, blue stain fungus), also related to climatic drivers (Goode et al. 2011). These stochastic drivers and their coupled, complex responses make predicting future sediment yield a challenge (Benda and Dunne 1997). Thus far there has been preliminary theoretical and conceptual work completed on this question and some attempts at coupling climate scenarios with hydrologic and sediment transport models (e.g., Istanbulluoglu and Bras 2006, Gomez et al 2009, and Goode et al. 2011). However, future changes in sediment yields will be unique to the antecedent climatic conditions, vegetation characteristics, and geology within a basin of interest, and therefore are regionally unique.

General, global predictions of future climate conditions call for increased average temperatures and increase precipitation variability (IPCC 2007). In Colorado, downscaled climate predictions and hydrologic modeling indicate future reductions in snowpack and/or precipitation, yielding a shift towards earlier spring flows in conjunction with an overall decrease in water yield (Ray et al. 2008). Increased variability in precipitation could mean many things for Colorado including more intense convective precipitation as well as more severe droughts. With more frequent droughts and warmer temperatures come forests more vulnerable to fire and disease, which may lead to increased sediment yields. However, decreased runoff may reduce the transport capacity of Colorado streams resulting in a fluvial geomorphic response.

The proposed study will consider the how future climate change scenarios will impact the sediment yields and morphologic characteristics of streams in the Rocky Mountains. A probabilistic and mechanistic modeling approach that incorporates the complex interactions between climate, vegetation, and geology is proposed. Once a distribution of predicted sediment yields has been developed, existing quantitative relationships between sediment supply and transport capacity and morphologic response will be used to predict the likely changes to channels within a stream network. Characteristics of and location within a particular drainage network will influence channel response to changes in supply and transport capacity: not only is sediment delivery to the channel scale dependent (e.g. position in network), the channel response to changes in sediment delivery is also scale dependent (Benda et al. 2004).

When is an Archeological Depression not a Reservoir?

Eleanor Griffin, Larry Benson, John Stein, and Rich Friedman

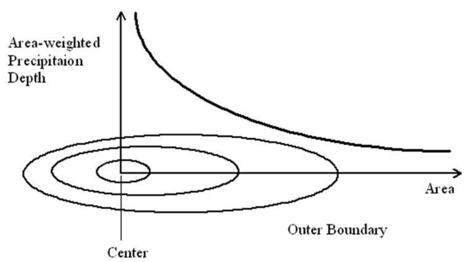
Mummy Lake, also called Far View Reservoir, is a walled circular structure located on a ridge on the northern part of Chapin Mesa, Mesa Verde National Park. Although this structure has been reported to be a surface-water collection feature since the 1892 Chapin study, recent studies have questioned that interpretation. We computed surface runoff characteristics using a 10-m DEM from the USGS National Elevation Dataset and a grid surface derived from high-precision GPS survey data. Results of our hydrologic analysis indicate that surface runoff directions are away from the ridge crest and toward side canyons, and that observed constructed features would not have been sufficient to capture water in the hypothesized upslope collection system. Computations of flow and sediment transport indicate variable slope along the ditch path would have hindered the delivery of water to Mummy Lake.

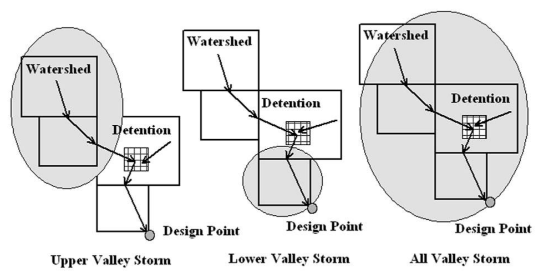
Climate data suggest precipitation onto the limited catchment area of Mummy Lake would not have been adequate to provide water for domestic use. Comparison of monthly precipitation and evaporation/sublimation rates indicates the volume of water that could have accumulated during the winter through spring of the wettest water year on record, 1941, would have evaporated by the end of June. Analysis of existing tree-ring dates for the Far View Village Complex and ceramics from Far View Reservoir suggest that construction of both the reservoir and the village began about AD 850 with occupation of the village continuing until the onset of the late-13th century drought. Based on historical climate records and precipitation reconstructed from tree-ring data for the period of occupation, in most years, snowmelt water ponded within the structure would have evaporated before the end of April. We hypothesize that Mummy Lake was primarily a ceremonial structure, with evidence supporting this hypothesis being an abundance of decorated pottery, a stairway on the south side of the structure (one of only two know to exist in the Park), and a prehistoric road leading from an unexcavated great kiva to Mummy Lake.

Storm Centering Technique for
Flood Predictions from Large Mountain Watersheds

James C.Y. Guo, PE, Professor and Director, CU Denver

Most stormwater numerical models assume that the entire watershed area is under the design storm and shall be considered as the tributary area to the design point. Care must be taken when simulating storm runoff generation from a large watershed because the rain storm may only cover a portion of the watershed. Since the area-averaged rainfall depth decays with respect to the storm-cover area, the experience of “the larger the watershed, the higher the flood flow” is no longer true.





In this study, a storm centering technique is developed to identify the conservative size of storm cell so that the design runoff rate and volume can be maximized among various locations of storm center. For a case of direct release, or no flow detention at all, the solution for maximal runoff volume is sensitive to how the local DARF curve decays. A large regional storm system tends to have a flat DARF curve that will produce higher flows when the storm cover area increases. Consequently, the conservative design with a flat DARF curve is the one that covers the entire tributary area. On the contrary, a small, local storm tends to have a sharply decayed DARF curve. In comparison, a large storm system tends to have a long duration or more like a general or winter storm pattern, while a small storm system tends to have a short duration or more like a thunderstorm pattern. For the case that involves detention basins or significant natural depression areas, the extended releases serve as the key factor in determination of the critical location of storm center. In an urban area, a large regional detention system can act as a man-made topographic barrier that converts the upstream tributary area into a negligible equivalent area. Although the procedure presented in this study is a linear approach, it is sensitive enough to identify the critical storm-cover area as long as the local DARF is readily available

This maximization procedure has been tested by the Lower Detention Basin designed and built in the City of Las Vegas, Nevada. The method is simple, but sensitive enough to identify the critical storm size for conservative designs.

Key Words: Large Watershed, DARF, Storm Center

Review of the 2011 Water Year in Colorado

Wendy Ryan and Nolan Doesken
Colorado Climate Center
Dept of Atmospheric Science
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This presentation will provide a descriptive summary of climatic conditions affecting precipitation and runoff during the 2011 Water Year (October 1, 2010 - September 30, 2011). The year was characterized by a remarkably persistent storm track and jet stream pattern that carried Pacific storms and moisture across California and the Pacific Northwest and delivered snow to the northern and central mountains of Colorado while leaving much of south central and eastern Colorado dry. December 2010 was particularly interesting with widespread heavy precipitation from the mountains westward, but with much warmer than average temperatures and primarily lower elevation rain, rather than snow. East of the mountains, dangerously dry conditions developed with a number of serious wild fires. But by later in April, spring storms repeatedly brought moisture both to the northern and central mountains and also to the northern Front Range and northeastern plains ending the drought conditions in those regions. Southeastern and south central Colorado, however, missed these storms and severe to extreme drought continued. As storms and cool weather continued through May, record-breaking snowpacks were achieved in several areas of northern Colorado. Concern over snow-melt driven flooding was high, but very dry June weather with consistently mild temperatures allowed the snow to melt at a steady rate. Streamflow was very high throughout June and into mid July on many rivers and streams, but severe flooding did not materialize. Weather patterns then transitioned to summer mode. Monsoonal precipitation was not excessive, but there was a period in early July with frequent heavy storms over portions of central Colorado. August ended up warm and dry over most of the state with all-time high temperatures for the month as a whole set at many locations across the state. Overall, the water year ended with normal to above normal temperatures for much of the state with the exception of the NW corner which saw below normal temperatures. Much of the state ended up near to above normal precipitation for the water year, with the exception of the Arkansas and Rio Grande basins which saw below normal precipitation and extreme drought conditions.

Aquatic Measurements and the STREON Experiment at the National Ecological Observatory Network (NEON)

Glenn Patterson and Heather Powell

The National Ecological Observatory Network (NEON), in partnership with the National Science Foundation, is building a continental-scale ecological observatory comprising a network of integrated monitoring sites. The goal is to enable understanding and forecasting of the impacts of climate change, land use change and invasive species on continental-scale ecology by providing infrastructure to support research, education and environmental management in these areas. In each of 20 ecological domains, NEON will be monitoring variables related to climate, hydrology, water quality, and ecology over three decades or more in an effort to better understand the dynamics and effects of drivers of ecosystem change. The aquatic component of NEON focuses on 29 streams, 7 ponds or lakes, and a network of monitoring wells, generally co-located with the climate and ecological monitoring sites. This component includes, in addition to monitoring, an experiment to determine the effects of artificial nutrient enrichment on streams, both with and without top-level predators. The 584 primary and 117 derived data products produces by NEON will be publically available. NEON is working to ensure a complementary approach with existing watershed studies in experimental watersheds that are co-located with NEON sites.

Endocrine Disruption Responses to Long-Term Wastewater Treatment Facility Infrastructure Modifications

Alan M. Vajda [1], Larry B. Barber [2], Jeffery H. Writer1, and Chris Douville,
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Stream ecosystems are strongly influenced by urban development, chemical loading, and other landscape-scale processes. The urban water cycle modifies natural stream hydrology, and domestic and commercial activities increase the burden of anthropogenic chemicals, including steroidal hormones and 4-nonylphenol, that can disrupt endocrine system function in diverse aquatic organisms. Municipal wastewater treatment facility (WWTF) infrastructure changes can impact stream hydrology, water chemistry, and ecology. This study summarizes results from a series of integrated chemical and biological investigations in to the occurrence, fate, and effects of endocrine disrupting chemicals in the City of Boulder, Colorado's WWTF and Boulder Creek, the receiving stream. Results are presented for the effects of modifying the WWTF from a trickling filter/solids contact to an activated sludge process on the concentrations of endocrine disrupting chemicals through each of the major treatment units. Corresponding effects of pre- and post-upgrade effluent chemistry on fish reproductive endpoints were evaluated using on-site, continuous-flow experiments, in which male fathead minnows (*Pimephales promelas)* were exposed for 28 days to Boulder Creek water and WWTF effluent. The upgrade of the WWTF resulted in improved removal efficiency for most endocrine disrupting chemicals and fish exposed the post-upgrade effluent indicated reduction in endocrine disruption relative to pre-upgrade conditions. The improved effluent quality following the WWTF modification likely will result in improved long-term stream ecosystem health.

Aquaponics: Recommended areas for research

Greg Cronin
Associate Professor of Integrative Biology and Sustainability
University of Colorado Denver

Aquaponics is a technology that creates aquatic ecosystems using edible species. It combines time-tested practices of aquaculture (e.g., aquatic animal farming) and hydroponics (e.g., growing plants without soil) in a manner that recirculates water and capitalizes on the beneficial ecosystem services of aquaculture and hydroponics. In aquaponic systems, water from the aquaculture subsystem that contains waste from the animals is pumped into the hydroponics subsystem, where the nutrient-rich water fertilizes edible vegetation and the vegetation purifies the water. The water then flows back to the aquaponics subsystem, completing the cycle. Though the technology is very promising, it has yet to be widely adopted. Barriers to adoption, gaps in knowledge, and recommended research will be discussed in this presentation.