PROGRAM & ABSTRACTS

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER
46TH ANNUAL MEETING

EMERGING ISSUES IN WATER & ENVIRONMENTAL SCIENCES

Saturday, August 17, 1991, 9 am to 4 pm
Wild Basin Lodge near Allens Park, Colorado

EMERGING ISSUES IN WATER AND ENVIRONMENTAL SCIENCES

ROCKY MOUNTAIN HYDROLOGIC RESEARCH CENTER
46TH ANNUAL MEETING
SATURDAY, AUGUST 17, 1991, 9:00 AM TO 4:30 PM
WILD BASIN LODGE NEAR ALLENS PARK, COLORADO

9:00 RMHRC Opening Remarks

9:15 Raymond Herrmann, National Park Service, Fort Collins, Co, **Protecting Global Natural Resources: Interdisciplinary Biosphere Monitoring and Research (I)**

9:35 Mark Meier, Institute of Artic and Alpine Research and Department of Geological Sciences, University of Colorado, Boulder, Co, **Global Change and the Mountain Watershed (I)**

9:55 Roger Barry, Department of Geography, University of Colorado, Co, **Mountain Climates: Potential for Change (I)**

10:15 **Morning break**

10:40 Donald Sullivan, Michael Keables, and Patricia Cec, Department of Geography, University of Denver, Denver, Co, **Tree-Ring Evidence of Precipitation Variability on the Palmer Divide, Eastern Colorado**

10:55 Connie Woodhouse, Mountain Research Station, Institute of Artic and Alpine Research, University of Colorado, Boulder, Co, **The Potential Use of Dendrochronology for Reconstructing Hydrologic Variables**

11:10 Randy Parker, U.S. Geological Survey, Lakewood, Co, **Assessing Effects of Potential Climate Change on the Hydrology of the Gunnison River basin**

11:25 William Rense, Department of Geography and Earth Sciences, Shippensburg University, Shippensburg, Pa, **Applications of the Thornthwaite Water Budget to the Analysis of Front Range Hydrology**

11:40 Cynthia Paulson, Brown and Caldwell Consultants, and Dottie Nazarenus, City of Fort Collins, Co, **Stormwater Quality Monitoring as a Planning Tool**

11:55 **Lunch, Wild Basin Lodge**

1:00 Carol Angel, Colorado Department of Law, Denver, Co, **Federal Reserve Water Rights: Implications for Water Sciences in the Rocky Mountain West (I)**

1:20 Katherine J. Chase, Department of Civil Engineering, Colorado State University, Fort Collins, **Co, Threshold for Gravel and Cobble Motion in the Gunnison River, Black Canyon of the Gunnison National Monument**

1:35 Rebecca Summer, Private Consultant, Carrollton, Tx, **Development and Application of a Method to Estimate Short-Term Alpine Sediment Transfer in the Colorado Front Range, USA**

1:50 Dorothea Panayotou, Department of Earth Resources, Colorado State University, Fort Collins, Co, **Nutrient Movement and Accumulation Between Grazed and Ungrazed Reaches of Sheep Creek, Colorado**

2:05 **Afternoon Break**

2:30 Terence Boyle, Nancy Hoefs, Gary Smillie, and William Jackson, National Park Service, Fort Collins, Co, and Julia Watson, Department of Statistics, Colorado State University, Fort Collins, Co, **Determination of the Retention Ability of Eddies in Lotic Ecosystems**

2:45 Robert Edwards, and Jill Baron, National Park Service and Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Co, **A Long-Term Study of Ecosystem Dynamics in the Southern Rocky Mountains; the Loch Vale Watershed Study**

3:05 John Turk, Norm Spahr, and Don Campbell, U.S. Geological Survey, Lakewood, Co, **An Investigation of the Water, Energy, and Biogeochemical Budgets of Loch Vale and Other Rocky Mountain Watersheds (I)**

3:20 **Open Discussion**

PROTECTING GLOBAL NATURAL RESOURCES: INTERDISCIPLINARY BIOSPHERE MONITORING AND RESEARCH

R. Herrmann, U.S. National Park Service, Water Resources Cooperative Park Studies Unit, Colorado State Univ., Ft. Collins, CO 80523 USA

Today's questions of direct and critical concern to Park or protected area managers involve understanding ecosystem change in a complex environment. Management strategies, to effectively protect natural resources must be based on an understanding of the physical, hydrologic, and biologic processes which are actively shaping these systems and on an appreciation of the potential for resources impacts by many human activities. Local, regional, or frequently global issues are often associated with today's modern technological world. They include: biogeographic changes or habitat alterations; climate changes (e.g. temperature, mean sea level, and precipitation); and, biogeochemical changes. Common to the U.S. National Park Service and to most conservation agencies is the lack of baseline knowledge and monitoring data needed to demonstrate change in resource status related to many of these regional or global scale forces. To develop a monitoring network of parks or biosphere reserves that can assess potential alterations, it has been important to be aware of potential changes at the watershed level. Our initial approach for meeting this requirement for natural resources monitoring has been built on accumulated experiences gained from U.S. National Park Service, U.S. National Science Foundation, U.S. Forest Service and US/USSR bilateral programs, contributing to environmental protection, research and monitoring of biosphere reserves. Thus, a site network based on a long-term ecological/watershed research concept was implemented and long-term watershed research and monitoring sites were established. An integrated program design focused sites toward a set of biotic and abiotic elements of change needed to analyze cause and effect relationships at the ecosystem and watershed level. Essential program continuity is provided for by collection of equivalent core measurements at all sites. Data collections now serve to meet both reference and early warning objectives of the National Park Service and the Man and the Biosphere Programme.

Today's discussions will serve to exchange long-term monitoring and research concepts and experiences relevant to our understanding of the state of knowledge about water and watershed science as it applies to evaluating the status of conservation lands and waters.

Global Change and the Mountain Watershed

Mark F. Meier
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Department of Geological Sciences,
University of Colorado, Boulder, CO

We now recognize, for the first time, that mankind is causing changes in our environment of truly global extent, and that the cause and the future course of these changes cannot be understood without an integrated study of the whole earth system. This presents a challenge and an opportunity: we cannot attack this problem in the local, single-discipline research mode that has been the standard of the past, but must develop a new, interdisciplinary, and global-view paradigm for understanding the Earth. Mountain ranges, with their distinctive climates, hydrologic regimes, and ecosystems, affect large regions on all continents. Orographic precipitation, reduced evapotranspiration, and the effect of ice and snow combine to make mountains the source areas for much of the world's runoff. Changes in the land surface and ecosystems affect the water supply, as well as the transport of sediments, nutrients, and other constituents; changes may also occur in the rate and timing of runoff and in the frequency of extreme events that shape the landscape and affect mankind. Tundra ecosystems, with their large reserves of soil carbon, may respond to changing climate by changing the uptake or release of the greenhouse gases carbon dioxide and methane. Such changes may be caused by global processes, or by local works of humans. Unfortunately, the response of mountain watersheds to changes in climate or land use is not always predictable with our present state of knowledge.

Mountain watersheds may also be sensitive indicators of global change. Snow and glaciers may exist in a delicate balance with climate, and may change markedly with small changes in climate; on the other hand, some snow and ice masses are relatively robust in their response to climate change. The same can be said of mountain ecosystems, both terrestrial and aquatic. Mountain areas may provide excellent records of past global changes, obtained by the study of, for instance, lake sediments, tree rings, and glacial ice cores. However, climate change in the mountains is likely to be somewhat different from that in the adjacent lowlands: global warming in response to the greenhouse effect decreases, in general, with increasing altitude. Current atmospheric general circulation models are ill-equipped to handle the high mountains. Perhaps the most serious difficulty in relating mountain watershed processes to the global earth system is the issue of scaling. Mountain systems are, by their very nature, extremely heterogeneous. It will not be possible in the foreseeable future to relate a particular alpine basin to a grid cell output of a general circulation model; this may be difficult even using a hierarchy of nested models. Extending the results from site- or basin-level studies to the analysis of regional mountain systems is likely to be one of the most important challenges of interpreting mountain hydrology as part of the global earth system.

ABSTRACT

48th Annual Meeting
Rocky Mountain Hydrologic Research Center (17 August 1991)

MOUNTAIN CLIMATES: POTENTIAL FOR CHANGE

R. G. Barry
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Historical evidence shows that mountain areas have experienced major changes in glacio-hydrological conditions in response to changes in climate. The question of the relative intensity of these changes, compared with conditions in adjacent lowlands has received little attention, yet this issue is crucial to regional and local scale interpretations of global climate model simulations of possible future climates.

A brief review is given of the evidence for past changes in mountain climatic conditions. Historical records of conditions during the Little Ice Age interval in Europe (ca. A.D. 1550-1850) are summarized and recent instrumental records of meteorological-hydrological conditions are discussed using examples from the Rocky Mountains of Colorado and the European Alps.

These comparisons are briefly discussed in the context of model simulations for the climatic effects of increased concentrations of atmospheric greenhouse gases. Modeling studies are urgently required for impact assessment of potential hydro-meteorological changes in mountain areas.

ABSTRACT

Submitted for consideration for the Annual Meeting of the Rocky Mountain Hydrologic Research Center, Saturday, August 17, 1991.

Tree-Ring Evidence of Precipitation Variability on the Palmer Divide, Eastern Colorado, by Donald G. Sullivan, Michael J. Keables, and Patricia A. Cec, Department of Geography, University of Denver, Denver, Colorado 80208.

Studies of past climate variability in eastern Colorado are hampered by the dearth of long-term weather records. This problem is exacerbated by the sparcity of recording stations and the spatial variability of summer precipitation over eastern Colorado. In an effort to develop a long-term proxy record of climate in the area we have begun a dendrologic study using the *Pinus ponderosa* stands of the Black Forest on the Palmer Divide, a dissected upland that separates the valleys of the South Platte and Arkansas Rivers. In this paper we report the preliminary results of our research. Tree-ring cores were taken from several locations across the Palmer Divide. The sampling locations were determined by their proximity to established weather stations so that we could calibrate the record using historic data, and determine the significant factors influencing tree-ring width. We report on the nature and sensitivity of the dendrologic record, and its calibration with the existing weather data from several stations on the Divide. The results to date suggest that the tree-ring record provides insight into the cyclical nature of annual precipitation fluctuations, and the relationship between those fluctuations and the frequency of drought.

THE POTENTIAL USE OF DENDROCHRONLOGY FOR RECONSTRUCTING HYDROLOGIC VARIABLES.

Connie A. Woodhouse Mountain Research Station, INSTAAR, University of Colorado

Tree growth, as reflected in annual growth rings, is influenced by a variety of climate-related factors. This study examines the relationships between seasonal precipitation and monthly snowpack, and tree growth. Tree-ring chronologies from two different sites and two different species were used. Limber pine (Pinus flexilus) from the City of Boulder Watershed at 10,500' and ponderosa pine (Pinus ponderosa) from lower Boulder Canyon at 6,000' showed marked differences in response to these variables. Limber pine growth was found to be positively correlated to late spring precipitation while ponderosa pine growth was related to April and May snowpack at upper elevations. Spring precipitation and snowpack are major factors in determining runoff. The limber pine chronology, extending back to 1169, may be used to reconstruct a record of spring precipitation. The ponderosa pine chronology records tree growth back to 1619 and may be used to reconstruct late season snowpack. Used together, they could provide a past record of spring runoff. A record of variations in past runoff is a source of information for the potential magnitude of variations in the future.

APPLICATIONS OF THE THORNTHWAITE WATER BUDGET TO THE ANALYSIS OF FRONT RANGE HYDROLOGY

William C. Rense, Department of Geography & Earth Science, Shippensburg University, Shippensburg, PA 17257

The Thornthwaite water budget is a useful tool for hydrologic analysis of catchments. Because the Thornthwaite technique requires only temperature and precipitation data for its calculation, this method is especially versatile since such basic climatological data is widely collected and available. In the Front Range of Colorado, the Thornthwaite technique predicted the flow of Boulder Creek over a 17 year period within 5% of the gaged flow. Thus, the Thornthwaite method can be used to estimate flow in ungaged catchments or to predict changes in flow under conditions of climatic change. The flow characteristics of Boulder Creek are demonstrated in this paper under current climatic conditions and under conditions of climatic warming. An estimate is also made of the flow of the North St. Vrain at the Rocky Mountain Hydrologic Research Center.

STORMWATER QUALITY MONITORING AS A PLANNING TOOL

Cynthia Paulson, Brown and Caldwell Consultants
Dottie Nazarenus, City of Fort Collins

New stormwater permitting regulations require extensive monitoring of urban runoff quality to support municipal and industrial permit applications and long-term management programs. A comprehensive stormwater quality monitoring program must address stormwater management planning information needs as well as the permit application process. This paper outlines the comprehensive approach to stormwater quality monitoring that has been successfully applied in the City of Fort Collins, which is presented as a case study.

The following monitoring objectives provide the basis for the City's stormwater quality monitoring program:

- --identification of problem areas
- --detection of illicit discharges
- --preliminary evaluation of:
  - dry-weather runoff quality
  - impacts of stormwater runoff on receiving waters
  - wet-weather runoff pollutant concentrations and loads
  - reported water quality problems
- --development of benchmark data for future trend analysis
- --preparation for NPDES permit application

To address these program objectives, the City pursued a cost-effective approach to stormwater quality monitoring. The approach began with a preliminary evaluation of existing inventory information and known potential pollutant sources. This information was used to design a focused, yet flexible, sampling program. Results from the early stages of the monitoring program were used to modify the program plan as necessary to ensure that data collected was sufficient to meet the objectives.

The program involved both wet-weather and dry-weather monitoring at key sites where water quality problems were suspected or at sites that were considered to be representative of specific land use types. Monitoring is currently being performed at two instream sites as well as storm sewer outfalls.

Constituents monitored included a basic set of typical stormwater runoff constituents as well as selected organic compounds based on the sources within the drainage area being monitored and on expectations of seasonal use. An accessible database is being developed to allow effective interpretation of the data collected.

THRESHOLDS FOR GRAVEL AND COBBLE MOTION IN THE GUNNISON RIVER, BLACK CANYON OF THE GUNNISON NATIONAL MONUMENT

K J Chase, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80521; (303)-678-1562

Research conducted for
National Park Service, Water Resources Division

In this experiment, flows necessary to initiate motion of rocks on a lateral cobble bar along the Gunnison River are observed. Gravel and cobbles are painted and measured in situ. Velocities and water surface elevations in the vicinity of the rocks are observed during each of four flood releases from an upstream dam. Motion of the rocks is ascertained by visual inspection, photographs and topographical surveys.

Of the 145 rocks painted, 110 are exposed to flow and 43 move. All but one of the 43 rocks move from the same area. The smallest rocks move only during the highest flow release.

Five predictive equations are used to calculate the velocity or shear required to move each rock. These theoretical velocities and shears are compared with those observed during the flow releases. In general, clasts that move during the second release move at smaller velocities and shears than those predicted by the 5 equations. This could be due to turbulent velocity fluctuations. Conversely, according to the predictive equations, many of the stones that move during the fourth release should move at smaller velocities. The bed pocket angles of these rocks may be higher than estimated.

Critical shears and velocities can be predicted to within an order of magnitude using existing predictive equations. However, to improve predictive accuracy, more study is needed on how to determine or predict velocity profiles, bed pocket angles, and turbulence from field measurements.

DEVELOPMENT AND APPLICATION OF A METHOD TO ESTIMATE SHORT-TERM ALPINE SEDIMENT TRANSFER IN THE COLORADO FRONT RANGE, USA

REBECCA M. SUMMER, private consultant, 2925 Country Place Circle, Carrollton TX 75006

Abstract.

Clastic sediment movement was evaluated in Roaring River Watershed in the Mummy Range of the Colorado Front Range. Photogeologic techniques and field work on identifiable landforms were used to develop a terrain classification of sediment transfer. Terrain units formed the bases for assessing contemporary processes of sediment transport and for testing its usefulness in evaluating sediment flux. Contemporary behavior of terrain units suggests relative stability (short-term = 50 years) of the present system. The hillslope sediment transfer system appears to act as a closed system and is dominated by internal transfer of sediment moving on slopes with little clastic material entering the fluvial system. The method proposed here can be used by mountain park and wilderness area managers as a framework for determining alpine and subalpine ecosystem disturbance that results from recreational impact. However, geochemical or solute transport has not been measured, and future work may be required to assess chemical impacts of sediment disturbance.

Key words: sediment, erosion, hillslope, alpine, talus, soil creep.

Abstract

NUTRIENT MOVEMENT AND ACCUMULATION BETWEEN GRAZED AND UNGRAZED REACHES OF SHEEP CREEK, COLORADO

by:

Dorothea Panayotou
Graduate Student
Department of Earth Resources
Colorado State University

Professional Organizations:

American Water Resources Association

Mountainous riparian zones perform important hydrological functions in the western rangelands, acting as either sources or sinks for nutrients. These lands are an important link for groundwater flow between forested lands and streams. In this study, the effects of grazing on nitrate accumulation and movement was analyzed in a montane riparian ecosystem. Research was conducted along Sheep Creek, located approximately 80 km northwest of Fort Collins, Colorado, in the Roosevelt National Forest. Background data was taken in the Spring of 1991, before seasonal grazing began. Additional data was collected during the summer of 1991. Exclosures which prevent cattle from entering two of the stream reaches were studied. These data were compared to data collected from two grazed reaches. Nitrate concentrations are flow driven and increase in concentration with increased discharge. Weekly samples were extracted from lysimeters located at four different reaches along Sheep Creek. Discharge was measured at each location along the stream in parallel to the lysimeters. In addition, standard survey methods were used to determine water table depth from approximately 34 wells located along seven different reaches of Sheep Creek. Survey data was used to trace the path of groundwater flow from the forest, through the riparian zone and into the stream. This data was used to correlate the movement of groundwater to the amount of nutrients present in the stream.

Determination of the Retention Ability of Eddies in Lotic Ecosystems

by

Terence P. Boyle, Nancy J. Hoefs, Gary Smillie, and William Jackson
National Park Service
&
Julia B. Watson
Department of Statistics
Colorado State University

In lotic ecosystems the energetic links between the input of organic material and energy utilization by the biological food chain are dependent on local retention and processing of the detrital material. The role of woody debris dams, lateral sloughs, and other obvious physical retention devices have been explored with respect to early life histories of fish, invertebrate ecology, and the processing of detrital material in small first to third order streams. However, there have been few studies of the physical habitat, hydrological dynamics, geomorphological aspects, or the critical ecological components of eddies in streams and major rivers with respect to retention of organic material.

A set of experiments was conducted to determine the following:

1] If eddies collect and retain organic matter in the size range of coarse particulate organic matter (> 1mm) of different specific gravities, and

2] If different patterns of hydrological discharge affect the collection and retention of organic matter by eddies.

The investigation was conducted at the Engineering Research Center at Colorado State University (CSU) in an experimental flume. An eddy is operationally defined as a hydraulic phenomenon due to channel morphology that contains a gyre in the water column with measurable retrograde motion relative to the general direction of stream flow. The experiment tested the retention power of an eddy built into a flume operated at three different discharges and with material introduced simulating coarse particulate organic matter of three different densities. Repeated runs were made for purposes of statistical comparison.

One and two compartment statistical models were used to reflect the different sets of observed behavior of the material introduced into the eddies. Several general conclusions were made an the basis of statistical analysis of these models. For material with a specific gravity greater than unity, a two compartment model was found appropriate in analyzing the physical process governing the retention of organic material by the eddy. Material of two different densities above specific gravity of unity did not appear to behave differently in the eddies. Less dense material below a specific gravity of unity was analyzed with a single compartment model and was retained by the eddy to a lessor degree than the denser material. For all three materials analysis showed that the lighter the material the less is was retained by the eddy. The higher hydrological discharge changed the physical aspects of the eddy and reduced its ability to retain the organic matter.

A Long-term Study of Ecosystem Dynamics in the Southern Rocky Mountains; the Loch Vale Watershed Study.

Robert L. Edwards and Jill Baron
National Park Service and Natural Resource Ecology Laboratory, Colorado State University.

Loch Vale is a 660ha alpine-subalpine catchment along the east face of the continental divide in Rocky Mountain National Park. Elevation ranges from 4010m at Taylor Peak to 3110m at the outlet to the Loch. Bedrock is composed of Precambrian granite and gneiss. The surface area is dominated by exposed rock and talus (82% of total area), followed by alpine ridge (11%), forest and wet meadows (6%), and surface waters (1%). There are three lakes located along Icy Brook, the main drainage stream, and numerous smaller water bodies.

Ecosystem oriented research began here in 1980, with the goal of monitoring inputs and outputs, and identifying the major biogeochemical processes occurring within the watershed. The surface waters exhibit low ionic strength (conductance < 20 umho/cm) and low acid neutralizing capacity, thus they are considered to be susceptible to the effects of acidic deposition. The inputs are measured as part of the National Atmospheric Deposition Program, using a remote area weather station and wet/dry collector centrally located within the watershed. Outputs are measured using a Parshall flume with stage height recording equipment located at the Loch outlet. Water chemistry is collected at least weekly when there is flow. Annual input/output budgets for water and the major ions have been constructed since water year 1984.

Various research projects have examined some of the bio-geochemical processes occurring within the watershed. These include studies of mineral weathering, soils and soil exchange processes, the dynamics of lake algae, vegetation and dissolved organic carbon, snow deposition and estimation of hydrological parameters. Current studies include sources and flowpaths of water in the upper basin, alpine nitrogen dynamics, and inter-ecosystem comparison of litter decomposition rates. Loch Vale is also one of the sites selected for the USGS Watershed Energy Biogeochemical Budgets program.

The commitment to long term monitoring continues in Loch Vale. This type of research program in sensitive areas such as Loch Vale are invaluable; both for tracking the effects of large scale concerns such as acid rain and global warming, and to provide a framework for more detailed studies of ecosystem processes.

An Investigation of the Water, Energy, and Biogeochemical Budgets of Loch Vale and Other Rocky Mountain Watersheds

J T Turk N E Spahr and D H Campbell (All at: USGS, Box 25046, MS 415, Denver Federal Center, Lakewood, CO 80225-0046; 303-236-4886; Telefax 303-236-4912

The interaction of climatic change with water, energy, and biogeochemical budgets will be most pronounced in watersheds that have biotic communities at the limit of their tolerance to climatic conditions. One such class of watershed is the alpine/subalpine/montane watersheds typical of the Rocky Mountains. Minor shifts in climate can markedly alter boundaries of community structure that define transitions in the watershed processes. Because such boundaries are especially well defined in these watersheds, and because such watersheds are widespread throughout the Rocky Mountains and other great mountain ranges worldwide, they are a critical element in understanding the most immediate effects of climatic change on watershed processes and the feedback of watershed processes to climate.

There are three topics in which there is a critical lack of understanding of watershed processes in the alpine/subalpine/montane watersheds of the Rocky Mountains:

1) Processes controlling the flow path and flux of water.
2) Processes controlling the energy balance and chemistry of snowpacks.
3) Processes controlling weathering and biogeochemical budgets.

The basin and chemical characteristics of the Loch Vale watershed, Colorado are similar to alpine and subalpine watersheds throughout the Rocky Mountains. Such watersheds are among the most extensive of unaltered ecoregions in the Nation. Thus, understanding of processes that affect such watersheds is very likely to be transferable.

Metropolitan State College of Denver

Department of Earth and Atmospheric Sciences

A SCENARIO FOR GLOBAL WARMING-INDUCED CHANGES IN CLIMATE AND WATER RESOURCES IN SOUTHWESTERN COLORADO

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Abstract

A major drawback to the application of global climate models to the prediction of regional water resources is the current lack of spatial resolution. An alternative to models is the scenario method, which offers better spatial resolution but is limited by the quality of historical meteorological and streamflow data. The scenario method compares 30-year averages to averages of the same variable for the 5 globally warmest years on record. While it is impossible to predict conditions under a doubled-CO2 regime since global temperatures of the predicted warmth have not occurred in the historical record, the scenario method offers interim suggestions of climate and water resources.

Four annually-averaged meteorologic variables were used for this study: maximum temperature, minimum temperature, precipitation, and snowfall. In addition, annual streamflow totals from Vallecito Creek, a USGS Hydrologic Benchmark Station, were used. The preliminary results of the scenario suggest that under globally warm conditions, the maximum temperatures in Southwestern Colorado cool, while the minimum temperatures remain the same. West of the Continental Divide, slightly more precipitation falls, and annual streamflow amounts increase. East of the Continental Divide, the precipitation amounts remain the same. These results show the local climatic changes which have occurred under historically globally warm conditions.

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RESEARCH AND MONITORING PRIORITIES FOR NATURAL RESOURCE MANAGEMENT PLANNING WITHIN THE COLORADO ROCKY MOUNTAINS.

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Natural resources of the Colorado Rocky Mountains are threatened more than ever before by a combination of threats from within and without their boundaries. Overuse has led to local trampling of vegetation and contamination of natural waters from human waste. Industrial and urban emissions threaten to cause regional-scale acidification of sensitive natural lakes, streams, and soils. And increasing greenhouse gases, increased solar UV-B radiation, and changes in land use patterns threaten global scale changes, with potentially grave repercussions to the Colorado Rocky Mountains. Resource managers must be cognizant of these locally-, regionally-, and globally-driven disturbances as they attempt to preserve natural montain ecosystems. An additional threat, which I think is equally important, is that caused by lack of communication between scientists and managers. It is hoped this presentation will lead into a general discussion of resource management and communication priorities for federal and stae-owned natural lands of the Colorado Rocky Mountains.