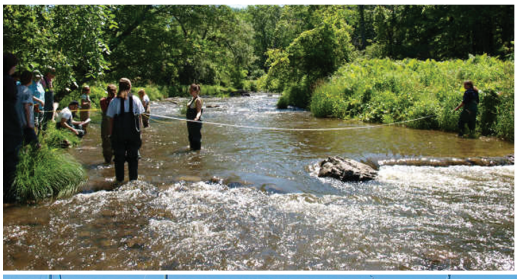

NSF EPSCoR WATER WORKSHOP:
WATER DYNAMICS

Hosted by Vermont EPSCoR

November 9–12, 2008

Sheraton Hotel and Conference Center
Burlington, Vermont

Vermont EPSCoR

NSF EPSCoR

National Science Foundation

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Received as of 3 November 2008

Presenter Biographies

State Water Templates

November, 2008

Welcome to the 2008 NSF EPSCoR Water Workshop on Water Dynamics hosted by Vermont EPSCoR.

Water is a topic that should be of high priority in this century. Fundamental studies of water are important to all the NSF EPSCoR jurisdictions, and, indeed, are sponsored across many of the directorates at NSF.

This important workshop features research on water across the NSF EPSCoR jurisdictions. The goals of the workshop will include sharing of information, exploration of collaborations and learning about the opportunities for research on water through the NSF.

As Dr. Arden L. Bement Jr., Director, NSF said at the February 2008 NSF Budget Rollout:

"Although the movement of water links natural systems and human social systems, there are many gaps in our basic scientific understanding of water dynamics. We still know very little about the effects of climate change and resulting changes in human interventions and land use on the availability and quality of fresh water.

One of the greatest environmental and economic challenges we face this century is to ensure an adequate, high-quality water supply for human use while maintaining the integrity of ecosystems. While humans can survive without petroleum, they can't survive without water."

We hope you find the workshop useful in your future research endeavors and enjoy your visit to Vermont. Thank you for attending and best wishes for continued success. We look forward to interacting with you!

Sincerely,

Judith Van Houten, Ph.D.
Vermont State EPSCoR Director

Beverely Wemple, Ph.D.
Conference Co-Chair

AGENDA

Water Dynamics Workshop

Sunday, November 9, 2008

6:00–8:00 p.m. Evening Reception *(Lake Champlain Exhibition Hall)*
Registration *(Conference Center Lobby)*

Monday, November 10, 2008

7:00 a.m. Registration Continues *(Promenade I and II)*
Continental Breakfast *(Emerald Ballroom I and II)*
Mount Posters

8:00 a.m. Welcome Remarks *(Emerald Ballroom III)*

Henry Blount, *NSF EPSCoR Office Head*
Pamela Stephens, *Senior Associate for Science Coordination, NSF Directorate for GeoSciences*
Judith Van Houten, *Vermont State EPSCoR Director*
John M. Hughes, *Provost, University of Vermont*
George Crombie, *Secretary, Vermont Agency of Natural Resources*

8:30 a.m. Introduction of NSF Directors and Program Officers
Short presentations by NSF Directors and Program Officers

Todd Crowl, *Program Director, Ecosystem Science Cluster*
Pamela Stephens, *Senior Associate for Science Coordination, NSF Directorate for GeoSciences*
Robert O'Connor, *Program Director, Division of Social and Economic Sciences*
Teofilo Jun Abrajano, *Section Head, Earth Science, NSF Program Officer, Program on Environmental Sustainability*

10:15 a.m. Keynote Speaker
Introduction by Beverley Wemple *(Vermont)*
Richard Hooper, *Executive Director, CUAHSI*
Advancing Hydrologic Science through Community Engagement

11:10 a.m. Break

11:25 a.m. Research highlights from NSF EPSCoR jurisdictions: Comparisons, divergences and learning from each other

Moderator – Beverley Wemple *(Vermont)*

Michelle Daley *(New Hampshire) – Northeastern U.S. and Appalachia*

Ric Hauer *(Montana) – Northwestern U.S.*

Kyle Hoagland *(Nebraska) – Midwestern U.S.*

Tom Piechota *(Nevada) – Southwestern U.S.*

Durga Poudel (Louisiana) *– Southeastern U.S.*

12:30 p.m. Lunch and Speaker *(Emerald Ballroom I and II)*

Introduction by Lesley-Ann Dupigny-Giroux *(Vermont)*

Konstantine Georgakakos,
Director, Hydrologic Research Center, San Diego

Demonstrating science benefits of water resource predictions for water management: The need for reliable forecast uncertainty estimation and adaptive management

2:00 p.m. Theme 1 – Change Dynamics *(Emerald Ballroom III)*

Co-Chairs Jeffrey Gaffney *(Arkansas)* and Mary Watzin *(Vermont)*

Brian McGlynn *(Montana)*:
Hydrologic connectivity from hillslope to landscape scales: Implications for runoff generation and water quality

Walter Dodds *(Kansas State Univ)*:
Thresholds, non-linearity and prediction in freshwater ecosystems

Tom Giambelluca *(Hawaii)*:
Global change threats to Hawaii's hydrology and terrestrial ecosystems: Impacts of global warming and species invasion in Hawaii

Shaleen Jain *(Maine)*:
The impact of hydroclimate variations and change on Water Resources Decision-Making and Adaptation

4:00 p.m. Moderated Discussion of Theme 1

4:30 p.m. Breakout Sessions *(Diamond Ballroom)*
with NSF Directors and Program Officers

6:00 p.m. Hors d'oeuvres *(Emerald Ballroom I and II)*

6:30 p.m. Dinner and Speaker *(Emerald Ballroom I and II)*
Introduction by Breck Bowden *(Vermont)*
David Maidment, *Hussein M. Alharthy Centennial Chair in Civil Engineering and Director of the Center for Research in Water Resources at the University of Texas at Austin*
Hydrologic Data and Modeling

8:00 p.m. Poster Session & Networking *(Emerald Ballroom I, II and III, Promenade)*
with Dessert Buffet

Tuesday, November 11

7:00 a.m. Continental Breakfast *(Diamond Foyer)*

8:00 a.m. Theme 2 - Water Research Tools *(Diamond Ballroom, with Amphitheater for overflow)*
Co-Chairs Lilian Alessa *(Alaska)* and Donna Rizzo *(Vermont)*

Andrew "Andy" (Anaru) Kliskey *(Alaska)*:
Forecasting resilience in Arctic landscapes: an agent-based model of water resource use

Donna Rizzo *(Vermont)*:
Identifying Model Structure and Scale Dependencies in Complex Systems

Venkat Lakshmi *(South Carolina)*:
Studies of the water cycle using modeling and satellite remote sensing

9:15 a.m. Break

9:30 a.m. Theme 2 *(continued)*

Juan de Dios Barrios *(West Virginia)*:
Historical landsat images for rivers and streams

Scott Tyler *(Nevada)*:
Distributed Temperature Sensing: A Transformative Technology in Water Resources and Ecology

Sloane Ritchey *(Kentucky)*:
Watershed Scale Assessment of a Karst Drainage Basin Using Microbial, Geospatial, and Geochemical Approaches

Austin Troy *(Vermont)*:
Integrating water quality into the planning process using a land use simulation model

11:15 a.m. Moderated Discussion

12:00 p.m. Lunch and Speaker

Introduction by Judith Van Houten

Jill Karsten, *NSF, Directorate for Geosciences, Program Director for Education and Diversity*
Beyond the Pipeline: A Watershed Model for Broadening Participation in the STEM and Geoscience Workforce

1:30 p.m. Theme 3 - Implications for Management

Co-Chairs Barbara Kucera *(Kentucky)* and Charles Somerville *(West Virginia)*

Ric Hauer *(Montana)*:
Satellite and Airborne Remote Sensing in Basic and Applied River Research

Charles Somerville *(West Virginia)*:
Current Bacteriological Assessment Practices Sufficient for Water Resource Management in the Ohio River Basin

Mickey Hazelwood *(Nevada Nature Conservancy)*:
NGOs and Government Agencies Partnering on River Restoration: Truckee River Case Study

David Conrad *Senior Water Resources Specialist, National Wildlife Federation*
What do water policy makers need from scientists and engineers?

3:15 p.m. Break

3:30 p.m. Theme 4 - Water and Society

Co-Chairs Teferi Tsegaye *(Alabama)* and Gail McClure *(Arkansas)*

Lilian Alessa *(Alaska)*:
One Wet Failure: Bridging the Gaps in Understanding Water as a Social Process

KathiJo Jankowski *(Vermont)*, Declan McCabe *(Vermont)*
The Vermont EPSCoR Streams Project: Involving Students and the Community in Water Research

Jessica Leahy *(Maine)*:
Citizen and Volunteer Science: A Review and Future Directions within Human Dimensions Research

5:00 p.m. Moderated Discussion of Themes 3 & 4

5:30 p.m. Closing remarks

Henry Blount, *NSF EPSCoR Office Head*

Judith Van Houten, *Vermont State EPSCoR Director*

6:30 p.m. Dinner on Your Own

Buses will be available to take attendees to the pedestrian walkway on Church Street where there are many nearby restaurants. Buses arranged for return, or public transportation can be used

NSF Water Workshop: Water Dynamics Organizing Committee

State/Jurisdiction	Name	Institution
Alabama	Teferi Tsegaye	Alabama A&M University
Alaska	Lilian Alessa	University of Alaska Anchorage
Alaska	Anne Sudkamp	University of Alaska Anchorage
Arkansas	Gail McClure	Arkansas Science & Technology Authority
Arkansas	Jeffrey Gaffney	University of Arkansas at Little Rock
Arkansas	Cathy Ma	Arkansas Science & Technology Authority
Delaware	Steve Borleske	University of Delaware
Kentucky	Barbara Kucera	University of Kentucky
Louisiana	Durga Poudel	University of Louisiana at Lafayette
Maine	John M Peckenham	University of Maine
Montana	Ric Hauer	University of Montana
Nebraska	Lorrie Benson	University of Nebraska-Lincoln
Nebraska	Dr. Kyle Hoagland	University of Nebraska-Lincoln
Nevada	Laurel Saito	University of Navade Reno
Oklahoma	Will Focht	Oklahoma State University
Oklahoma	Aondover Tarhuke	University of Oklahoma
Puerto Rico	Dr. Rafael Rios	University of Puerto Rico
South Dakota	Dr. Boris Shmagin	South Dakota State
Vermont	Judith Van Houten	University of Vermont
Vermont	Lillian Gamache	University of Vermont
Vermont	KathiJo Jankowski	University of Vermont
Vermont	Mary Watzin	University of Vermont
Vermont	Breck Bowden	University of Vermont
Vermont	Beverley Wemple	University of Vermont
Virgin Islands	Meri Whitaker	University of the Virgin Islands
West Virginia	Charles Somerville	Marshall University

Funding made possible through NSF EPS Grants 0849385 & 0701410

Vermont EPSCoR

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National Science Foundation

Program Notes

Monday, November 10th
Dinner and Speaker
David Maidment, *Hussein M. Alharthy Centennial Chair in Civil Engineering and Director of the Center for Research in Water Resources at the University of Texas at Austin*
Hydrologic Information Science

Tuesday, November 11th
Dinner on Your Own
Buses will be available at 6:15pm outside the Conference Center Lobby to transport people to Church Street, where there are many restaurants. Buses will return to the Sheraton at 9:15pm with pick up at the same location as drop off.

Title: *One Wet Failure: Bridging the Gaps in Understanding Water as a Social Process*

Lilian Alessa

Resilience and Adaptive Management Group; Institute of Northern Engineering, University of Alaska; Center for Social Dynamics and Complexity, Arizona State University.

Conditions of rapid environmental change challenge the management of biophysical and sociocultural systems. Underlying these interacting domains is the implicit need for fresh water. Water resources have shaped societies in the past and continue to be powerful drivers of vulnerability and adaptability. Natural resource management systems do not currently address the challenges of scale, both in time and across space, regarding water as a complex, coupled social ecological system. In this talk some key failures to incorporate social dynamics into water management are highlighted and a call is issued for a paradigm shift toward characterizing the human hydrological system (H2S).

Historical landsat Images for rivers and streams.

Juan de Dios Barrios

The development of remote sensing for earth resource evaluation has origins with the launch of the Landsat Systems. The satellite systems were designed to collect information about the earth's natural and anthropogenic resources. Marshall University College of Science has access to a collection of Multispectral Scanner System (MSS) images (70 mm film) from Landsat I and II that swathed the globe from 1972 to 1976. The MSS imagery has green, red, and two near infrared bands and a spatial instantaneous field of view of 79 meters. Each landsat satellite provided coverage of the earth every 18 days. The information has an important role because of the historical value of the data.

Evaluation of Streambank Stability

Jaron Borg[1], Mandar Dewoolkar[1] and Paul Bierman[2]
[1]School of Engineering, [2]Geology, The University of Vermont

The erosion of streambanks constitutes a significant nonpoint source of pollution to the streams and lakes in Vermont. Extensive agriculture has resulted in stripping of riparian vegetation and soil impregnation with nutrients such as nitrogen and phosphorous. With over 7,000 miles of waterways in Vermont these nutrient deposits represent a significant source of water pollution. This research investigates what makes some banks stable and other banks fail over both time and changing river and groundwater conditions. The goal is to develop a quantitative model of streambank slope stability. To develop such a model, quantitative and semi-quantitative approaches are adopted. The quantitative approach utilizes an in-depth geotechnical analysis incorporating measured soil strength parameters, water levels, bank geometries and failure processes. The semi-quantitative approach is similar; however, the soil strength parameters are empirically correlated to index properties. Since the summer of 2006, reaches of two streams (Winooski River and Lewis Creek) in the Champlain Basin have been selected for the study. About 7 to 8 stream cross-sections, some on the verge of failure and some marginally stable, were surveyed and subsurface investigations were performed. Several boreholes were augered at each of these sites to determine the soil profiles and obtain soil samples. . One cross-section on each reach was instrumented with several groundwater wells, tilt switches and rain gages. In-situ tests were performed at these sites to determine soils' shear strength parameters; laboratory shear strength tests were also performed on select soil samples including some containing grass roots. Shear strengths and grain size distribution tests were conducted at each site. The soil shear strength properties determined in the laboratory compared fairly well with those determined from the borehole shear tests. Methods for evaluating erosion potential of streambank soils are currently under development. A stream bank stability evaluation model is also being validated.

Improved Estimation of Evapotranspiration in Semi-Arid Ecosystems

Robert Bowman, Jan Hendrickx, and Enrique Vivoni
New Mexico Tech
Clifford Dahm, James Cleverly, Julie Coonrod, Marci Litvak, and Karl Benedict
University of New Mexico
Zohrab Samani and Salim Bawazir
New Mexico State University

The goal of the hydrology component of the 2005-2008 New Mexico EPSCoR RII project was to improve estimates of evapotranspiration (ET) in semi-arid environments. Specific objectives were to:

(1) Extend and integrate a network of telemetered instruments that provide ground-based measurements of ET;

(2) Develop appropriate algorithms to provide ET estimates on a regional scale based upon multispectral satellite imagery, and

(3) Develop high-performance computing, data archiving, and integrated modeling to produce geospatial hydrologic information products and distribute them to users.

The project coordinated and expanded a network of 18 ET flux towers sited in the Rio Grande riparian corridor, agricultural fields, desert shrublands and grasslands, and high-elevation conifer forests, making it one of the most extensive such networks in the world. Data from flux towers are telemetered and archived at a central data management facility accessible by researchers and water managers.

We further developed the Surface Energy Balance Algorithm for Land specifically for semi-arid and riparian conditions in New Mexico ($SEBAL^{NM}$). In addition to model optimization, upscaling and downscaling algorithms were developed to allow use of both MODIS and Landsat imagery for ET estimates. Data from our flux tower network, along with data from a new scintillometer network installed throughout the state, were used for validation of the satellite-based estimate.

Finally, we developed high performance distributed modeling and visualization tools to provide improved operational forecasting of hydrological processes including infiltration, evapotranspiration, and hydraulic routing. Among other products, we developed a new data management and modeling framework that allows detailed hydrologic simulations at the watershed scale. This tool is available to users who wish to perform hydrologic simulations in watersheds of particular interest.

"Optimizing Stormwater Management to Reduce Phosphorus Loads to Lake Champlain" by
Karim J. Chichakly[1], Margaret J. Eppstein[1], William B. Bowden[2]

[1]Department of Computer Science, Complex Systems Center, UVM
[2]RubensteinSchool of Environment and Natural Resources, UVM

High-levels of phosphorus loading to Lake Champlain have been linked to algal blooms within the lake and to eutrophication of sections of the lake. Impervious land from development in the surrounding watersheds has increased the strength of rainfall runoff, and hence sediment and phosphorous loads, leaving many watersheds impaired. In this project, a process-based model will be incorporated into a multiscale, multiobjective genetic algorithm for determining optimal watershed management practices, trading off between effectiveness and cost. Automatic innovization techniques will be developed to extract fundamental design principles for "best solutions" from the optimal management practices selected by the genetic algorithm. This will be accomplished by examining characteristics of solutions along and orthogonal to the Pareto-optimal front.

This research is supported by VT EPSCoR Grant NSF EPS #0701410.

The effects of land use on benthic macroinvertebrate diversity and abundance in Vermont streams

Jacqueline Cote

Champlain basin watersheds include agricultural, forestry, and urban land uses. We sampled stream macroinvertebrate communities from streams draining each of these land use types and evaluated a series of community metrics to determine which best differentiated community responses to land use.

Streams draining predominantly forested watersheds had significantly more species sampled and higher values of Hurlbert's PIE (Probability of Interspecific Encounter; a measure of evenness) than either urban or agricultural streams. Rarefaction, or correcting number of species for number of individuals sampled did not affect the outcome of our analysis. Macroinvertebrate abundance, % *Hydropsychidae*, % EPT species (Ephemeroptera, Plecoptera, and Trichoptera; a standard metric used by benthic ecologists) did not differ significantly among site types.

These results are of general interest to biologists, planners, and community watershed organizations in that they contribute to the selection of indices appropriate for differentiating land use impacts on streams. It is of particular interest that indices used broadly by community ecologists were generally more useful than the two stream-specific indices we tested.

Water Dynamics Research at Clemson University

Christopher Cox
Department of Mathematical Sciences
& Center for Advanced Engineering Fibers and Films
Clemson University

We present an overview of research at Clemson University related to water dynamics. The Clemson hydromodeling research group is an interdisciplinary team of faculty from several science and engineering departments. Particular interests include hydrogeology, porous media flows, and groundwater remediation. We have developed predictive finite element and finite difference codes to simulate these processes.

Another interdisciplinary team at Clemson which overlaps with the hydromodeling group is the filtration and separations group, formed within the Center for Advanced Engineering Fibers and Films (CAEFF), an NSF Engineering Research Center. Experiments and simulations are being used to develop shaped-fiber-based filtration media and separation columns, as well as other membrane devices, which have a variety of applications relative to improving water quality.

Specific examples of recent and ongoing research projects will be provided, with the goal of developing collaborations with workshop attendees.

Scaling the Geomorphic and Ecological Consequences of Contemporary Climate Change within the Salmon River Watershed, Central Idaho

Crosby, B.[1], Baxter, C. [1], Wheaton, J. [1], Pierce, J. [2], Yager, E. [3], Kennedy, B. [3], Hicke, J. [3]
[1] Idaho State University, [2] Boise State University, [3] University of Idaho

Because of their capacity to accumulate snowfall, headwater catchments in the intermountain west provide a disproportionate share of the waters that sustain urban, industrial, recreational, hydroelectric and agricultural economies downstream. Over the last 50 years, a well documented warming and change in precipitation has potentially affected a wide range of physical and ecological processes that span from the ridgelines down to the trunk streams. We propose within our 2008-2014 NSF EPSCoR RII project to examine the cascading consequences of contemporary climate change on the greater Salmon River watershed in Central Idaho.

The Salmon River watershed offers a number of unique attributes that make it an ideal candidate for this type of study. First, the watershed is large (30,000 km^2) and spans an elevation range of 280 to 3861 meters. This large elevation range encompasses tributary basins with hydrographs dominated by snow melt runoff as well as basins dominated by rainfall. The Salmon River is also undammed, contains very few irrigation diversions, is extremely sparsely populated and is home to the largest wilderness area in the contiguous United States. This unimpacted character offers an opportunity to examine system response to climatic forcing independent of human land use or water diversion. The third and most opportune characteristic of the Salmon River is the availability of a 30 year coupled time series of hydrological and stream ecological observations distributed throughout the basin. These observations have not yet been evaluated in concert with each other or with records of past weather, geomorphic change, fire history or insect outbreak. By evaluating progressive or abrupt changes in physical or ecological parameters relative to meteorological or hydrological records, we hope to develop predictive tools that can be used to anticipate how future changes in climate will impact water supply, water quality and the physical and biological processes that depend on it.

A Pilot Study of Watershed Flow Using Stable Water Isotopes in Support of the Development of the Lamprey River Watershed (Southeast New Hampshire) as a Hydrologic Observatory

Matt Frades[1], Matt Davis[1], Julie Bryce[1], Bill McDowell[2]
[1]*Department of Earth Sciences, University of New Hampshire*
[2]*Department of Natural Resources, University of New Hampshire*

The Lamprey River Watershed provides a suite of ecologic, geographic, geologic, and cultural characteristics that together provide an excellent opportunity to establish a convenient, unique, instructive, and informative natural laboratory. Researchers at the University of New Hampshire are establishing the Lamprey River Watershed, located in the seacoast region of New Hampshire, as a long term hydrologic observatory, where the instrumentation, data, and results from multi-disciplinary studies can be integrated to achieve greater understanding of the hydrologic system as a whole.

One component of this proposed research is the establishment of a long term record of water isotope data. The results of a 1.5-year pilot study of stable water isotopes in the Headwaters of the Lamprey River Watershed (HLRW) are the focus of this presentation. In order to better understand groundwater flowpaths and residence times within the HLRW, we used stable water isotopes as natural tracers. For the period of June 2006 through October 2007, over 200 total water samples of groundwater, surface water, precipitation, and infiltration were collected and analyzed for stable hydrogen and oxygen isotopes. Based on analysis of isotopic and hydrometric data, the groundwater system is interpreted to be comprised of three distinct but interconnected reservoirs: a *shallow groundwater reservoir* which does not directly contribute to stream flow at the watershed outlet and has a mean residence time greater than 9 years; a *near-surface groundwater reservoir*, which is fed by the shallow system, flows through surface water bodies and wetlands with a mean residence time of approximately 1.5 months, and is the primary source of baseflow in the stream network; and a deep groundwater reservoir.

The findings have significant implications for the interpretation of biogeochemical mass balance models of the Lamprey River Watershed and ongoing strontium isotope and trace element tracer studies. In a broader sense the results also advance the development of the Lamprey River Watershed as a long term hydrologic observatory.

Thresholds, non-linearity and prediction in freshwater ecosystems

Walter K. Dodds
Division of Biology, Kansas State University

Ecological systems have non-linear properties and alternate states that make predicting relevant properties difficult. Methods for defining thresholds include statistical and empirical approaches. Some non-linearities are so obvious (e.g. species extinctions) that statistics are unnecessary. Statistical approaches include (but are not limited to) non-linear curve fitting, breakpoint regression, 2 dimensional Kolmogorov-Smirnov testing, and logistic regression. Thresholds can occur driven by either biological or abiotic properties. An example of an abiotic threshold is groundwater abstraction in the High Plains (Ogallala) aquifer that has led to the disappearance of most small perennial streams. An example of a biotic threshold is the relationship between stream macroinvertebrate diversity and water column total phosphorus; above a threshold total phosphorus value diversity is predictably low. Biotic thresholds are likely related to systems moving to states outside those experienced over the evolutionary history of organisms. Management of aquatic ecosystems and maintenance of ecological goods and services requires prediction, particularly as we enter the no-analog world of increased global temperatures, associated change in hydrologic cycles, and pervasive human environmental influences.

Effects substrate diversity on macroinvertebrate community metrics in forested headwater streams: a description of proposed research

Erin M. Doyle
Saint Michael's College

Variation in habitat tends to increase organismal diversity. I propose to use macroinvertebrate and substrate diversity data from the Vermont EPSCoR Streams Project to examine this relationship in Vermont streams. Macroinvertebrates were sampled and identified during summer 2008. Standard pebble counts were recorded from the same field sites as a measure of substratum habitat variability. I will measure five indices of species diversity and use regression analysis to relate these indices to the pebble count data. Data sets from two of the field sites are presented in this poster as proof of concept. Additional sites will be added during the coming semester. This project will be of general interest to stream ecologists because similar datasets are gathered by a variety of state and federal agencies and citizen monitoring groups.

Connecting temporal and spatial scaling of transpiration from trees to stands and implications for evapotranspiration

BE Ewers*[1], DS Mackay[2], JL Angstmann[1], MM Loranty[2], Brian Amiro[3]

[1]University of Wyoming, Dept. of Botany & Program in Ecology, Laramie, WY, USA; [2]SUNY-Buffalo, Dept. of Geography, NY, USA; [3]University of Manitoba, Dept. of Soil Science, Winnipeg, Canada; Email BE Ewers: beewers@uwyo.edu;

A key contribution of sap flux measurements in ecohydrology has been the ability to quantify woody vegetation water use directly through both space and time. The patterns and processes behind temporal dynamics have been explained by plant hydraulics, stomatal conductance and their connection to whole plant physiology. However, virtually no studies have explicitly connected how temporal drivers of transpiration affect its spatial patterns.

We tested our ability to spatially scale transpiration in time across four different forest stands in North America. The first stand (lodepole pine hereafter) is a subalpine forest in Wyoming composed of lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarps*), Engelmann spruce (*Picea engelmanii*) and trembling aspen (*Populus tremuloides*). The second stand (aspen hereafter) is a transition from upland *P. tremuloides* to wetland speckled alder (*Alnus incana*) and the third stand (sugar maple) is a mix of sugar maple (*Acer saccharum*) and red pine (*Pinus resinosa*) both of which are in Wisconsin. The fourth stand (boreal hereafter) is a mix of black spruce (*Picea mariana*), jack pine (*Pinus banksiana*) and *P. tremuloides* transitioning from well- to poorly drained soils in Manitoba. We made standard micrometerological and other measurements such as depth of organic soil or water table. The number of sap flux measured trees in each stand was 129, 173, 134, and 288 for the lodgepole pine, aspen, sugar maple and boreal stands respectively. Semivariograms quantified the range of spatial autocorrelation (the distance at which individual trees become statistically independent of each other), the sill (the maximum spatial variance), and nugget (the amount of spatial variance at the shortest distance measured) of transpiration. We sorted the data by time or environmental conditions to run semivariograms and tested 1) if the spatial patterns of transpiration change with time and 2) what temporal drivers may explain these spatial patterns.

In each of the four stands we found that the range, sill and nugget of spatial transpiration significantly changed with time indicating that spatial scaling of transpiration should not be taken as a constant. We also discovered that the sill and nugget were strongly and positively driven by vapor pressure deficit while the range was negatively driven and varied between 80 and 20 m. This discovery indicates that plant hydraulic theory concerning the impact of vapor pressure deficit on transpiration can be used to explain both temporal and spatial processes of tree transpiration at the stand scale. Finally, in each stand we found that the primary tree driver of absolute magnitude of transpiration spatial autocorrelation was tree size which was responding to different drivers depending on the particular stand. Using the model TREES (Terrestrial Regional Ecosystem Exchange Simulator) and/or micrometerological measurements of evapotranspiration, we show that how transpiration is modeled in space (big leaf vs. complex canopy, small vs. large plot areas) has a profound effect on estimates of water loss from forested ecosystems.

Diurnal cycling of chemical and isotopic constituents in rivers and streams

Christopher H. Gammons[a] and Stephen R. Parker[b]
Montana Tech of the University of Montana, Butte, MT 59701
[a]Dept. of Geological Engineering; [b]Dept. of Chemistry and Geochemistry

The daily cycle of light and dark imparts 24-h patterns in the chemistry of rivers and streams. The list of measurable parameters that exhibit significant diurnality in rivers grows longer each year as new detailed field investigations are completed. At a minimum, most flowing waters will show diurnal patterns in water temperature, pH, dissolved oxygen, and dissolved carbon dioxide. Temperature is mainly driven by solar radiance, although diurnal changes in the influx of groundwater can also be a factor. Diurnal changes in pH and dissolved oxygen concentration are driven by the photosynthesis-respiration cycle of aquatic plants, algae, and cyanobacteria. Productive rivers in Montana typically show diurnal pH cycles of 0.3 to 1.0 units, but in extreme cases can vary as much as 2.0 units. On a typical summer day, dissolved oxygen can vary from 70% to 80% of atmospheric saturation at night to 120% to 150% saturation in the day.

The substantial diurnal changes in master variables such as sunlight, temperature, pH and dissolved oxygen often impart diurnal cycles in the concentration and aqueous speciation of other parameters, such as trace metals, metalloids, and nutrients. In pH-neutral to alkaline streams, dissolved concentrations of cationic metals such as Zn^{2+}, Mn^{2+}, and Cd^{2+} tend to increase at night and decrease during the day, whereas the reverse temporal pattern is exhibited by anionic compounds, such as arsenate ($HAsO_4^{2-}$)[1]. These patterns are attributed to cyclic adsorption and desorption onto inorganic materials (e.g., hydrous Fe or Mn oxides)[2] and/or organic biofilms on the river or stream bed. In acidic streams, such as those draining abandoned mines, large diel cycles are typically observed in the concentration and redox speciation of Fe[3,4]. These cycles are driven by daytime photoreduction of ferric to ferrous iron and re-oxidation of Fe^{2+} to Fe^{3+} by iron-oxidizing bacteria. In some streams, the diurnal iron cycle drives a complimentary cycle in trace elements that have an affinity for Fe-oxides, such as Cu[3], rare earth elements[5], and arsenic[6].

Our group has recently documented strong diurnal cycles in the concentration and speciation of nutrients in a hyper-eutrophic stream in Butte, Montana, receiving municipal sewage effluent. At monitoring stations close to the source, the dominant form of nitrogen in the water column changes from nitrate (NO_3^-) during the day to ammonium (NH_4^+) at night. Inorganic and/or biological processes can also induce diurnal cycles in nitrate and phosphate in stream reaches that are far removed from nutrient point sources. Other recent work by our group[7] has focused on large and robust cycles in the stable isotopic composition of dissolved oxygen (DO) and dissolved inorganic carbon (DIC) in Montana streams and rivers. During the day, photosynthesis by aquatic plants and algae produces DO that has a similar isotopic composition to river water, causing a shift in δ^{18}O-DO to more negative values. At night, diffusion of atmospheric oxygen and preferential consumption of ^{16}O during biological respiration causes δ^{18}O-DO to shift to more positive values. A complimentary inverse cycle in the isotopic composition of DIC has been observed in several streams, with δ^{13}C-DIC increasing during the day (due to kinetic fractionation during photosynthesis) and decreasing at night (due to return of isotopically depleted biogenic CO_2 through community respiration).

The fact that so many chemical parameters change on a diurnal basis has obvious implications to scientific and monitoring studies of rivers. What you measure will very much depend on what time of day you measure it. The next challenge is to examine the various couplings between the 24-h inorganic and biological cycles in rivers. This needs to be done not only at the microbial scale (e.g., biofilms, algal mats) but also at the macroscopic scale (e.g., plants, macroinvertebrates, fish).

References: [1]Nimick et al., 2003, Water Resources Res. 39, 1247; [2]Shope et al., 2006, Appl. Geochem. 21, 476-491; [3]Gammons et al., 2005a, Geochim. Cosmochim. Acta 69, 2505-2516; [4]Gammons et al., 2008, Chem. Geol. 252, 202-213; [5]Gammons et al., 2005b, Geochim. Cosmochim. Acta 69, 3747-3758; [6]Parker et al., 2008a; J. Volc. Geotherm. Res., in press; [7]Parker et al. 2005, Environ. Sci. Tech. 39, 7134-7140.

Comparison of total phosphorus and sources of fecal coliforms in streams surrounded by forested, agricultural, and impervious land uses in the Lamoille River, VT, drainage basin.

Robert B. Genter, Greggory A. Perry, and Timothy R. Thurston. Johnson State College, Johnson, Vermont 05656.

Nineteen stream sections from tributaries in the Lamoille River drainage basin were examined in the Summer of 2008 for amounts of total phosphorus and fecal coliform bacterial contamination. The stream sections were classified based on the predominant surrounding and upstream land uses into forested, agricultural, or impervious sites. Total P was measured on seven occasions from June 13 through August 5. Total P concentrations in stream water were generally three times higher during a period of heavy precipitation in late July than during base flow in the middle of June. Some agricultural and impervious sites had total P concentrations comparable to reference forested sites, but impacted agricultural and impervious sites could have total P concentrations two to twenty-fold higher than forested sites during base flow and storm events.

Fecal coliforms were collected on June 23 and 24, and isolates were confirmed to be *E. coli* using the IMViC method. Genetic fingerprints of the *E. coli* isolates were obtained using the ribotyping method. Cluster analysis was employed to compare genetic fingerprints of these isolates to those in our small library of known human and livestock isolates of *E. coli*. The results suggest that the source of *E. coli* in agricultural areas was predominantly from livestock. The source of *E. coli* in impervious sites was also largely from livestock, but the contribution from human sources increased to one-fourth of the isolates. The source of most isolates of *E. coli* in forested sites was unable to be determined, possibly because wildlife were not included in the genetic library, but livestock were still the source for one-fourth of the *E. coli* isolated. The frequent occurrence of *E. coli* from livestock (predominantly cows, goats, horse, and sheep) reflects the pastoral nature of the landscape in Lamoille County. As would be expected, human sources were predominantly associated with human habitation (impervious) sites.

VT EPSCoR, Nov 10-11, 2008

Title:

Demonstrating science benefits of water resource predictions for water management: The need for reliable forecast uncertainty estimation and adaptive management

Speaker:

Konstantine P. Georgakakos

Director, Hydrologic Research Center, San Diego, California

Abstract:

The talk outlines theoretical and experimental results pertaining to the importance of treating uncertainty for improving multi-objective water management using science-based climate and hydrology predictions. Past and on-going large-scale, multidisciplinary demonstration projects in the US and abroad form the experimental basis of the discussion. The discussion motivates several fruitful research directions and science-cooperation/reciprocal-technology-transfer activities.

The role of floodplain connections in controlling DOC quality and export in coastal urban sub-basins, Ipswich River Watershed, MA

Gretchen M. Gettel[1] , Wilfred M. Wollheim[1], Tamara Harms[2], and Chuck Hopkinson[2]

[1] University of New Hampshire, Water Systems Analysis Group
[2] University of Georgia, Georgia Sea Grant Program

This study examines the role of fluvial wetlands (those connected to the stream via floodplains) in controlling DOC export and the quality of the DOC that is exported. We have performed synoptic surveys in the headwaters of the Ipswich and Parker River watersheds (Plum Island Estuary Long Term Ecological Research) in northeastern MA above and below wetlands in urban and rural systems. We are testing the hypothesis that wetlands downstream of urban systems absorb flashy hydrographs and increase stream-floodplain connections. Under high flow conditions, DOC export may increase, and over-land and sub-surface flow-paths may facilitate leaching of more recalcitrant forms of DOC from wetland plant sources. Under low flow conditions, autochthonous sources of DOC from the stream channel may be more prevalent. In contrast, wetlands in rural areas are less flashy and sources of DOC more consistent with autochthonous sources.

We are using the optical characteristics of DOC determined by fluorescence and absorbance to quantify DOC quality. Excitation Emission Matrices (EEMS) are used to determine the relative importance of autochthonous and allochthonous sources of DOM. In addition, we are using process measurements of denitrification and respiration to link to explore relationships between DOC quality as measured by fluorescence and lability.

Global change threats to hydrology and terrestrial ecosystems: Impacts of global warming and species invasion in Hawai‘i

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Abstract

The Hawaiian Islands are among the most geographically isolated land areas on earth and depend entirely on local sources of freshwater to meet agricultural and domestic water needs. A growing population, irrigated agriculture, and high inter-annual rainfall variability often lead to water supply shortages in the islands. Given these existing stresses, significant concern exists regarding the prospect of changes in rainfall and rates of evapotranspiration (ET) that may result from global warming. Recent research has shown that temperature in Hawai‘i has increased during the past 30 years by about 0.5°C overall and by 0.8°C at higher elevations. Rapid warming at high elevations is particularly alarming because of possible impacts to vulnerable native ecosystems found there. These mountain slopes are also responsible for much of the water input to surface and ground water systems, which may be negatively affected should warming lead to higher ET. Rainfall has declined in recent decades, a possible consequence of a warming-related upward trend in the persistence of the trade-wind inversion over the islands. Should the trend in rainfall be maintained as warming continues, serious ecological and hydrological consequences are likely.

Preliminary results of our work in a native rainforests has shown that while they currently act as a significant carbon sink, net ecosystem exchange is highly sensitive to variations in temperature. Warming reduces carbon sequestration in these forests by increasing ecosystem respiration. As temperature increases, these forests are likely to become less competitive against invasive species, which have already displaced vast swaths of native forest. The consequences of current and future invasion by alien tree species are extreme, and are not limited to loss of native biodiversity. The hydrological services provided by native forests are also likely to be negatively affected. For example, the widespread invasive tree *psidium cattleianum* has been shown to increase stand-level ET by 27%, which would reduce ground-water recharge and base flow. These findings suggest that the combined and synergistic effects of climate change and species invasion on Hawaii's water resources and terrestrial ecosystems will be severe.

Exploration of Hydrologic Dynamics during the Colonial Era in the Northeastern United States

Mark B. Green, Charles J. Vörösmarty, and Caroline M. Hermans

Department of Civil Engineering – The City College of New York

We are addressing the emerging view that humans are today embedded into the basic character of the water cycle through a myriad of processes including land cover change, water engineering projects, and climate alteration. Thus, our primary goal is to quantify the widespread alteration of hydrologic systems over local-to-regional domains focusing on the Northeast corridor of the United States over a 500-yr period (1600 to 2100). Our initial effort to understand the state of the Northeast hydrologic system included a synthesis of existing historical information regarding deforestation practices, beaver hunting, mill dam construction, wetland drainage, and existing data and proxies regarding climate. We quantified hydrologic change using water residence time as a primary metric. The impact of deforestation on water storage in biomass and through evapotranspiration showed the largest hydrologic impact. Loss of impounded water through the shift from beaver to mill ponds was a secondary change to the hydrology. Our results indicated that water residence time on the landscape shifted towards shorter residence time in response to European human activity. Our analysis represents a first attempt at quantifying the impact of European humans on the hydrologic cycle at the Northeast U.S. regional scale.

Increasing Precipitation and Runoff Over the Last 70 Years, the Winooski River Basin, Vermont

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University of Vermont

[1] Department of Geology, [2] School of Natural Resources [3] College of Engineering and Mathematical Sciences

Analysis of more than seventy years (1936 to 2008) of daily discharge and weather data in the 2,704 km^2 Winooski River Basin of northern Vermont shows statistically significant increases in both precipitation and river discharge as well as a regular periodicity on a 10-year cycle. We analyzed data from six discharge stations, both on the Winooski River and on its major tributaries, as well as nine weather stations at five locations within the basin.

At all five weather stations average annual precipitation is increasing. At a 95% confidence level, this trend was significant at three of the five locations. Similarly, each of the six discharge stations showed an increasing trend in total annual discharge; half of these were significant at a 95% confidence level. Lowest annual daily flows increased significantly at all stations. In contrast, highest daily discharges for each year increased at some stations while decreasing at others. Inconsistent peak flow trends between stations could be evidence of the factors associated with changing landuse, which affects the way the sub-basins respond to storm events. In addition to the overall trends in the data, a linear spline reveals a ~7-8 year cyclicity in total annual precipitation and discharge data, which is well correlated with the behavior of the North Atlantic Oscillation (NAO).

The relationship between weather and discharge has also been changing on a monthly scale, with precipitation increasing significantly at three stations during March or April, while the discharge is trending downward during those same months. This trend may be indicative of the changing timing of seasonality. If spring comes earlier on average, the increases in precipitation could be buffered from the river by earlier snowmelt or increased transpiration reducing spring flows.

TITLE

Satellite and Airborne Remote Sensing in Basic and Applied River Research

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ABSTRACT

Our research group at Flathead Lake Biological Station in Montana uses satellite and airborne imagery to characterize and quantify terrestrial and aquatic habitats and other important characteristics of river floodplains. This work has been employed primarily in alluvial gravel-bed rivers, but has broad application across river and floodplain types. Satellite (Quickbird: panchromatic 0.6m and multispectral 2.5m) and airborne (LIDAR, hyperspectral [1m], ultra-high resolution RGB [0.1m]) imagery are integrated to maximize quantification of ecological attributes that related directly to system structure and function. LIDAR data provides a detailed bare earth Digital Elevation Model and vegetation canopy DEM. River hydraulics and aquatic habitats are classified from LIDAR and high resolution RGB data coupled with spatially explicit Acoustic Doppler Velocity Profile data of water depth and velocity. Accuracy of depth classification was at 70% while velocity classification was correct 57% of all reference data. We have found departure from the classified velocity was on average < 10% among those areas not correctly classified. We use the classifications of velocity, depth, and Froude to aggregate similar hydraulic zones into aquatic habitat classes that allow us to project system production of PP and SP. We also classify the riparian vegetation of the floodplain using spectral reflectance characteristics of the hyperspectral data. Vegetation patch separation into age classes can be done for the dominant gallery forest species by coupling the LIDAR first-return metrics of canopy height with the hyperspectral classification of species composition. The integration of these various sources of remote sensing data allow us to characterize floodplain riparian and aquatic habitats and model their change through space and time.

Keywords: river, floodplain, satellite multispectral, airborne hyperspectral, LIDAR, hydraulics, vegetation, habitat

NGOs and Government Agencies Partnering on River Restoration: Truckee River Case Study

Mickey Hazelwood

Abstract

The health of the lower reach of the Truckee River, downstream of the cities of Reno and Sparks, Nevada has been on the decline since European settlement in the 1850s, impacted by clearing and leveling of floodplain areas for ranching and other agricultural practices; residential, commercial, and industrial development right up to the river's edge in Reno and Sparks, consuming natural floodplain, restricting the river, and generating point and non-point source pollution; engineering of the river system to retain water in a system of reservoirs and divert water for agriculture; and manipulation of the channel itself as part of a failed attempt at flood control that resulted in significant channel incision, depression of the local water table, and loss of the majority of the remaining riparian forest.

Many organizations and agencies had studied the lower reach of the Truckee River for years in largely disconcerted efforts that too often failed to take into account the implications of the research. Much data existed that demonstrated that the ecosystem of the lower Truckee River was highly degraded and still on the decline, but little was being done to apply the research to the solution. The Nature Conservancy (TNC) stepped in to bridge the gaps in the research and bring the various stakeholders to the table to discuss solutions. Although the stakeholders had different interests in the health of the river (e.g. Nevada Division of Wildlife and U.S. Fish and Wildlife were primarily interested in the declining fisheries and recovery of the listed Lahontan cutthroat trout and endangered cui-ui, the cities of Reno and Sparks were primarily interested in ways to improve water quality in order to meet the discharge limits set for the water reclamation facility, U.S. Army Corps of Engineers and Truckee River Flood Management Project were primarily interested in flood mitigation), TNC, working with stakeholders, staff scientists, and consultants, came to the conclusion that ecosystem restoration had the potential to ensure the interests of all the stakeholders, including itself.

Finding this common ground solution allowed TNC to build an extensive partnership with the local, state, and federal agencies and organizations that had an interest in the health of the river. In 2002, TNC was able to acquire one of the priority sites on the lower Truckee River, part of the historic McCarran Ranch, a property including the floodplain along about 4.5 river miles. Working with the partners, TNC immediately began planning ecosystem restoration for the site and began restoration the following year with a small-scale pilot project that included about 1 river mile and about 20 acres of adjacent floodplain. This project was a test of the restoration methods proposed for large-scale projects, and follow-up monitoring and research opportunities proved the methods to be effective. Since then, TNC has continued to build the partnership for restoration of the lower Truckee River, and the program is currently comprised of four priority restoration sites, which are held by TNC or partner agencies and are fully funded for restoration at about $28 million. Full restoration of the McCarran Ranch property has now been implemented, restoration is currently underway at two additional priority sites, and restoration is scheduled for next year for the fourth site. Upon completion of these four projects, over ten miles of river will have been restored, and TNC continues to work with partners to acquire additional lands for restoration.

For the research community, this effort has not only served to pull the previous research conducted on the lower Truckee River into a coherent story of what is wrong with the system and why and to guide the corrective measures taken. It has also produced new research opportunities and funding mechanisms to continue and enhance some of the ongoing research on the lower Truckee River.

Bacterial Source Tracking for In-Stream Water Samples

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Abstract

Water, a natural resource that all living species need to survive is, however; more important because human survival is dependent on water quality. As such, this project has considered microbial pollution in watersheds surrounding Madison County. The research has been made as specific as possible by considering the Indian Creek (IC) and Huntsville Spring Branch (HSB) watersheds. The existence of Methicillin Resistance *Staphylococcus aureus* (MRSA) and *Listeria monocytogenes* have been known to cause human health risks. As such, these two specific microbial pollutants have been investigated as hazardous waterborne pathogens for the two watersheds in this project. In this project, Bacterial Source Tracking (BST) and DNA Fingerprinting were conducted to objectively address the problem of MRSA and *Listeria* polluting the IC and HSB watersheds. The main objective of this research is to discover what living sources are carrying the MRSA or *Listeria* strain as a form of fecal coliform that is being released and eventually matriculating into the IC and HSB watersheds. In addition, some examples of possible sources included in this project are: waterfowl, livestock, human, wildlife, and pet. The project requires collecting water samples for two years. In addition, successful conduction of DNA Fingerprinting has distinguished microbial genes that will be compared to a library of genes from each of the suspected sources, thus; revealing the identity of the sources. Furthermore, the researchers of this project will be able to quantify the sources of pollution and determine which watersheds have the most of each source. The findings will assist to answer some of the questions related to microbial pollution in watersheds surrounding Madison County of Alabama.

CUAHSI: Advancing Hydrologic Science through Community Engagement

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Consortium of Universities for the Advancement of Hydrologic Science, Inc.

Modern hydrologic science studies the occurrence, distribution, circulation and properties of water, and its interaction with a wide range of physical, chemical and biological processes, including human-engineered processes[1]. Recent discussions in the hydrologic science community, however, make clear that we need to move beyond a definition of *what* hydrologic science studies to *how* hydrologic science studies it. In other words, we need to define the unique perspective that hydrologists bring to earth and environmental science. A few key principles emerge: (1) the use of the hydrologic cycle as an organizing concept, (2) use of quantitative approaches, (3) the use of both "bottom-up" (e.g., fluid mechanics) and "top-down" (e.g., systems analysis) approaches, and (4) the use of both deterministic and stochastic approaches.

Phenomena of hydrologic interest have a great range of spatial and temporal scales. Hydrologists tend to define their subdisciplines with compound names (e.g., hydrometeorology, ecohydrology) that don't express their relation to one another nor the intellectual approach used. These subdisciplines tend to divide the field rather than unite it because no inclusive structure or taxonomy has been defined. In this paper, a simple three-part taxonomy for hydrologic science is proposed as a starting point for defining the intellectual structure of the science that is organized around the hydrologic cycle. The vertical dimension extends from bedrock to boundary layer and includes the subdisciplines of ecohydrology and hydrometeorology. The down-slope dimension extends from ridge top to stream and includes the subdisciplines of hillslope hydrology, hydropedology (including mineral weathering and biogeochemistry). The down-valley dimension extends from headwater to the ocean and includes the disciplines of groundwater transport, stream hydraulics, biogeochemistry and hyporheic exchange. Each of these dimensions has different time and space scales. These dimensions form a framework in which to place our subdisciplines and to better communicate our research objectives.

This taxonomy helps to place hydrologic science in a tangible framework that allows us to describe water movement to highlight couplings among components of the hydrologic cycle that have traditionally been studied separately due to differing dynamics (e.g., groundwater vs. surface water vs. atmospheric water). Moreover, a sufficient description of water movement in this framework clearly requires far more than reproducing streamflow at a gage or the water level in a well. Rather, the stores, fluxes, flowpaths, and residence time of water are needed to describe its vertical, down-slope, and down-valley transits. These are the properties needed to link with disciplines such as biogeochemistry, ecology, geomorphology, and water resources engineering in which water plays a critical role.

[1] National Research Council. 1991. *Opportunities in the Hydrologic Sciences.* Washington, DC: National Academies Press. 368 pp.

TRANSIENT ALONG-SHORE JETS IN A NARROW LAKE ARISING FROM AN IMPULSIVE WIND STRESS

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ABSTRACT

A wind stress is imposed along a channel containing a viscid, one-layer (shallow-water) fluid influenced by planetary rotation. The transient response of the channel constitutes a modified problem of geostrophic adjustment as the fluid evolves from an initial imbalance to a final state of dynamic equilibrium. An asymptotic solution – in the limit of a Rossby deformation radius small compared to the channel width – is presented. Particular attention is given to the behavior of the inertia-gravity wave mode and the non-oscillating viscous mode. The interplay of these modes results in transient along-shore jets. The model may be applicable to Lake Champlain where the along-shore currents generated by an along-lake wind event might influence both runoff discharges into and withdrawals from the lake.

Evaluation of the roles of groundwater in basin water balance using the Budyko hypothesis

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Simple models for estimating annual and mean annual basin runoff and evapotranspiration, such as the one proposed by Budyko, are useful for investigating the relationships between the components of water balance and climate. These models are often based on the assumption that annual precipitation is in balance with annual runoff and evapotranspiration, and change in basin water storage is negligible. This assumption may be challenged in regions where runoff is dominated by baseflow. In this study, we examine the role of groundwater in catchment-scale mean annual and annual water balance in basins located in and around the Nebraska Sand Hills, the largest native grassland-stabilized sand dune area in the Western Hemisphere. In the analysis, basin evapotranspiration is calculated as a closure in the basin water balance.

On a mean annual basis, the relationship between aridity index and catchment evapotranspiration-to-precipitation ratio (ET/P) is positive and consistent with the Budyko hypothesis, but significantly different with respect to soil texture. For a given range of aridity indices, the catchment ET/P is found to be the smallest in basins within the Sand Hills, and the largest in those outside the Sand Hills and composed by loam and silt loam soils. Basins partially located in the Sand Hills show intermediate values between the two end members. These trends reverse in the case of runoff-to-precipitation ratio. Higher runoff and lower calculated evapotranspiration values are attributed to the significantly higher rates of infiltration in sand dunes.

On annual basis, the relationship between aridity index and estimated ET/P is negative in basins located within the Sand Hills. This finding contradicts the original Budyko's curve. The strong dominance of base flow is identified as the primary reason for this observation. In the basins studied several different annual runoff-precipitation response types are identified and discussed in relation to topography and soil properties. Secondly, a lumped basin annual water balance based on the Budyko hypothesis but with a dynamic storage component is developed to decipher the observed differences in the annual hydrology of the basins.

The impact of hydroclimatic variations and change on water resources decision making and adaptation

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Effective decision-making and adaptation within the context of climate variability and change hinges upon an understanding of the multiple time scales of hydroclimatic variability and the sensitively linked decision/policy variables relevant for the coupled human-natural (CNH) systems sustainability. The identification of climate precursors, projected changes therein, and a characterization of their potential predictability (and associated uncertainty) provides useful new knowledge in assessing: (a) the potential for thresholds and nonlinear responses to cause irreversible and/or abrupt shifts in CNH systems, (b) role of harnessed predictability in influencing decisions and policy, (c) development of illustrative models (with a few variables) that are amenable to quick decision-analysis and (d) methods and tools for an iterative dialogue between decision-makers and scientists. Using the recently promulgated sustainable water allocation policy in Maine as a case study, we present examples of research that investigates the impact of nonstationary climate on policy prescription, analysis, and adaptation.

Vermont EPSCoR Streams Project

KathiJo Jankowski

The VT EPSCoR Streams Project is a collaboration among high schools, undergraduate students and faculty from several colleges around Vermont to collect water quality data in streams and rivers of the Lake Champlain Basin. The project is designed to both provide high quality data to the state in streams of varying surrounding land uses including agriculture, urban and forested sites as well as to increase the number and diversity of students pursuing STEM majors and careers.

Fifteen teams of high school students and teachers monitor water chemistry, stream physical conditions, total Coliform and *E. coli* bacteria and macroinvertebrate community composition throughout the course of the summer and academic year in streams of the Lake Champlain watershed. Undergraduate students from around the state and Puerto Rico work together with the high schools to analyze water samples and create reference macroinvertebrate collections for each stream site. Undergraduate students also work with faculty or graduate student mentors to carry out independent projects related to the larger context of the Streams Project. Faculty and undergraduates from seven different colleges and students from 13 high schools in Vermont and New York participated in the project in its first year.

The Streams Project has formed collaborations with the Vermont Department of Environmental Conservation and many local watershed groups who can further utilize the dataset in implementing watershed restoration and protection projects. Data from the project will serve to inform public debate and influence management policies regarding phosphorus and bacterial loading of Lake Champlain. The data generated by this project will also be used in combination with many existing data sets in Vermont EPSCoR Complex Systems Modeling effort to understand watershed dynamics. Immediate outcomes of the project include the participation of more than 40 high school students & teachers from 13 high schools in Vermont and New York, 25 undergraduate students from 6 colleges, 5 faculty members from 5 colleges around Vermont; an online, publically accessible shared dataset; web-based identification keys specific to streams used for education and research by partner high schools; and student research posters to be presented in early November at the *NSF EPSCoR Water Workshop: Water Dynamics*. A symposium will be held annually in the spring to showcase the student research projects.

Monitoring Sustainable Development: the Remote Data Acquisition Network at Bannockburn Plantation

Anand D. Jayakaran[1], Daniel R. Hitchcock [1], William H. Conner[2], Thomas M. Williams[2], Bo Song[3], and Sam Esswein[4]

Increasing pressures on the landscape associated with development of the Southeastern coastline have resulted in vast tracts of forested lands being converted to urban and suburban tracts. The key to providing sustainable solutions to tackle the adverse impacts of land use change is a greater understanding of the hydrological and ecological processes that drive undisturbed forested watersheds. The Bannockburn Plantation, located on the South Carolina coast, offers a unique opportunity for measuring hydrologic process in both the spatial and temporal domains. The 3500-acre property is a pilot installation site for a remote data acquisition and digital watershed project known as the Intelligent River™ network. This network is being deployed for the real-time collection, transmission, storage, and visualization of hydrological and ecological data for coastal headwater streams and forested wetland landscapes. Six (6) overlapping levels of sensor networks have been integrated into a comprehensive monitoring protocol for the property: (1) meteorological data; (2) surface hydrology and water quality; (3) groundwater hydrology and water quality; (4) soil and water carbon dynamics; (5) vegetative ecology, and (6) amphibians and soil moisture. Remotely-accessed environmental sensors could save time and labor while providing real-time data streams, useful for research and computer visualizations that in turn could be used for education and outreach. An overview of the network and some preliminary results from the sensor network will be presented.

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3 – Associate Professor, Forestry & Natural Resources, Clemson University.
4 – Graduate Research Assistant, Forestry & Natural Resources, Clemson University.

Beyond the Pipeline: A Watershed Model for Broadening Participation in the STEM and Geoscience Workforce

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The "*Rising Above the Gathering Storm*" report (NAP, 2005) and resultant America COMPETES Act (ACA) have made compelling arguments that a strong, diverse, and capable scientific and technical workforce are essential to America"s economic prosperity and security. This is especially true for the geosciences. With continued population growth, the impact of humans as an influential factor in the complex Earth system is increasingly apparent, to the extent that some scientists have proposed a new geological era – the Anthropocene. Economists predict that the boom of the next few decades will be fueled by issues related to energy and climate change. Drought and the social conflicts that will arise in response to scarce water resources loom large. The workforce needed to both understand our dynamic planet"s continued evolution and create innovative solutions to mitigate or adapt to its impact on mankind will require substantial understanding of fundamental Earth system science concepts. Further, we need a broadly geoscience literate society that can make informed policy decisions and wise personal choices.

The Bureau of Labor Statistics estimates that geoscience workforce needs will grow by 22% in the next decade, much faster than the 10% rate predicted for all jobs. In spite of this growing demand, the number of students earning geoscience degrees remains flat. U.S. production of PhDs in the geosciences has remained level at ~800 degrees per year since 1993. Women now earn ~45% of these degrees, but only 1-2% of them are earned by underrepresented minorities. The picture is no better at the undergraduate and MS degree levels. Lack of minority students in the geosciences is due less to a „leaky pipeline" than to inadequate flow into the system at the outset, even though there are many pathways a student can take into the geosciences. This „input" problem documents a substantial lack of awareness about geoscience career paths and reflects the weak status and quality of Earth Science education in the secondary school curriculum. Only 7% of high school students nationwide take an Earth Science class – and in many schools it is taught as a remedial science; in contrast, >90% of high school students take Biology (CCSSO, 2007). The normal „drivers" that would encourage talented high school students to consider advanced study and careers in a field are lacking: there is no AP in geoscience and the subject commonly does not qualify as a laboratory science or count toward science requirements for graduation. The paucity of geoscience degree programs at minority-serving institutions (e.g., <10 at HBCU"s) also severely limits flow into the pipeline.

To address the situation, NSF is investing in development of the future geoscience workforce through a strategy that might be called a „watershed model." Our ultimate goal is to have a strong outflow of diverse, well-trained geoscientists who can advance our basic understanding of Earth system processes and apply that knowledge to the betterment of humankind. By raining resources across a broad educational terrain (i.e., K-16 & informal education), we seek to raise awareness of opportunities in the geosciences and provide students with practical, hands-on experiences in Earth system science research. Many programs utilize existing channels that are known to be effective in recruiting and retaining STEM students (e.g., LSAMP and AGEP programs). Bridging between programs and institutions help coalesce the flow of students from high school- or after-school-based projects to the post-secondary and graduate school level.

An important corollary to this model is that, as in a true watershed, losses from the surface flow have local benefit. Students, educators, and members of the general public who have participated in some of GEO"s education and outreach programs but have chosen to not pursue advanced learning or careers in the geosciences-related fields are still an extremely important output of our investments. Some will go onto other STEM disciplines. Many will be the future teachers, politicians, and CEO"s who will use their knowledge of Earth system science to help our Nation confront the many challenges and opportunities facing us in the decades to come.

Forecasting Resilience in Arctic Societies: Agent-based modeling tools for assessing social-hydrological systems

Andy Kliskey, Lilian Alessa, Mark Altaweel

Abstract: Arctic communities are increasingly faced with social-ecological changes that act at variable speeds and spatial scales. Such changes are beginning to affect vital resources, particularly water supplies. Currently, there are few computational tools that integrate multiple social and environmental processes in order to aid communities' adaptation to change. We propose a modeling and simulation approach that can integrate such processes at different spatiotemporal scales in order to address issues affecting community water supplies. Demonstrating the proposed approach, an agent-based modeling tool is developed and applied to a community on Seward Peninsula. Results show patterns of water use and perceptions of water availability, enabling forecasting trends for this resource to be made based on current understanding. More broadly, we demonstrate the need for constructing tools that address issues at the community level for better understanding human and hydrological interactions and policy decisions affecting water supplies.

Studies of the water cycle using modeling and satellite remote sensing

Lakshmi Venkat

There has been a lot of research in the past few years on use of satellite remote sensing to understand the hydrological status of the land surface and coupled modeling of teh land-atmosphere system to understand the two way interaction between the land surface and teh atmospher. This talk will pesent both of these aspects. We will use MODIS vegetation and surface temperature data along with AMSR vegetation water content to study the hydrological variability under different climatic conditions. The Weather Research Forecast WRF model will be used to simulate a few days before and after rainfall in the IHOP experiment region of Kansas. Discussions on the simulation performance of the model and comparisons with satellite data will be presented.

Citizen and Volunteer Science: A Review and Future Directions within Human Dimensions Research

Jessica Leahy, Ph.D., School of Forest Resources, University of Maine
Teresa Thornton, School of Forest Resources, University of Maine
Crista Straub, School of Forest Resources, University of Maine
John Peckenham, George J. Mitchell Center for Environmental and Watershed Research, University of Maine
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Citizen science is defined as the participation of non-scientists in scientific research (Trumbull et al., 2000). Also referred to as community science (Carr, 2004) and volunteer monitoring (Gouveia, Fonseca, Camara, & Ferreira, 2004), citizen scientists are trained by professional scientists to collect scientific data according to standardized protocols. These data are then analyzed and interpreted for multiple purposes, from environmental education, stewardship, monitoring, and protection of the environment (Savan, Morgan, & Gore, 2003). The need for citizen science and community-based monitoring programs has increased as government-funded programs, previously active in establishing baseline surveys of ecological health, have decreased (Carr, 2000). In response, citizen science has been applied around the globe to monitor, map, discover, and measure changes in the state of the environment, including water resources.

This presentation will review existing human dimensions research about citizen science. We will examine citizen science as a community-based conservation tool appropriate for public education, providing opportunities for personal change, developing a connection between person and place, and encouraging tangible impacts on natural resource management decisions (Berkes, 2003; Cuthill, 2000; Lawrence, 2006; Calhoun & Reilly, 2007). A reoccurring concern among researchers is the validity of volunteer data. In many cases, the data collected by citizen scientists have been found credible and used effectively to draw attention to environmental issues (Calhoun and Reilly, 2007: Fore, Paulsen, & O'Laughlin, 2001; Tudor & O'Malley, 2007). There are several areas of needed future research that will be outlined. Even if the citizen science is accurate compared to professionally collected data, research is needed to determine local government official trust in citizen science. How citizen science is channeled through social networks for policy change is another area of investigation. Furthermore, the lack of data about knowledge, attitude, and behavior change suggests additional areas for future research. Plans for addressing these research needs through a Northeastern U.S. study of water testing for salinity in private drinking water wells with youth-based citizen scientists will be presented.

Developing a model of cyanobacterial blooms and toxin production using a hybrid genetic programming and parameter estimation approach

Josh Bongard[1], Maggie Eppstein[1], Matthew Luck[1,2], Mary Watzin[2]

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Cyanobacteria (blue-green algae) naturally present in many lakes often form large blooms visible as surface scums or mats, and some species may release toxic compounds into the water. Effects of cyanobacterial production can range from unappealing aesthetics to closure of surface waters for recreational purposes and as a drinking water source because of the presence of toxins. In Lake Champlain, the blooms generally occur from July through September and are thought to be controlled by the concentration of phosphorus in the water. However, the existing data are sparsely sampled in space and time and are characterized by a high degree of variability among samples, and traditional statistics have been inconclusive in revealing conditions responsible for the initiation, intensity, duration, or toxicity of these blooms. To address this problem, we are developing a modeling approach based on evolutionary computation, specifically genetic programming, to evolve the best model (in the form of a system of differential equations) from data on environmental factors – temperature, nutrients (e.g., nitrogen and phosphorus), etc. – and biological measurements (e.g., concentrations of zooplankton predators on cyanobacteria) and to explore nonlinearities, such as feedbacks and thresholds that may operate in the system at different times. From an initial population (set) of randomly assembled mathematical expressions (expected or known parts of equations from published literature or expert knowledge can be incorporated to assist the model selection), our hybrid method first estimates the parameters (coefficients) of the model by a nonlinear least squares routine and then evaluates the fitness (error) of the models by their ability to predict the data series. The individual models with the highest fitness (lowest error) are then mutated and recombined to form a subsequent generation of models. The best model resulting from multiple iterations of parameter estimation and evolution by genetic programming will then be examined to explore the mechanisms responsible for components of the model. We are developing our methods by starting with data simulated from a predator–prey system for which we can control the parameters, sampling frequency, and noise characteristics before confronting our modeling with real data. We hope our modeling results will lead to an increased understanding of the processes driving cyanobacterial dynamics as well as provide a novel method for revealing patterns in sparse and noisy environmental data.

Hydrologic connectivity from hillslope to landscape scales: Implications for runoff generation and water quality

Brian McGlynn

Hydrologic linkages between uplands and streams are requisite for the transmission of water, solutes, and nutrients from uplands through riparian zones to streams. However, understanding how local hillslope-riparian-stream hydrologic connectivity influences watershed scale hydrologic response remains a challenge. Investigations have typically focused on plot scale or watershed outlet observations with little integration of the two or understanding of the frequency and spatial organization of water and solute delivery to streams. Because hydrologic connectivity is heterogeneous in space and often temporally transient, new approaches are needed to transfer reach and plot scale understanding to stream network and watershed scales. This presentation addresses four interrelated aspects linking landscape structure and hydrology that impact runoff dynamics and water quality: 1) conceptualizing and testing upland–stream connectivity over space and time (where and when streamflow is generated along the stream network), 2) assessing controls on riparian buffering potential across the stream network, 3) integrating intensive and extensive connectivity and buffering observations to stream networks and larger catchment scales, and 4) transferring this new understanding gained from natural landscapes to those undergoing rapid landuse change to assess controls on the spatial and temporal variability of streamwater nitrogen. We suggest that internal watershed structure can affect its response to perturbations such as climate variability or landuse change.

MAPPING CYANOBACTERIA BLOOMS IN LAKE CHAMPLAIN USING SATELLITE REMOTE SENSING

S. M. Wheeler[1], L. A. Morrissey[1], S. N. Levine[1] and W. F. Vincent[2]
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Nuisance and harmful algal blooms in Lake Champlain (VT-NY-QC) are a serious concern to resource managers, scientists and the public. Such blooms impact drinking water supplies, recreational use of lake waters, and, if toxic, pose a threat to human health. An improved means of mapping and monitoring the distribution of such blooms over current point sampling methods is needed. Remote sensing offers great promise although current operational sensors are limited in either their spectral or spatial resolution for freshwater applications.

This study assessed the utility of three operational satellite sensors to detect and quantify cyanobacteria blooms in Missisquoi and St. Albans Bays, Lake Champlain. Data from QuickBird, SPOT, and MERIS multispectral sensors were acquired coincident with *in situ* water samples in the summers of 2003 and 2004. *In-vivo* fluorescence of chlorophyll and phycocyanin, and transmissivity were measured along 5-15km transects located with GPS. Regression models linking cyanobacteria concentrations and satellite radiances were developed using single band, band ratios, and principal components. Model parameters were developed using one half of the field data; chlorophyll concentration model predictions were verified with the remaining half.

Our results demonstrate within northern Lake Champlain that high spatial resolution QuickBird imagery (2.4m) successfully quantified and mapped the spatial distribution of algal blooms and their chlorophyll concentrations. SPOT 20m imagery also showed similar potential to map blooms, although field instrument problems limited quantitative analyses. Designed for marine applications, MERIS also proved successful in detecting blooms, although its 300m spatial resolution limits its application to larger water bodies. We conclude that all three satellites have value for detecting and mapping algal blooms in Lake Champlain and could thus prove of great value to augment point-sampling efforts in future studies or monitoring efforts.

Comparison of macroinvertebrate diversity, abundance of EPT species and total abundance between kick and hand sampling techniques

Ian E. Myers

Citizen monitoring groups as well as state and federal agencies have frequently used kick samples as the standard methodology to sample stream macroinvertebrate communities. Hand-cleaning of cobbles and boulders before agitating smaller sediments has been a recent modification of the older kick sampling technique. Our research goal was to assess the differences in macroinvertebrate communities sampled using the kick and hand sampling techniques. We hypothesized that the hand sampling technique would have a higher abundance and diversity because scrubbing the large substrates by hand might would tend to be more thorough than kick sampling. Our results showed that the hand sampling technique yielded higher abundance, yet a lower diversity of macroinvertebrates. Shannon's diversity index and Hurlburt's PIE were both significantly higher in kick samples while the number of hydropsychid caddisflies was higher in hand-swept samples. Number of EPT (*Ephemeroptera, Plecoptera,* and *Trichoptera*) species did not differ between techniques. These results have implications for comparisons made in long-term data sets gathered using the two techniques.

Quantifying sediment and solute wash-off from a mixed land use headwater tributary of Potash Brook watershed

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Watershed sediment and solute loads originate from many different sources. These can include point sources, soil erosion, impervious surface wash-off, channel bank and bed erosion, and others sources depending on the land use activities within the watershed. However, the inherent difficulty in quantifying the contributions of specific nonpoint sources creates uncertainty in watershed management efforts aimed at mitigating these pollutants. The goal of this research is to quantify the contribution of wash-off from residentially developed land uses to total watershed sediment and solute loadings within a tributary of Potash Brook. To do so, we apply a mass balance approach to this small, mixed land use headwater watershed in South Burlington, VT. Flow, total suspended sediment, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, and chloride are measured flow-proportionately in stream during storm events. Additionally, two storm drain outfalls underlying residentially developed portions of the watershed (capturing 15% of the total developed area, 3.5% the total area) were instrumented in the summer of 2008 to measure flow and residential land use wash-off of sediment and solutes from theses areas during storm events. Preliminary data suggest greater per unit area rates of sediment and solute generation from the residential storm drained areas, relative to the average watershed generation rates, and relative to those of an undeveloped upland area. Continuation of this research will allow us to better quantify the contribution of surface wash-off to total watershed loads over a range of seasonal and hydrologic conditions.

Mapping Aquifer Zones Based on Microbial Ecology and Geochemistry in a Landfill Leachate Plume with a Self-Organizing Map

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Abstract

We implemented a self-organizing map (SOM) to delineate aqueous geochemistry and microbial ecology in landfill leachate. In subsurface ecosystems microorganisms mitigate a myriad of chemical processes such as contaminant degradation and immobilization, redox cycling and nutrient transport. Resident microbial communities depend on geochemical energy for their metabolism, thus microbial diversity and survival depends on geochemical and contaminant variations in groundwater. Environmental systems analysis would benefit from including microbial diversity; yet traditional multivariate statistical methods are not suited for multi-dimensional data.

We developed an SOM (non-linear clustering algorithm) to reduce high-dimensional data to a lower dimension. The SOM is effective with multiple data types (*e.g.* microbial communities and the environmental parameters that describe their habitat). We tested the SOM on data from monitoring wells in a shallow landfill leachate-contaminated groundwater aquifer. The dataset available from the Schuyler Falls Landfill in Schuyler Falls, NY includes detailed site-wide apparent conductivity as well as hydrochemical and microbiological data from 28 different monitoring wells. Groundwater samples were analyzed for temperature, pH, redox potential, turbidity, specific conductance and a suite of organic and inorganic contaminants. Microbiological ecology is described with 16S rRNA gene surveys using primer sets specific for Bacteria, Archaea and *Geobacteraceae* and DNA sequences were identified as operational taxonomic units (OTUs) for further analysis.

The SOM clusters and delineates the hydrochemical and microbial data, identifying redox zones in the subsurface. Identification of different zones using this clustering algorithm is an important step in linking microbial activity to biogeochemical processes that are important for site characterization and long-term monitoring stewardship (*i.e.* delineating groundwater plumes, identifying changes in redox condition, types of contamination or potential for biodegradation or immobilization).

Use of High Resolution Remote Sensing to Characterize Geomorphic Stability of Stream Reaches

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Streambank erosion is one of the most important but least understood nonpoint sources of sediment and phosphorus threatening the impairment of surface waters within the Lake Champlain Basin. Despite extensive studies in recent decades on sediment loading in response to agricultural practices, land use change, and streambank erosion, the identification and quantification of nonpoint sources and transport mechanisms of sediments have proven difficult. In particular, the high spatial and temporal variability and the difficulties of quantifying erosion rates at watershed scales have severely limited understanding the role and relative contribution of streambank erosion to water quality degradation. These uncertainties, in turn, have limited the development and implementation of effective management strategies to reduce sediment loading in Vermont's surface waters.

As part of a larger study addressing fluvial geomorphology, we explored the use of high spatial resolution aerial and satellite remote sensing to assess stream stability to augment current ground-based monitoring efforts. To this end, we analyzed 1:1250 (0.16m) digital orthophotography, QuickBird (0.6m and 2.4m) satellite imagery and LiDAR elevation data for the Allen Brook and Indian Brook watersheds in Chittenden County, VT to characterize the geomorphic condition and sensitivity of stream reaches to watershed and corridor stressors. Stream centerlines were digitized from the 2005 QuickBird imagery and 2004 1:1250 digital orthophotography and compared with stream channel data (VT Hydrography data) derived from 1:5,000 panchromatic digital orthophotos acquired in 1999. Streambank heights were measured using LIDAR-derived digital surface models (DSM). Channel migration was mapped as the lateral and vertical shift in stream centerlines between any two dates of observation. Lateral distance, area and soil volume loss were then calculated for each erosion feature and summarized by reach and watershed. Mapping and elevation accuracies were verified through field surveys.

Our analyses documented substantial channel migration over the 1999-2005 period of study in both watersheds and identified critical source areas of sediment loading to each stream due to streambank erosion. Within Indian Brook, 111 migrations ranging in length from 2.3 - 59m and representing a net total migration of 917m were observed. Measures of channel migration for Allen Brook were consistently less than that for Indian Brook, but nonetheless substantial (n = 71, range = 2.5-49m, sum = 608m). Over the six year period of observation, preliminary estimates of the volume of eroded streambank material from Allen and Indian Brook watersheds ranged from 22,000-42,000m^3, respectively. These estimates of soil loss due to streambank erosion are not only the first to be derived from watershed-scale observations, but also substantially larger than previous point-based estimates in the literature, thus confirming the importance of streambank erosion to Lake Champlain water quality. These results also demonstrate the potential that remote sensing offers to map and monitor stream geomorphologic change at watershed scale accurately, effectively, and at relatively low cost.

Nevada Infrastructure for Climate Change Science, Education, and Outreach

Thomas Piechota, University of Nevada, Las Vegas
Gayle Dana and Nick Lancaster, Desert Research Institute
Scott Mensing, University of Nevada, Reno

The Nevada System of Higher Education, including the University of Nevada, Las Vegas, the University of Nevada, Reno, the Desert Research Institute, and Nevada State College have begun a five year research and infrastructure building program, funded by the National Science Foundation Experimental Program to Stimulate Competitive Research (NSF EPSCoR) with the vision "to create a statewide interdisciplinary program and virtual climate change center that will stimulate transformative research, education, and outreach on the effects of regional climate change on ecosystem resources (especially water) and support use of this knowledge by policy makers and stakeholders."

Six major strategies are proposed to address infrastructure needs and attain our vision: 1) Develop a capability to model climate change at a regional and sub-regional scale and its effects to evaluate different future scenarios and strategies (Climate Modeling Component) 2) Develop data collection, modeling, and visualization infrastructure to determine and analyze effects on ecosystems and disturbance regimes (Ecological Change Component) 3) Develop data collection, modeling, and visualization infrastructure to better quantify and model changes in water balance and resources under climate change (Water Resources Component) 4) Develop data collection and modeling infrastructure to assess effects on human systems, responses to institutional and societal aspects, and enhance policy making and outreach to communities and stakeholders (Policy, Decision-Making, and Outreach Component) 5) Develop a data portal and software to support interdisciplinary research via integration of data from observational networks and modeling (Cyberinfrastructure Component) and 6) Develop educational infrastructure to train students at all levels and provide public outreach in climate change issues (Education Component).

Two new climate observational transects will be established across Great Basin Ranges, one anticipated in southern Nevada to cover the Spring and Sheep Mountains, and the second to be located in Great Basin National Park and reach the ancient bristlecone pine stands on Wheeler Peak. Climatic, hydrologic and ecological data from these transects will be downloaded into high capacity data storage units and made available to researchers through creation of the Nevada climate change portal. Our research will aim to answer two interdisciplinary science questions: 1) How will climate change affect water resources and linked ecosystem resources and human systems? And 2) How will climate change affect disturbance regimes (e.g., wildland fires, invasive species, insect outbreaks, droughts) and linked systems?

Seasonal dynamics of carbon and nitrate uptake in streams draining watersheds underlain by discontinuous permafrost

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Permafrost plays an important role in shaping the chemistry of streams by restricting subsurface flows through catchments to soils. During the summer thaw of soil, subsurface flows migrate through deeper soil horizons presumably resulting in seasonal shifts in the inputs of carbon and nitrogen to the streams. Within streams, the extent of the hyporheic zone may also shift with seasonal thaw. Hyporheic zones have high mineralization and nitrification rates; thus expansion of the hyporheic zone throughout the season has important implications for the chemistry of the stream. This study examined nitrogen cycling in two streams draining watersheds with varying extents of underlying permafrost to understand how nitrate uptake is affected as carbon sources shift during soil thaw. Additionally, we examined the extent of transient storage (hyporheic zone, eddies, pools) in order to determine if storage increases as the active layer thaws and if storage differs between the two streams. The research was conducted in two streams draining sub-catchments with low and high permafrost extents (5% and 50% permafrost) of Caribou-Poker Creeks Research Watershed located in interior Alaska. Steady-state solute injections, amended with acetate and $^{15}NO_3^-$, were performed in both streams throughout the summer of 2008 to capture the seasonal thaw of soils. In the stream draining the low permafrost catchment, acetate uptake was rapid initially, then decreased as the season progressed. In contrast, acetate uptake in the stream draining the higher permafrost watershed increased throughout the season from 3525 meters early in the season to 2073 meters late in the season. Addition of a labile carbon source appears to have stimulated nitrate uptake in both streams indicating microbes were carbon limited. Later in the season, however, nitrate concentrations increased post-injection suggesting nitrifiers were competitive due to senescence of surrounding vegetation and possibly algal communities. In the low permafrost stream, carbon sources may shift seasonally from recalcitrant material leached from surface soils, to more labile sources as soils thaw resulting in changes in the acetate uptake length. Acetate uptake in high permafrost stream, in contrast, appears to be driven by the amount of carbon reaching the stream thus the gradual increase in acetate uptake is a result of the reduction of background carbon concentration. These contrasting patterns in carbon and nitrogen cycling have important implications for future functioning of streams as permafrost thaws, subsurface flows through watersheds change, and the resulting inputs of materials into streams is altered.

Watershed Scale Assessment of a Karst Drainage Basin Using Microbial, Geospatial, and Geochemical Approaches

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This research activity will address the relevance of karst topography and its influence on the hydrogeology and water quality of the Brushy Creek watershed located in rural southeastern Kentucky. Karst topography is an integral component of the Kentucky landscape with approximately 55% of the state underlain by karst limestone. The Brushy Creek watershed lies in a karst region where the level of groundwater-surface water interaction is suspected to be high, but is largely unknown. The Kentucky Geological Survey has mapped Brushy Creek watershed as 72% intensive karst or karst prone topography. The Brushy Creek watershed drains approximately 28,000 acres and is a major tributary to Buck Creek, with a drainage area of nearly 189,000 acres. Once a karst area becomes polluted, it is generally very difficult to remediate based upon the unusual surface and subsurface features, such as underground drainage systems that may flow very rapidly over long distances. In 2001 and 2002, the watershed was designated as an Environmental Quality Incentives Program (EQIP) Priority Area leading to the allocation of $490,000 to install best management practices (BMPs) associated with livestock production within the watershed. While Kentucky is the largest cattle-producing state east of the Mississippi River, the average herd size is only 29 head. With such a substantial sector of Kentucky's agricultural economy in the hands of small independent producers, it is critical to determine land use practices that are most effective at mitigating nonpoint source pollution from cattle operations. Fecal coliform levels indicate that pathogens are a significant problem throughout the watershed, and that cattle grazing practices are the most likely source, but failing septic systems and straight pipes are also suspected contributors to nonpoint source contaminants. A previous study was conducted from May 2006 through May 2007 on Brushy Creek watershed using water quality, statistical analysis, and geotechniques to assess BMP effects. It was concluded that the BMPs did not significantly improve the water quality of Brushy Creek. It is suspected that the absence of karst as consideration in national BMP prescription policies and practices may provide a plausible explanation for the lack of significant water quality improvement in this impaired watershed. This study will continue the water quality monitoring of the 2006 study and include dye traces, climate data, stream discharge, and application of microbial source tracking (MST) techniques using real-time PCR (qPCR). The qPCR technique allows for the identification and quantification of human versus non-human origins of nonpoint source pollution. This is achieved by the use of a DNA sequence-specific primer available for *Bacteroides*. The combination of water quality data and MST data, using qPCR, collected from watersheds containing karst topography may greatly improve the existing management tools for these complex hydrologic interactions. The strength of qPCR lies in the higher degree of certainty these techniques provide for fecal source loadings as they relate to hydrologic processes.

IDENTIFYING MODEL STRUCTURE AND SCALE DEPENDENCIES IN COMPLEX SYSTEMS

Donna Rizzo

Environmental managers are increasingly required to forecast long-term effects and/or the resilience and vulnerability of biophysical systems to human-generated stresses across a wide variety of spatial and temporal scales. In addition, once remedies to threatened or damaged biophysical systems have been put in place, environmental professionals are required to design, implement, and evaluate long-term monitoring plans for stakeholders, who often have disparate goals and objectives. Part of this process is the development of rigorous statistical models that relate environmental data to identifiable stream classes or categorical population responses (*e.g.*, geomorphic condition, inherent vulnerability, species presence or absence, biota diversity, *etc*.). Recent advances in the computational and statistical sciences have led to the development of sophisticated methods for parametric and nonparametric analysis of data with categorical responses. In this work, we develop new computational methods, using data-driven artificial neural networks (ANNs), to identify model structure and scale dependencies associated with these complex systems to assist scientists and environmental professionals in mining their data and making management decisions.

The Vermont Agency of Natural Resources' (VTANR) is tasked with solving multi-objective problems associated with Vermont's dynamic waterways; such as mitigating loss of property from stream bank erosion and flooding, minimizing aquatic habitat threats due to geomorphic instability and reducing fluvial erosion hazards as well as sediment and nutrient loading. In this research, we apply non-parametric, clustering and classification artificial neural networks (ANNs) to assimilate large amounts of multiple data types for use in fluvial hazard management decision-making. We use expert knowledge and geomorphic assessment field data on more than 750 Vermont stream reaches (+950 miles). Two types of artificial neural networks (Kohonen self-organizing map and counterpropagation algorithm) are used in hierarchy to predict reach-scale stream geomorphic condition, inherent vulnerability and sensitivity to adjustments. The ability of the counterpropagation algorithm to classifying non-linear predictor-response functions is demonstrated by predicting reach-scale stream geomorphic condition and inherent vulnerability. Predictions compare well with expert evaluations. The Kohonen self-organizing map has been used to cluster the reaches into stream sensitivity (or instability) classifications. By adjusting weights of input variables, experts can fine-tune the classification system to understand and document similarities/differences among experts, and classify reach-scale stream inherent vulnerability, geomorphic condition and overall susceptibility to channel adjustment. Using ANNs for these purposes: 1) documents important factors for determining stream reach condition, 2) is data-driven and 3) does not require the development of site specific process-based stream model and provides a standardized approach for classifying stream sensitivity in various contexts.

Nitrate Export from Small Northeastern Forested Watersheds as a Function of Soil Nitrification Rates

Donald Ross, University of Vermont, Beverley Wemple, University of Vermont, Jamie Shanley, USGS, Gregory Lawrence, USGS, Scott Bailey, USFS, John Campbell, USFS
Guin Fredriksen, Cornell Univ., Austin Jamison, Chesapeake Bay Foun. (MS, UVM)

Soil nitrification rates and nitrate concentrations in stream water vary considerably across northeastern USA sites that receive similar levels of atmosphere N deposition. We measured soil net nitrification rates and stream nitrate export in ten watersheds in Vermont, New Hampshire and New York. These sites included adjacent watersheds with differing amounts and patterns of nitrate export. Our objectives were to determine the relationship between nitrification rates and watershed characteristics (e.g. vegetation, soils, topography), and to explore the link between these rates and watershed nitrate export. Net nitrification rates were highly variable both within and among the ten sites but average watershed rates were well correlated with stream nitrate export. Using watershed averages, soil C/N ratio and tree species composition were good predictors of both average net nitrification rates and stream nitrate export. The impact of continued N deposition is difficult to discern within the background of soil and vegetation processes. It is likely that these processes will continue to control watershed nitrate export.

Poster/Research Title:
Baltimore City Neighborhood Greening & Community Garden Census Project: A Case Study in Community Directed Research and Collaboration

Names Associated: Satish Serchan, University of Vermont, URI Intern, Celine Manekin, University of Maryland, College Park, URI Intern, and Miriam Avins, Baltimore Green Space, Mary L. Washington, Parks & People Foundation/Baltimore Ecosystem Study, Megan Arenberg, Yale University and Amanda Behren, Johns Hopkins School of Public Health.

Department: Urban Resources Initiative, Parks and People Foundation, Baltimore, MD 21211

Abstract: The Baltimore City Neighborhood Greening and Community Garden Census Database Project builds on an initial survey of community green spaces prepared by the Parks & People Foundation in 2002 which produced a geo-coded database and a series of reports relating to vacant lot restoration, community-managed open space, and greening strategies in Baltimore and other cities. While the survey produced a useful map of community greening projects, it was not designed nor maintained as a comprehensive listing or "census" of open space, community gardens, greening projects. However, in order to develop a comprehensive approach to the management issues of vacant lot acquisition, greening opportunities, and placement of water sources for example, local decision-makers and community greeners alike must be able to answer to not so simple questions: How many have we created and where are they? This project seeks to extend the prior research by documenting all of Baltimore City's community-based green spaces beginning with a site visits and phone survey to verify the administrative and geographic information of databases maintained by Parks & People, Baltimore Green Space, Center for Livable Future at the Johns Hopkins University, and Master Gardeners. Each of these groups provided volunteers and graduate students to work together to begin to answer the following questions:

- Who and what institutions are the stewards of these informal and formal green infrastructures? Where are these greening activities located and how and when did they come about?
- What factors contribute to continuous, intermittent, and lapsed management regimes?
- How do non-profit organizations begin to track, evaluate performance past and plan future investments in neighborhoods-based greening projects?

Regional Hydrology & Fresh Water Challenge: Models & Data, Tools & Maps

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Regional hydrology addresses the temporal and spatial variability of water balance components for areas from continents to river basins covering hundreds of square miles. The methodology of regional data analysis provides quantitative description of the diversity of landscapes.

Models as formal integrators of knowledge play a central role for hydrological process in the landscape environment study. The use of cyber multilevel model of landscape (Krcho, 1978) and watershed as part of it (Shmagin, 1997) provides the conceptual approach for integration of climate, soil, geological and biological empirical characteristics of landscape. The cyber model for watershed allows the formal presentation of research tasks and composition of initial matrixes for data analyses.

The data analysis (multivariate exploratory techniques) operates with two kinds of data: time series and maps that are integrated with use of GIS Data analysis with use of multivariable statistics (particularly factor analysis) transforms the initial matrixes containing empirical data to two new kinds of matrixes: matrixes of linear connection and residuals. Matrixes of linear connections have fewer components than those variables in initial matrixes and present a statistical structure of variable connections for analyzing process or object. Statistically obtained structure allows the spatial temporal description of regional hydrological processes or objects. To combine the results of data analysis of layered quantities and qualitative information onto a map of water balance components of landscape with defined unit boundaries requires the fuzzy logic approach for regionalization (Shmagin and Chen, 2006).

Regional hydrological analysis of river runoff was completed for a range of territories and scales: conterminous U. S., Mid-continental U. S., Upper Missouri River basin, U. S. part of Great Lakes basin, South Dakota and Minnesota. For some of these regions, additional analysis was also done for precipitation, total snowfall and air temperatures.

In Minnesota, this regional hydrological research allowed for team of researchers to start work on Atlases of water sustainability for the state: (https://wiki.umn.edu/view/Water_Sustainability).

Spatial temporal variability of water balance components in many landscapes is the main deterministic condition for the dynamics of ecological communities. Quantities results presented on maps of water recourses create new opportunities for improving water management methods and practices. Use of this methodology and rethinking of obtained results allows the ideas (approaches, concepts) and the tools (methodologies, models) in regional hydrology to be revised.

Are Current Bacteriological Assessment Practices Sufficient for Water Resource Management in the Ohio River Basin? Charles C. Somerville, Department of Biological Sciences, Marshall University.

Background: We began studying antibiotic resistant bacteria in surface waters of the Ohio River Basin in 2001. Those studies initially addressed two simple experimental questions; i) are antibiotic resistant bacteria present in significant numbers and, ii) if present, what is the pattern of their distribution? An underlying assumption of the initial studies was that the presence of antibiotic resistant cells at a site would be caused by contamination of surface waters at or near that site with fecal matter from human or animal populations with a history of exposure to antibiotics. Several years of survey data cast doubt on this assumption, prompting a set of experiments designed to test the hypothesis that cultivable antibiotic resistant bacteria are a subset of cultivable fecal-derived bacteria. **Methods**: We compared counts of cultivable bacteria grown on R2A agar supplemented with individual antibiotics to MPN estimates of total coliforms, *Escherichia coli*, and antibiotic resistant coliforms and *E. coli*. Mid-channel, sub-surface water samples were collected at five mile intervals on two 100-mile reaches of the Ohio River. Sub-samples were cultivated on R2A agar and R2A agar supplemented with ciprofloxacin (4 μg/ml), tetracycline (12.5 μg/ml), or viginiamycin (8 μg/ml). Coliform and *E. coli* counts were estimated using the IDEXX Colilert® QuantiTray®/2000 method according to the manufacturer's directions. Antibiotic resistant coliform and *E. coli* counts were estimated by supplementing the IDEXX culture medium with the same antibiotics at the concentrations noted above. **Results**: Cultivable, antibiotic resistant bacteria counts (on R2A) averaged from 75 CFU/ml (tetracycline, upper reach) to 289 CFU/ml (virginiamycin, lower reach). Cultivable antibiotic resistant counts were always significantly ($P < 0.01$) higher than MPN estimates of antibiotic resistant coliforms, *E. coli* or antibiotic resistant *E. coli*. Furthermore, the distribution patterns of cultivable antibiotic resistant bacteria and coliform bacteria were distinct. **Conclusions**: These data indicate that the cultivable antibiotic resistant bacteria were not a subset of cultivable fecal bacteria, and suggest that the distribution of resistant bacteria cannot be adequately predicted by monitoring for fecal indicator organisms. Therefore; if antibiotic resistant cells present a credible risk, no commonly used bacteriological assessments are providing data that can be used to protect public health. Further research is required to determine what environmental factors affect the distribution and persistence of antibiotic resistant strains, and whether or not the organisms found in surface water pose risks to human health.

Venkataramana Sridhar

Water balance analysis in a semi-arid mountainous watershed of Idaho

The physically-based distributed Soil Water Assessment Tool (SWAT) hydrologic model was applied to a research watershed, the Dry Creek Experimental Watershed (DCEW), near Boise Idaho to investigate its water balance components both temporally and spatially. Natural variability in hydroclimatology of the basin (with average monthly precipitation ranging between 1.3 mm and 92.3mm) was large even during the short span of study period (2001-2007). Monthly spatially distributed soil moisture and evapotranspiration (ET) maps were produced for the growing season of 2007 from the SWAT model outputs. These maps showed significant spatiotemporal variation of ET (varying from 0-350 mm) and soil moisture storage (varying from 0-160 mm). Parameters pertaining to soil (e.g., available water content, saturated hydraulic conductivity), groundwater recharge (e.g., deep groundwater recharge), and vegetation (e.g., leaf area index, maximum canopy index) processes were estimated matching the overall basin hydrologic conditions during model calibration. This study highlights the necessity for better techniques to precisely identify and drive the model with commonly observed inversion-related snow melt or rain-on snow weather events as well as to prescribe soil hydraulic properties and vegetation conditions that more closely represent the conditions in this complex terrain.

Soil moisture retrieval from AMSR-E: A statewide application and verification using observations and a hydrology model

Soil moisture is one of the important variables in hydrology and energy budget studies and is highly variable in space and time. Quantifying soil moisture over the watershed to river basin scales is critical and a precursor to formulating better water and land use management practices. Unfortunately measurements of *in-situ* soil moisture are mostly time consuming and expensive and need a dedicated sampling strategy, especially over larger scales. The objective of this study is to evaluate the AMSR-E based soil moisture through the development of cumulative distribution function and scaling it up based on hydrology model-simulated soil moisture and assess the results using observed soil moisture during the growing season for three years in Nebraska. Results from this study are promising and highlights the utility of remotely sensed surface soil moisture in capturing spatial and temporal variation of soil moisture.

Impact of Weather Modification on Streamflow of North Platte River

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Abstract

Shifts in the temporal and spatial distributions of global water have resulted in a need to improve the existing water management practices. For this reason, Wyoming Weather Modification Program has conducted various cloud seeding operations for snowpack augmentation in Medicine Bow and Sierra Madre mountains of the North Platte basin. There is a critical need to quantify the increase in the streamflow as a result of increase in snowpack. Moreover, there is interest in evaluating the impacts of antecedent moisture conditions and air temperature on snowpack-streamflow relationship.

Variable Infiltration Capacity Model (VIC) is a macro-scale water and energy balance model that uses meteorological, soil, and vegetation data to estimate grided surface and subsurface runoff. The meteorological data applied to the model includes grided daily precipitation, minimum and maximum air temperature, and wind speed. The soil data includes field capacity, wilting point, saturated hydraulic conductivity, soil type, and porosity. The vegetation data is the land composition at each grid cell and constitutes 14 classes. VIC model is forced by grided precipitation, temperature, wind series, landcover type, and soil properties; and calculates the snow, runoff, and moisture fluxes for each grid cell. The moisture is computed for three soil layers, i.e, 0–10 cm, 10–40 cm, and 40–140 cm. Routing of grided runoff is performed to calculate streamflow.

In this research, we develop VIC model for the North Platte basin to understand and quantify its snowpack-streamflow relationship. North Platte VIC model is forced under various *what-if* meteorological scenarios and simulation results are used to develop statistical relationships between snowpack and streamflow. The effects of previous Fall season soil moisture and the following Spring-Summer season air temperature on the resulting streamflow from the snowpack are also studied. The optimum relationships are developed and applied to quantify streamflow increase due to snowpack increase as a result of weather modification.

Interdisciplinary water resources and ecohydrology research and education in the Central Plains

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A number of recent water resources studies have been conducted at Kansas State University to addressed groundwater resources in the Central Plains region. This presentation presents results from these studies and discusses their significance both regionally and globally. Transient models have been constructed for aquifers with a sloping base. The goal of this study is to understand the impact a sloping base has on the movement of transient responses to changes in groundwater use. This model is applied to study regions in western Kansas. Mathematical and computer models of groundwater uptake by phreatophytes have been constructed to study how tree communities impact long-term water balance. Groundwater models have been linked to economic models to develop retrospective studies and understand the impact of hypothetical changes in policy on crop production and groundwater resources. GIS technology has been developed to provide a framework for groundwater studies that have been conducted in the US, Europe and Africa. This method of data organization supports a broad range of computer tools including MODFLOW, FEFLOW, and SPLIT/ArcAEM. Throughout, important findings will be summarized, and additional references provided.

Separation of river network scale nitrogen removal between surface and hyporheic transient storage compartments

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Reach scale experiments have shown that the characteristics and distribution of surface transient storage (STS) and hyporheic transient storage (HTS) may be important controls on nitrogen (N) export to coastal waters. We investigated the relative impact that STS and HTS have on N removal at the river network scale using a daily time step river network N removal model applied to the Ipswich River (a 5th order basin) in northeastern Massachusetts, USA. Spatially distributed runoff and discharge were predicted using a daily time step Water Balance and Routing Model. Nitrogen inputs to streams were calculated using simulated runoff and N concentrations based on land use type. Field investigations in 1st through 5th order reaches of the Ipswich River provided the scaling rules for hydraulic characteristics of STS and HTS throughout the network. The size of the STS and HTS relative to the size of the channel cross section (As:A) had positive relationships with stream size whereas the coefficients of exchange between the transient storage compartments and the main channel remained generally constant. On average, the cross-sectional area of the HTS was 4x that of STS while the exchange coefficient of the STS was 18x greater than that of the HTS. Nitrogen removal was simulated in three channel compartments (STS, HTS and the main channel) for every river grid cell using hydraulic characteristics, simulated river discharge and a time specific removal rate (k). For our initial model runs we assumed that k was identical in all compartments to assess how gradients in STS and HTS hydraulic parameters as a function of stream size influence network scale N removal and its distribution across stream order. Initial model results indicate that N removed in the HTS potentially dominates N removal, both at the reach and river network scales. This suggests that the longer residence time of water in the HTS compared to STS outweighs the effect of smaller exchange rates between the main channel and the HTS compared to STS in determining the fate of N. However, a better understanding of the rates of various N cycle processes in both the STS and HTS is needed to identify the fate of N in entire river systems.

Water Quality Assessment: Developing PCR-based Methods to Enhance Environmental Research at Tribal Colleges in the Rocky Mountain EPSCoR States.

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Tribal colleges have a unique mission among community colleges because they serve as educational as well as cultural centers for local communities. Building research capacity at tribal colleges provides both hands-on science learning for students and also empowers the community and college to conduct independent research in areas relevant to the tribe. We have worked extensively with Little Big Horn College (LBHC) over the last few years with two goals in mind. **The first goal** is to contribute to the science curriculum in the area of genetics, cell biology and molecular genetics. To meet this first goal, we conduct annual workshops at LBHC in the area of classical genetics. We focus on teaching genetics relevant to the Crow people, including the genetics of horse coat color, genetics of human diseases such as diabetes, and current genetics topics that are of particular interest to the students, such as the science of GMOs. **The second goal** of our program is to enhance research at LBHC in the area of molecular environmental genetics. We are developing techniques in molecular water quality testing, adapting the techniques to LBHC facilities and providing training for students and faculty. The longterm outcome will be for the college to incorporate molecular methods into water quality research ongoing at LBHC. To accomplish this, we have successfully tested methods of source tracking microbial populations in water samples that can be used directly at LBHC. We have held two workshops at the University of Wyoming focused on learning about DNA and the use of the Polymerase Chain Reaction as a fingerprinting tool. The workshops teach students and faculty from LBHC and other participating tribal colleges how to sample water sites, isolate microorganisms, extract DNA and use PCR fingerprinting methods to track bacterial populations (and hence contamination sources). We follow up with workshops at LBHC. The program focuses on both training in the relevant techniques and also translation of the methods to the college facilities. The methods, results, progress, outcomes and assessment of the program will be presented.

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Importance of sediment as a phosphorus source in the Rock River watershed, Vermont

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Phosphorus (P) pollution continues to pose water quality concerns for Lake Champlain. In the Northern Lake Champlain Basin, the Rock River contributes a disproportionate P load to the lake relative to other streams. It is estimated that the Rock River's P load is similar to the Lamoille river's, despite having a much smaller watershed size (59 square miles versus 759, respectively). Water quality monitoring at multiple sites is needed to support ongoing water quality improvement efforts. The objectives of this investigation were to determine if P forms and total suspended sediment concentrations varied from the headwaters to the mouth, and to examine the relationship between suspended sediment and P concentrations in the river. Six sampling sites were chosen based on their relative location in the watershed and their suitability for collecting grab samples. Samples were collected approximately weekly from early June 2008 to late August 2008. Water samples were analyzed for total suspended sediment, total P, dissolved molybdate-reactive P (orthophosphate), particulate-reactive P, and molybdate-unreactive (an estimate of organic P). The sediment and P concentrations in river water varied widely among the sites and over the sampling period. At the headwater site (above agricultural landuse), total P was <0.10 mg L^{-1} and almost exclusively organic. At sampling sites located below agricultural landuse, average total P concentrations were approximately two-fold greater than the headwater sites, and P was mainly present as particulate and dissolved inorganic (molybdate-reactive) forms. Compared to the agricultural sites, the sites at the mouth tended to have lower particulate P, but still had average total P concentrations of approximately 0.20 mg L-^{1}. Total suspended sediment concentrations were strongly correlated with particulate-reactive P across sites and sampling dates, suggesting that a large fraction of the sediment-associated P is would be readily bioavailable. Results highlight the importance of suspended sediment as a source of P in the river, and support the need for additional best management practices (e.g., riparian buffers, improved nutrient management, and streambank erosion mitigation) that reduce sediment delivery to the river.

Integrating water quality into the planning process using a land use simulation model

Austin Troy

Abstract: This presentation discusses the development and implementation of an integrated land use, transportation, and environmental quality simulation modeling framework for Chittenden County, VT. This modeling framework allows planners and other stakeholders to simulate land use change, residential and commercial sector dynamics, traffic patterns, and environmental impacts associated with Chittenden County's projected population and job growth. It also allows alternative scenarios to be compared against baseline conditions to help evaluate the potential consequences of different policy and investment scenarios (e.g. construction of new highway infrastructure or changes to zoning). The framework integrates existing land use and transportation models (the UrbanSim open source land use simulation model and the TransCAD 4-step travel demand model) with new utilities that we are developing to estimate environmental impacts from traffic and development. Among these are modules on water quality, carbon footprint, plant community ecology, and habitat fragmentation. The framework of the water quality module is discussed in particular. After 5 years of data development and processing, UrbanSim and TransCAD have been successfully implemented for the County and are in the process of being validated, while data is currently being collected to parameterize the environmental modules.

Watershed Assessment and Comprehensive Water Quality Database Development

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The water quality program at Alabama A&M University (AAMU) has progressively expanded in the last few years addressing water resource related issues in northern part of Alabama. A comprehensive water quality monitoring and modeling research was launched to evaluate the surface water bodies. Field data collection was expanded in 2005 to evaluate four major watersheds including Flint River, Flint Creek, Indian Creek, and Huntsville Spring Branch. Five thrust areas in these water quality evaluation efforts are bioassessment of macroinvertebrates as bioindicators, heavy metals, pesticides, nutrients, and source tracking for pathogens and non-pathogenic microorganisms. Furthermore, this comprehensive study evaluated the applicability of some of the most popular water quality modeling tools, namely, AQUATOX, BASINS, AnnAGNPS and SWAT models for some of the watersheds. This paper summarizes our results. Our ultimate goal is to establish and archive a comprehensive water quality database for north Alabama. The database eventually can be used by interested end-users, stakeholders and policy makers to assess the overall health of the aquatic ecosystem, determine pollution trends within or among water bodies, and identify specific problems in relation to land use and cover changes within these watersheds.

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ABSTRACT

Distributed Temperature Sensing: A Transformative Technology in Water Resources and Ecology

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Temperature represents a fundamental variable in almost every hydrodynamic, ecological or ecohydrologic study that can be imagined. Whether thermal energy represents a fundamental driver of processes, or is being used to trace fluxes of water, solutes and nutrients, measurement at high spatial AND temporal resolution has not been possible. While remote sensing can provide high spatial resolution, temporal resolution is limited without tremendous cost. Point sensors can provide high temporal resolution, and with the development of low cost self organizing sensor systems, the cost for spatial resolution has decline somewhat.

Fortunately, advances in Raman spectra fiber optic distributed temperature sensing (DTS) now allow for the measurement of temperature over kilometer scales at meter resolution, the measurement at temporal scales of 0.1-0.3 Hz; all at temperature resolutions of less than 0.05 ^{o}C. DTS has been described as a “transformative” technology in hydrology and ecology as it can provide granularity of data that has never been seen before. Applications to date include tidal marsh mixing, stream/groundwater interactions, snow temperature mapping, soil moisture mapping, cave air circulation, salmon habitat restoration and alpine meadow ecohydrology. In this talk, the basic theory of operation will be presented, along with several recent hydrologic applications to demonstrate the information capacity of the emerging technology.

Spatial Patterns of Snow Distribution in a northern New England Mountain Landscape and Implications for Runoff Production

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Snowpacks in mountain settings exhibit extreme variation over small spatial scales, due to the influence of complex topography and vegetation on snow inputs and energy fluxes. Here, we describe the preliminary results of a field study in northern New England documenting spatial patterns of snow distribution in two forested watersheds. Our results document trends in snow water distribution over spatial scales ranging from $10^0 – 10^3$ km. We attribute spatial patterns in snow cover to elevation gradients, characteristics of the forest canopy and canopy openings, and activities associated with recreational use and management of the landscape. Our results have important implications on runoff production in this landscape.

Climate Change Impacts on New Mexico's Mountain Sources of Water

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Climate changes are affecting natural environments around the world. In NM, climate changes are altering processes associated with the water supply, which sustains the state's economy and determines to a great extent the quality of life. The first goal of the 2008-2013 New Mexico EPSCoR RIII project is to improve understanding and forecasting the effects of climate change on water resources in semiarid regions, with a specific focus on New Mexico and the Rio Grande basin. The second goal to enhance research competitiveness through the acquisition of critical climate change research infrastructure and cyberinfrastructure, and through strategic investment in human infrastructure. The project builds on existing EPSCoR funded infrastructure, like the network of scintillometers and ET flux towers sited in the Rio Grande riparian corridor, agricultural fields, desert shrublands and grasslands, and high-elevation conifer forests, and remote sensing products like SEBAL^{NM} used for ET estimation.

The science mission focuses on understanding hydrologic response to climate change through observations and modeling. The New Mexico hydrologic system is inadequately monitored at high elevations, and modeling of climate and hydrology is difficult in this complex terrain. Yet this snow-dominated portion of the region controls water resources (e.g., the timing, amount, and water quality of runoff to valleys) and is most sensitive to climate change. A multiscale, nested climate and hydrology observation system will leverage, improve and extend existing facilities, like NRCS SNOTEL and SCAN sites, and develop two 1,000km^2 intensively studied watersheds. The intensive study areas will descend from some of the highest mountains in northern New Mexico to acequia dominated agricultural areas in the mountain valleys below. Regional scale climate models, run both in weather and climate modes, will be coupled to high resolution hydrologic models in these study areas and used to understand processes that control the hydrologic response to climate change. These fine scale models will also be used, along with observational data, to test basin scale coupled climate-hydrologic models that will be some of the products delivered to decision makers. Other products include evaluation of the socioeconomic impacts of water management strategies, with emphasis on acequia areas.

Human infrastructure enhancements include workshops and summer academies for junior high school teachers, undergraduate research opportunities for students from non-PhD granting institutions, Junior Faculty Leadership Training workshops, museum exhibits, a multi-institutional seminar series, "Science Cafes" for the public in northern New Mexico, and a "Climate Change Web Portal." Diversity is integrated throughout.

Understanding biogeochemical processes at river network scales.

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River systems can significantly influence the flux of nutrients between terrestrial and coastal ecosystems. To understand how entire river networks affect material fluxes requires models that integrate spatial and temporal variability of hydrological, hydraulic, geomorphic, and biological characteristics across a range of aquatic ecosystem types. The central importance of upstream-downstream linkages along riverine flowpaths requires a river network perspective. Here we address how nutrient removal by river systems is influenced by temporal runoff variability, process saturation, and spatial heterogeneity of land use (i.e. N inputs). We applied a daily time step river network N removal model with non-linear parameters for denitrification, to the river network of the Ipswich River watershed (MA, 400km2 watershed area), a suburban basin with heterogeneous land use and associated N inputs. We find that hydrological variability determines the effectiveness of network-scale N removal at high and low flows, but that process saturation and land use heterogeneity strongly influence N removal at intermediate flows, including typical summer base flow conditions. Increased N inputs that could occur due to continued land cover change, or intensified land use (i.e. increased fertilization rates) would lead to disproportionate changes in N export to due to non linear process kinetics, especially at low flow conditions during times when biological activity in receiving waters is maximized. The model however focuses only on channel processes, and observations suggest that floodplains, lakes, and wetland dominated reaches must also be accounted for to adequately understand aquatic impacts on nutrient exports.

Phosphorus speciation in Vermont soils using phosphatase enzymes and nuclear magnetic resonance spectroscopy

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An improved understanding of soil organic phosphorus (P) cycling is important for optimizing nutrient management strategies and maintaining water quality. Traditionally, there has been an emphasis on inorganic P dynamics in agricultural landscapes despite evidence that organic P is critical to plant nutrition and water quality in both agricultural and undisturbed settings. In the Lake Champlain Basin, there is a critical need for an improved understanding of P speciation in soils and aquatic systems to support the development of novel water quality management approaches for P. The objective of this experiment was to investigate the forms of P in soils commonly mapped along streams in Vermont using phosphatase enzymes and nuclear magnetic resonance spectroscopy (^{31}P NMR). Fourteen surface horizon sample~~s~~ from several different soil series were collected along a reach of Lewis Creek in Starksboro (northwestern Vermont). In addition to a basic soil test, samples were analyzed for other P pools including: (i) distilled water-soluble molybdate-reactive P (orthophosphate), (ii) molybdate-unreactive P, and (iii) water-soluble P hydrolyzed by the addition of alkaline phosphomonoesterase (an estimate of labile sugar phosphates) alone or in combination with phosphodiesterase (an estimate of DNA and phospholipids). A subset of six of these samples was analyzed by solution ^{31}P NMR at the Stanford Magnetic Resonance Laboratory to speciate P forms in an alkaline extract. Results indicate that organic P was the dominant form of P in both the water and alkaline extracts. For the fourteen water extracts, approximately 70% of the total P was molybdate-unreactive P (organic and complex inorganic P forms), of which approximately 48% was hydrolyzed by the addition of phosphatase enzymes, implying its potential bioavailability. The ^{31}P NMR analysis verified the prevalence of soil organic P in the soils and revealed an array of P compounds, including orthophosphate, pyrophosphate, phytic acid, DNA, and other compounds. On average, orthophosphate monoesters accounted for about 59% of the organic P, while 4% was from DNA and other diesters. Results highlight the importance of organic P in the soils studied, and suggest that a significant fraction of the water-soluble organic P may be bioavailable in soil-water systems where phosphatase enzymes occur naturally.

Examining Arid Soil Processes in Nevada, USA, Using Weighing Lysimeters

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Southern Nevada is located in the Mojave Desert, one of the driest areas in the United States. Research is needed to understand whether and to what extent land use and land cover changes, associated with rapid urbanization and climate variability, will alter the relationships between soil, water, and plants in this arid setting. Beginning in 2005, the research universities in Nevada began collaborating on the development of a research program focused on the scaling of mass and energy movement across the soil-atmosphere interface and the impact of scaling techniques on quantifying environmentally important processes (e.g., water and element cycling and coupled biogeochemical processes). One limitation to this endeavor is the lack of a meso-scale research facility that can help connect point-scale measurements to basin-scale soil and environmental processes. Thus, a major component of this research program, which is called "Scaling Environmental Processes in Heterogeneous Arid Soils", or SEPHAS, involves the construction of a weighing lysimeter facility designed to examine arid soil processes. During the past 12 months, 3 weighing lysimeters were installed, each cylindrical (2.25 m diameter × 3 m high) and designed for repacked soils. A fourth lysimeter (2 m × 2 m × 3 m high) will be used for housing an intact soil block, sometime in early 2009. The lysimeter balances have a precision of ~100 g, or the equivalent of 0.025-mm water depth. Soil packing began in March 2008 using locally-derived material classified as a sandy, mixed, thermic Typic Torriorthents. The lysimeters were repacked to allow for comparative analyses; one lysimeter contains homogenized soil with a bare surface, and the other two contain layered soil (as found in the field) with an nitrogen-spiked layer added at 100-cm depth, and topped with desert shrubs (*Larrea tridentate* and *Ambrosia Dumosa*). Five other tracers were added in discrete layers to examine transport and mixing through water and bioturbation. Lysimeters were instrumented at eight depths with multiple technologies to measure temperature, water content, water potential, soil gas and soil water chemistry, rooting extent, etc. Almost 150 instruments were added. Data collected using automated systems are being archived and are available to facility researchers through the Internet. A diverse set of testable hypotheses are being tested at this time, through we seek additional collaborators as the experiments fully ramp up. A program website has been created (http://sephas.dri.edu) for more information. When completed, the weighing lysimeters will serve the US and international research community as one of the only facilities of its kind to study soil-related processes in arid settings.

TEOFILO A. ABRAJANO, JR. (JUN)
Biographical Sketch, 11/4/2008

Dr. Jun Abrajano is the ***Head*** of the Surface Earth Processes Section (GEO Directorate) at the National Science Foundation, and concurrently ***Professor and Director*** of Environmental Science at Rensselaer Polytechnic Institute, Troy, NY. His research spans the range of contaminant fate and transport in aquatic systems, biogeochemistry of marine and terrestrial freshwater systems, and Holocene paleo-climate/environments. Dr. Abrajano is also a developmental consultant for the United Nations Development Program, World Bank and several governments in South East Asia.

Dr. Abrajano received his PhD in Earth and Planetary Sciences from Washington University (St. Louis) in 1984 from where he became a ***Scientist*** in the Chemical Technology Division of Argonne National Laboratory up to 1991. He moved to Memorial University in Canada in 1991, and was ***Professor and Chair*** of the Environmental Science Program up to 1998. He joined Rensselaer Polytechnic Institute in 1998. Dr. Abrajano currently serves on three Editorial Boards, and served in various capacities on numerous committees for the Materials Research Society, Geochemical Society, National Aeronautics and Space Administration, Natural Science and Engineering Research Council, National Science Foundation and Department of Energy. He is a ***Fellow*** of the Geological Society of America and was a recipient of ***Fellowships*** from Fulbright, McDonnel Douglas and Wheeler Foundations.

Dr. Lilian Alessa received her Ph.D. from the University of British Columbia in 1998. Her expertise in cell architecture as well as her non-western cultural background has strongly shaped her current area of research: dynamics of social ecological systems. Specifically, she utilizes a complexity framework to uncover and resolve the characteristics of the human hydrological system, or the "H2S". In 2004 she established the Resilience and Adaptive Management (RAM) Group and, in 2008, became the Director. Her work has taken her around the world to examine the H2S as a social process and, in 2007, her group contributed the Arctic Water Resources Vulnerability Index (AWRVI), the first and only integrated tool to assess community resilience to changes in water resources at high latitudes. She serves on several regional and national committees that deal with cyberinfrastructure, water resources and social dynamics and is a Principal Investigator on several large National Science Foundation grants, including the Alaska EPSCoR and the Open Agent Based Modeling Community for the Social Sciences. Currently, she is testing a model hypothesizing that accurate decision making regarding water resources can be predicted through a "distancing effect" which is mediated by the levels of technology present in the system. Dr. Alessa's work draws heavily on the integration of unifying principles from diverse systems, ranging from cells to climate and she uses both qualitative and quantitative techniques to develop tools which can be used in policy and decision making for the H2S. Her publications include "Freshwater vulnerabilities and resilience on the Seward Peninsula as a consequence of landscape change" in Global Environmental Change (2008, 18, 256-270), "Social-ecological Hotspots Mapping: a spatial approach for identifying coupled social-ecological space" in Landscape and Urban Planning (2008, 85, 27-39) and "Anthropogenic biomes: a key contribution to earth-system science" in Trends in Ecology and Evolution (2008).

Juan de Dios Barrios

Juan de Dios Barrios is a research associate working in Geospatial Sciences in transportation. He is a member of the Marshall University College of Science Physical Science Program. He has been involved in the transportation field for the past five years developing new techniques in digital image processing and transportation at the Rahall Transportation Institute (RTI) in Huntington WV. Mr. Barrios has been involved in transportation and education at the Geobiophysical Program at Marshall University as a part time Instructor at the graduate level, and Instructor at Marshall Community and Technical College.

At RTI, his research included intelligent transportation system, land management and image processing.

His professional experience includes wining the 2004 Special Achievement Award from Environmental Systems Research Institute (ESRI) for Transportation and Economic Development Information System Project; Principal Investigator for Raleigh County GIS Implementation and Co-Principal Investigator of the West Virginia Intelligent Transportation System Evaluation. His international educational experience is at Shanghai University of Finance and Economics, and presentation on 3rd International Education Symposium in Durango Mexico.

Mr. Barrios has a B.S. in Biochemical Engineering from Tecnologico de Durango, Mexico; M.S. in Physical Sciences and Technology Management from Marshall University. He is working on his dissertation on Intelligent Transportation Systems and Geospatial Sciences.

He is married and has two daughters.

David R. Conrad, Senior Water Resources Specialist, National Wildlife Federation
David has been actively involved in water resource policy since 1977 and has served with NWF since 1989. In this position, and in previous positions with Friends of the Earth and American Rivers, he has been an advocate for river and water resources protection, concentrating on issues such as reforming hydroelectric power regulation, water resources development, flood insurance and floodplain management. Recently, David's work has focused on policies and programs to restore health of degraded aquatic ecosystems, and redirecting federal flood control programs toward greater emphasis on improved floodplain management. David was project director and a principal author of NWF's 1998 *Higher Ground* report that addressed repetitive flood insurance claims and argues for voluntary property buyouts as an alternative strategy for reducing flood risks. He was also a principal author of the 2000 *Troubled Waters* report issued by NWF and Taxpayers for Common Sense, which highlighted the 25 most wasteful and environmentally damaging Corps projects and also the recently published (March 2004) report called *Crossroads: Congress, the Corps of Engineers and the Future of America's Water Resources*, which lays out the case for comprehensive reform and new directions for the nation's largest water resources development agency. David was a founder and serves on the Steering Committee of the national Corps Reform Network, a group now with more than 160 conservation, taxpayer and civic organizations seeking reform and modernization of the nation's water programs. In 2000, David received the Federal Emergency Management Agency's Outstanding Public Service Award for his work to promote protection of the nation's floodplains. In May 2003, the Association of State Floodplain Managers granted David the Goddard-White Award, its highest honor, in recognition of his instrumental work in the field of floodplain management. He holds a B.A. in Environmental Sciences from the University of Virginia.

George R. Crombie
Secretary of Agency of Natural Resources
State of Vermont

In January 2007, George Crombie was appointed by Governor Jim Douglas as Secretary of Natural Resources for the State of Vermont. Secretary Crombie brings a wealth of hand-on experience in both public works and environmental management. He has served as both a public works director and was the Undersecretary of Environmental Affairs for the Commonwealth of Massachusetts. He has also served on the Adjunct Faculty at Northeastern University in Boston where he taught Environmental Policy. Secretary Crombie has guided numerous awards winning environmental and public works projects through the hurdles of oversight and development, many of which have won state and national awards. He has gained valuable insight in management, service delivery, and financial issues facing environmental and public works professionals in today's world. The common theme of his work has been coalition building, innovation, teaching and developing projects that co-exist with the environment. An example of this work was charting the course for a fifty-one million dollar clean up of water pollution on Lake Champlain in Burlington, Vermont His vision for his agency is creating the environmental organization of the future braking down cellos and creating new centers for watershed management and climate change and waste reduction. Mr. Crombie is spearheading Vermont's Climate Change Collaborative: A Signature Partnership of Vermont's Government, Academic and Private Sectors in creating a footprint to manage climate change through a new green economy.

Secretary Crombie has earned his Bachelors Degree from the University of New Hampshire and a Masters of Public Administration from Northeastern University. He is the national recipient of the Charles Walter Nichols award for his contributions in the environmental field and the Gold Leaf Award by the International Society of Arboriculture. He was also chosen as one of the top ten public works directors in the United States and Canada. Secretary Crombie studied solid waste and recycling operations in Slovakia and the Czech Republic on a Jennings Randolph Fellowship and is on the Board of Directors of the American Public Works Association representing APWA on environmental issues in the United States and Canada.

Secretary Crombie is married to Jacqueline Crombie, R.N., MS, and A neonatal intensive care nurse at New England Medical Center in Boston. They have three children and six grandchildren.

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Michelle Daley is a research scientist at the University of New Hampshire and has worked in the NH Water Resources Research Center (WRRC) since 2002. In May 2008, she was appointed as the associate director of the NH WRRC. She manages several research projects investigating the impacts of suburbanization on water quality in southeastern NH and is also in charge of investigating the linkage between wet deposition and atmospheric chemistry. She received her B.S. from UNH in 1997 and her M.S. from UNH in 2002.

Walter Dodds, professor of biology at Kansas State University specializes in research on aquatic ecology, river and stream ecosystems and how humans affect water quality and biological integrity. Nutrient criteria and stream eutrophication have been the focus of much recent research. Dodds received his PhD from the University of Oregon in 1986. With over 100 refereed publications to his credit, Dodds also is the author of three books.

Brief Bio for Jeff Gaffney

Dr. Jeff Gaffney joined the University of Arkansas at Little Rock as Chair and Professor of Chemistry in July 2006. He is also the Chief Scientist for the Department of Energy's Global Change Education Program, and Principal Investigator for the DOE Atmospheric Science Program. He received his B.S (1971 honors), M.S. (1973), and Ph.D. (1975) degrees in Chemistry from the University of California, Riverside working with Dr. James N. Pitts, Jr., a well known atmospheric- and photo-chemist. Before joining UALR, Dr. Gaffney was a Senior Research Chemist at three of the DOE National Labs, Brookhaven (1975-1985), Los Alamos (1985-1988) and Argonne National Lab (1988-2006). He is a well known for his work in climate change and environmental chemistry (air and water) and is very active in the American Chemical Society (Chair of Sub-committee on Policy for the Committee on Chemistry and Public Affairs), and in the American Meteorological Society (Member of the Board of Women and Minorities and History Committee). He has published over 200 papers, extended abstracts, and technical reports, and presented over 400 technical talks during his career.

Konstantine P. Georgakakos, Sc.D.

Dr. Konstantine P. Georgakakos is the Managing Director of the Hydrologic Research Center in San Diego, California. He is also an Adjunct Professor VI with the Scripps Institution of Oceanography of the University of California, San Diego, and Adjunct Full Professor with the Department of Civil and Environmental Engineering of The University of Iowa. He has held positions of Research Scientist IV with the Scripps Institution of Oceanography, of Associate Professor with tenure at the Department of Civil and Environmental Engineering of The University of Iowa, Research Engineer with the Iowa Institute of Hydraulic Research, and Research Hydrologist with the Hydrologic Research Laboratory of the National Weather Service.

Dr. Georgakakos holds Master of Science and Doctor of Science degrees from the Massachusetts Institute of Technology. Honors and awards include the Presidential Young Investigator Award from the U.S. National Science Foundation, the Faculty Scholar Award from The University of Iowa, and the NRC-NOAA Associateship Award from the U.S. National Research Council. He has authored or co-authored more than 100 refereed-journal publications regarding various topics of Hydrology, Hydrometeorology, Hydroclimatology and Water Resources Systems. He is the primary author of several software packages pertaining to real time hydrologic prediction for operational use by Agencies such as the U.S. Army Corps of Engineers, the U.S. National Weather Service and the NOAA Climate Prediction Center. He advised to completion of their degrees six Ph.D. students at The University of Iowa and two Ph.D. students at UCSD.

Dr. Georgakakos is a Fellow of the American Meteorological Society and a member of the American Geophysical Union, the Institute of Electrical and Electronic Engineers, the American Society of Civil Engineers, the American Association for the Advancement of Science, and the New York Academy of Sciences. He serves as Chief Editor for the Journal of Hydrology and Associate Editor for Advances in Water Resources. He serves as US Expert in Hydrologic Modeling for the World Meteorological Organization Commission for Hydrology (1997-present). He has served on several national and international committees and panels, and has organized national and international conferences on various hydrologic topics. He has supervised several large-scale international technology transfer projects in Africa, Europe, Central and South America. He is listed in the Who's Who in Technology and the Who's Who Worldwide.

Thomas Giambelluca

Tom Giambelluca has been conducting research on the climate and hydrology of Hawai‘i and other tropical regions for more than 25 years. He has led collaborative work on microclimate, energy balance, and the impacts of global climate change on the upper slopes of Haleakala Volcano, Maui Island, since 1987. In recent years his team has also been studying cloud forest hydrology in native and invaded forests and on Maui and Hawai‘i Islands by measuring canopy water balance and related variables to determine fog interception. He is currently operating two state-of-the-art eddy covariance flux towers within Hawai‘i Volcanoes National Park, located in native and invaded cloud forest sites. Tom also works extensively in other areas of the tropics, including SE Asia, where he is beginning work on a new project studying the impacts of expanding rubber cultivation on regional water and carbon fluxes.

F. Richard Hauer, is the University of Montana Professor of Limnology and holds the Flathead Lake Biological Station Chair in Limnology. His research interests encompass the fields of stream and river ecology, which by their nature and scope span a broad array of subdisciplines (e.g., geomorphology, hydrology, nutrient cycling, bioenergetics, energy flow through food webs, and population and community ecology). The continuing goal of his research is a synthesis of the many areas of organismal biology and ecology within a context of stream and river complexes. This goal has led to investigation of a broad range of topics including the interaction of temperature and stream hydrologic cycles on growth and production of stream invertebrates, nutrient and organic matter dynamics in stream systems, the role of groundwater/surface water interactions in salmonid spawning habitat; and the role of hydrology and geomorphology on floodplain vegetation structure and function. During the past decade, he has been working on the development and application of remote sensing tools in river ecology. The paper presented at the Vermont Water Workshop will focus on the biocomplexity of gravel-bed rivers and the use of remote sensing tools to assess and manage them.

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Mickey Hazelwood

Mickey Hazelwood is Director of The Nature Conservancy's Truckee River Project. He holds a B.S. in Applied Geography from Appalachian State University in Boone, N.C. and a M.S. in Applied Geography from New Mexico State University in Las Cruces, N.M. One of the main components of TNC's Truckee River Project is to restore ecosystem function along the highly degraded lower reach between Reno, NV and Pyramid Lake, the river's terminus. The project is supported through a partnership with numerous local, State, and Federal agencies and currently consists of four restoration sites with a budget of $28 million. Mickey joined The Nature Conservancy three years ago as Field Representative for the Truckee River Project with previous work experience in conservation easements (drafting baseline reports and working with landowners and land trusts to draft easement language), using conservation design for limited subdivision to pay for the protection of large tracts of ranchland, project management, GIS and GPS, and land surveying.

Kyle Hoagland, director of the Water Center and professor of aquatic ecology in the School of Natural Resources.

I'm associated with the environmental studies, fisheries and wildlife and water science majors, the aquatic ecology and hydrologic sciences graduate specializations and the water science program area. I also direct UNL's Water Center, a national network of water resources research institutes.

My research laboratory has focused on the toxicity of agricultural chemicals to algae in lakes and streams, with an emphasis on the two most commonly used herbicides, atrazine and alachlor. This research has been conducted from the population to the community levels, at both chronic (more diffuse, long-term) and acute (more intensive, short-term) exposures.

In addition, the lab addresses aquatic ecology issues, including lake restoration, lake classification and water quality assessment. In addition, I'm a co-leader of the Initiative in Ecology and Evolutionary Analysis and co-coordinator of the Great Plains Cooperative Ecosystem Studies Unit. I also participate in the water quality outreach program led by John Holz and Tadd Barrow.

Since coming to UNL in 1990, I've been involved in programs that address such concrete problems as agricultural chemicals B herbicides, insecticides and nutrients B that commonly occur in streams, wetlands, lakes, and ponds in Nebraska and throughout the agricultural Midwest. These pollutants affect water quality at the population, community, and ecosystem levels, sometimes in profound ways. Understanding their dynamics and impacts at various levels of ecological organization and how land-use and -management might be improved to limit their effects is key to managing this precious natural resource.

I have a bachelor's in zoology from Michigan State University, a master's in aquatic biology from Eastern Michigan University (1975) and a doctorate in life sciences (phycology) from the University of Nebraska-Lincoln.

Dr. Richard P. Hooper is President and Executive Director of Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI). CUAHSI exists to serve the hydrologic science community in the design and operation of infrastructure and to provide a voice for expressing community goals and aspirations. CUAHSI espouses a holistic view of hydrologic science because of water's multifaceted interactions with the biotic and abiotic environment.

Dr. Hooper received his PhD and M.S. from Cornell University in Environmental Systems Engineering. He came to CUAHSI from the US Geological Survey where he was a Research Hydrologist at the Panola Mountain Research Watershed outside Atlanta and chief scientist for the National Stream Quality Accounting Network and Hydrologic Benchmark Network. His research interests include network design, watershed biogeochemical cycling, streamflow generation mechanisms, and multivariate statistical techniques.

PROVOST JOHN M. HUGHES
UNIVERSITY OF VERMONT

John M. Hughes took office as provost and senior vice president at the University of Vermont in July 2006. Before joining the University of Vermont community, Provost Hughes built his academic career over the course of twenty-five years on the faculty at Miami University in Oxford, Ohio, where he rose through the ranks as a professor of geology before moving into administrative leadership. Immediately prior to accepting the provost position at UVM, Hughes served for three years as associate provost for research and scholarship and dean of the Graduate School at Miami.

As a geologist, John Hughes has conducted funded research in minerals and geologic education throughout his academic career with support from the National Science Foundation, private corporations, and the Ohio Board of Regents totaling more than $3 million. He has published three books and authored or co-authored hundreds of papers in publications such as *American Mineralogists, Canadian Mineralogist,* and the *European Journal of Mineralogy.* Hughes has remained active as a researcher throughout his years as an administrative leader, a commitment he has continued in this time as provost at UVM.

Hughes' move to Vermont in 2006 was a return to the state where he lived during his graduate school years at Dartmouth College. The UVM provost earned a master's degree and his doctorate from Dartmouth in 1981. Prior to that, he earned his bachelor's degree from Franklin and Marshall College in 1975.

John Hughes and his wife, Susan, an associate professor on the faculty of UVM's School of Business Administration, have been married for thirty-five years. They have two children, Gareth, 29 and Rebecca, 26.

Since Fall 2006, Dr. Shaleen Jain is an Assistant Professor of Environmental and Water Resources Engineering at the University of Maine, Orono. He is also a Cooperating Assistant Professor at the Climate Change Institute. From 2001-2006, he was a Research Scientist at National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory, Boulder, Colorado. During 2000-2001, he was Visiting Fellow at Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado-Boulder. Dr. Jain completed his graduate work in Civil and Environmental Engineering at Utah State University. He was appointed to the Editorial Board of the Journal of American Water Resources Association in 2007. His current research focuses on understanding the impacts of climate change on environmental and water resources management and decision-making for environmental sustainability.

Bio Sketch:

KathiJo Jankowski is the coordinator of the VT EPSCoR Streams Project. She is responsible for the day to day operations of the project, which include field sampling, laboratory analysis and data management. She works with several small colleges as well as community and state partners to develop collaborative monitoring projects and share the resulting data. She has been involved in a number of research projects prior to working with Vermont EPSCoR, including research on water quality and restoration strategies in agricultural and headwater streams. Her community work includes serving as an assistant to the Vermont Legislature's Natural Resources & Energy and Fish, Wildlife & Water Resources Committees, for which she did public relations work and policy research. She also worked briefly with The Nature Conservancy and its partners in Santiago, Chile to assist with the establishment of a coastal rainforest preserve. She has a Masters Degree in Biology from Loyola University Chicago and a B.S in Environmental Science and Anthropology from the University of Notre Dame.

Dr. Jill Karsten is Program Director for Education and Diversity within the National Science Foundation Directorate for Geosciences (GEO). In this capacity, she manages the Geoscience Education (GeoEd), Opportunities for Enhancing Diversity in the Geosciences (OEDG), Global Learning and Observations to Benefit the Environment (GLOBE), and Geoscience Teacher Training (GEO-Teach) programs, and participates in Foundation-wide working groups related to Ethics Education in Science and Engineering (EESE) and Broadening Participation in STEM disciplines. She is a member of the U.S. Climate Change Science Program *ad-hoc* Education Interagency Working Group. A marine geologist by training, Dr. Karsten spent 12 years on the research faculty at the School of Ocean and Earth Science and Technology at the University of Hawaii at Manoa. Her scientific research has focused on volcanic and tectonic processes occurring at mid-ocean ridges in the Northeast and Southeast Pacific oceans, evolution of oceanic crust, and water in magmatic systems. She has led or participated in 16 sea-going research expeditions. Dr. Karsten served for one year as a Program Officer in the Marine Geology & Geophysics program at the Office of Naval Research, followed by four years as the Education Manager for the American Geophysical Union, prior to joining NSF in November 2005. Dr. Karsten earned her B.A. degree in Geochemistry from Wellesley College (1977) and her M.S. (1980) and Ph.D. (1988) degrees in Geological Oceanography from the University of Washington.

Andy (Anaru) Kliskey comes from Aotearoa / New Zealand. He received BSurv, MPlanning, and PhD degrees from the University of Otago, NZ. He was a postdoctoral researcher at the University of British Columbia, BC and at the Arctic Institute of North America's Kluane Lake Field Station in Yukon Territory, Canada. He returned to New Zealalnd to take up a post as Lecturer and then Senior Lecturer in Geography and GIS at the University of Canterbury, NZ. In 2003 he moved to Alaska and is Associate Professor in Biology and Geography and co-leader of the Resilience and Adaptive Management (RAM) Group at the University of Alaska Anchorage. Anaru has spent the last four years working with people in Inipuiat communities in northwestern Alaska to understand their perception of environmental change. This is part of a broader research initiative that the RAM Group is engaged in examining community response and adaptation to multiple scale environmental changes with respect to water resources.

BIO:

Venkat Lakshmi received his PD in Civil Engineering in 1996 from Princeton University. After working as a research scientist at NASA Goddard he left for the University of South Carolina in 1999 where he is currently Professor and Chairman of the Department of Geological Sciences. He has over 50 publications in peer reviewed journals and 120 presentations at conferences and workshops and other institutions. His main areas of research are the role of the land surface hydrological cycle and vegetation in monsoons, use of remote sensing for hydrological studies and study of global climate change in coastal intertidal areas using satellite surface temperatures.

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Short Bio:

Dr. Leahy is an Assistant Professor in the School of Forest Resources at the University of Maine. She holds a B.S. in Forest Recreation Resources with an option in Environmental Interpretation, and an M.S. in Forest Resources with a minor in Environmental and Resource Economics from Oregon State University. Her Ph.D. is in Natural Resources Science and Management in the Economics, Policy, Management and Society track from the University of Minnesota. Her research primarily focuses on environmental communication issues related to resource-dependent communities, environmental non-profit organization members and citizen scientists, small woodland owners, and the general public. Dr. Leahy teaches the following classes: environmental interpretation, introduction to outdoor recreation, and issues and ethics of parks, recreation & tourism. She also serves as a deputy for the Nature Conservation and Protected Areas (06.01.07) working group of the International Union of Forest Research Organizations (IUFRO) and as a chair of the Social and Related Sciences (F) working group of the New England Society of American Foresters. She is also a member of the International Association for Society and Natural Resources and the National Association for Interpretation. Within the University of Maine's Forest Bioproducts Research Initiative, she is the Human Dimensions of Forest Bioproducts Thrust leader. She is lead project director on a USDA National Integrated Water Quality project entitled, "The Role of Social Capital, Trust and Learning in Solving Groundwater Quality and Quantity Issues in the Northeast with Citizen Science."

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David Maidment is the Hussein M. Alharthy Centennial Chair in Civil Engineering, and the Director of the Center for Research in Water Resources at University of Texas at Austin, where he has been a faculty member since 1981. He is co-author of the text "Applied Hydrology", Editor-in-Chief of the "Handbook of Hydrology" and has served as Editor of the Journal of Hydrology. His primary research interest is the application of geographic and hydrologic information systems in water resources. He is the leader of the Consortium for Universities for the Advancement of Hydrologic Science, Inc (CUAHSI) Hydrologic Information System project, an effort supported by the National Science Foundation to advance hydrologic science in the nation's universities by development of better information services.

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Declan McCabe is a community ecologist. His primary interest is in the interactions among aquatic organisms, particularly macroinvertebrates. Research projects include the effects of disturbance on river insects, facilitative effects of Caddisfly aggregations and impacts of zebra mussels on soft sediment communities. During the summers he does research in Vermont rivers, on Lake Champlain, and on the St. Michael's campus. Declan teaches hands-on, laboratory and field-based courses including Community Ecology and General Biology. He has recently developed partnerships with three elementary schools where students taking his Biology in Elementary Schools course teach science lessons to grades 1 through 5. He is actively involved in all aspects of the streams project, especially those that concern macroinvertebrates. His student research team has developed site-specific web sites to facilitate macroinvertebrate identification by the high school teams. He attended St. Joseph's University (BS), the University of Pittsburgh (MS), and the University of Vermont (PhD). For more information about Declan's research, go to http://personalweb.smcvt.edu/dmccabe/.

Dr. Gail McClure is a toxicologist and molecular epidemiologist. She spent many years in medical research managing clinical translational studies most of which focused on cancer research and metabolic risk factors. In 2004, she joined the staff of the Arkansas Science & Technology Authority as the Vice President Research. Her responsibilities include managing programs designed to increase the federal research funding of Arkansas universities, to increase Arkansas industry-university research partnerships and to enhance STEM (science, technology, engineering and mathematics) education in the state schools. The Authority targets STEM education using small grants to support science and technology materials, resources, and equipment in Arkansas schools enhancing math/science educational opportunities. Dr. McClure also manages the state's NSF EPSCoR program, Arkansas ASSET Initiative. ASSET Initiative is a multi-university research collaborative designed to strengthen university research infrastructure that will impact economic development in the state and produce new technology-based companies.

Before joining the Authority Dr. McClure held appointments in the Department of Surgical Oncology and the Department of Occupational and Environmental Health at University of Arkansas for Medical Sciences and a joint appointment at the National Center for Toxicological Research (NCTR), a research center for the Food and Drug Administration. She is currently adjunct faculty at the medical school.

Brian L. McGlynn
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Professional preparation

Ph.D. SUNY-Syracuse, Environmental Science and Forestry Watershed Hydrology 2002
M.S. SUNY-Syracuse, Environmental Science and Forestry Watershed Hydrology 1997
B.A. Gettysburg College *(double major)* Environmental Science and History 1993

Appointments

2008-present Associate Professor of Watershed Hydrology, Department of Land Resources and Environmental Sciences, Montana State University
2002-2008 Assistant Professor of Watershed Hydrology, Department of Land Resources and Environmental Sciences, Montana State University

Research Group Foci

Study of watershed hydrology (streamwater sources, flowpaths, and age), watershed land-atmosphere CO_2 fluxes, and watershed biogeochemistry using combinations of approaches that include source water tracing, physical hydrology, eddy-covariance, and landscape analysis techniques. Our field-based research is focused on the spatial and temporal scaling of hydrological and biogeochemical processes.

Robert E. O'Connor

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Since 2001 Robert O'Connor has been directing the Decision, Risk and Management Sciences Program at the National Science Foundation. At NSF he also manages the Decision, Risk and Uncertainty area of emphasis of the Human and Social Dynamics initiative. In addition, O'Connor serves on the management teams for the Decision Making under Uncertainty for Climate Change (DMUU) centers and the Dynamics of Coupled Natural and Human Systems Program.

Dr. O'Connor represents the National Science Foundation on three interagency groups; the US Climate Change Science Program's Interagency Working Group on Human Contributions and Responses; the Subcommittee on Disaster Reduction of the National Science and Technology Council of the Executive Office of the President; and the Working Group for Tropical Cyclone Research.

Prior to coming to NSF, Dr. O'Connor was a Professor of Political Science at the Pennsylvania State University where he also was part of the senior management team for the Center for Integrated Regional Assessment. The U.S. Department of Energy, U.S. Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, and the National Science Foundation funded Dr. O'Connor's research into public perceptions of cumulative, uncertain long-term risks, of technologies perceived as risky, and of agency risk communications.

His most recent articles have appeared in the *Agricultural and Resource Economics Review, American Journal of Political Science, Climate Research, Global Environmental Change, Journal of Environmental Education, Journal of Natural Resources and Life Sciences Education, Local Environment, Risk Analysis,* and the *Social Science Quarterly.* Dr. O'Connor earned his undergraduate degree at Johns Hopkins University and his doctorate in political science at the University of North Carolina at Chapel Hill.

Thomas Piechota, Ph.D., P.E.

Dr. Thomas C. Piechota is the Director of Sustainability and Multidisciplinary Research and Associate Professor in the Department of Civil and Environmental Engineering at the University of Nevada, Las Vegas (UNLV). Dr. Piechota received his B.S. in Civil Engineering in 1989 from Northern Arizona University, his M.S. in Civil and Environmental Engineering in 1993 from UCLA, and his Ph.D. in Civil and Environmental Engineering in 1997 from UCLA. His teaching and research interests are in the fields of climate change, sustainability, surface water hydrology, hydroclimatology, droughts, water resources planning, and stormwater quality in urban environments. In 2003, Dr. Piechota received a National Science Foundation CAREER Award for the project "Improved Hydrologic Drought Forecasting Using Climate Information." Currently, Dr. Piechota is part of a state-wide team that has received $15,000,000 in funding from National Science Foundation to study climate change in the State of Nevada. Dr. Piechota is a licensed Professional Engineer in the States of Nevada and California and serves on various committees with the American Society of Civil Engineers.

Dr. Durga Dutta Poudel

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Dr. Poudel was born on October 10, 1960 (Aswin 24, 2017 B.S.) in Sange, Chudher, Tanahu, Nepal. He spent his childhood in Sange Chudher, Tanahu and Jeeta Deurali, Lamjung, both in Mid-Hills of Nepal. Dr. Poudel passed his S.L.C. exam from Nirmal Vocational High School, Damauli, Tanahu in 1977 (2034 B.S.). Dr. Poudel received an I.Sc. in Agriculture at Tribhuvan University at Chitwan, Nepal in 1980; a B.Sc. in Agriculture (Major: Agricultural Economics) at University of Agriculture, Faisalabad, Pakistan in 1988; a M. Sc. in Natural Resource Development and Management at Asian Institute of Technology, Bangkok, Thailand in 1991; and a Ph.D. in Soil Science, University of Georgia, Athens, GA, U.S.A. in 1998.

Dr. Poudel's professional experience consists of Research Fellow at Asian Vegetable Research and Development Center, Taiwan (1991-1994); Graduate Research Assistant in Sustainable Agricultural and Natural Resource Management Collaborative Research Support Program, University of Georgia (1994-1998); and Visiting Research Scholar, University of California Davis (1998-2000). Dr. Poudel joined the University of Louisiana at Lafayette, U.S.A., as an Assistant Professor of Soil Science in August 2000, and currently is a tenured Associate Professor of Soil Science, South Louisiana Mid-Winter Fair/BORSF Regents Professor in Applied Life Sciences, Adjunct Professor of Geology, and the Director of Agriculture Auxiliary Units (Model Sustainable Agriculture Complex (600-acre Cade Farm), Crawfish Research Center, and Ira Nelson Horticulture Center) at the University of Louisiana at Lafayette. He is Fellow of the Center for Cultural and Eco-tourism, UL Lafayette.

Dr. Poudel has been senior author and/or co-author of 21 referred research journal articles and 37 other publications. Dr. Poudel has published many popular articles on newspapers and magazines. Dr. Poudel serves as a reviewer for several referred journals. As a Principal or Co-Principal Investigator, Dr. Poudel has generated over $3.3 Million of research money at the University of Louisiana at Lafayette, and his current research areas include surface water quality monitoring and modeling, wildflower and highway enhancement, and bio-fuels /bio-products feedstock.

Dr. Poudel is one of the resource persons for the Louisiana Organics. As a member, Dr. Poudel has served the Louisiana Technical Advisory Committee, US Department of Agriculture, Natural Resources Conservation Service, Louisiana, since 2003. Dr. Poudel initiated the Louisiana Surface Water Quality Conference in 2005, hosted the second conference in 2007 and plans to continue hosting such a statewide conference every two year. As a principal investigator, Dr. Poudel is involved in establishing Louisiana Native Wildflower Seed Bank at the University of Louisiana at Lafayette, which is the first seed bank of its kind in the State. This is a collaborative project between three universities in Louisiana and the Louisiana Department of Transportation and Development. Dr. Poudel served as the Panel Expert for the Best Practices for Field Days Delphi Expert Pannel, a NSF funded project managed by the University of Minnesota in 2007. Dr. Poudel is one of the organizing committee members of 2008 NSF EPSCoR Water Quality Conference at the University of Vermont, USA. Dr. Poudel has been recognized as the “Outstanding Minority Environmental Faculty” by the Minority Environmental Leadership Development Initiative (MELDI), University of Michigan, and his profile is being published in a booklet “The Journey Continues”, edited by Dr. Dorceta E. Taylor. Dr. Poudel was one of the Research Chairs of the Canadian Forum for Nepal Conference held on July 10-12, 2008 in Ottawa, Canada. Dr. Poudel developed the Asta-Ja framework of economic development for Nepal and is one of the founding members of the International Asta-Ja Society for Nepal which is going to be registered in Nepal. Dr. Poudel is one of the Composition Advisors for the monthly magazine Solidarity Nepal which is published from Kathmandu, Nepal. A collaborative project between the Center for Cultural and Ecotourism (CCET), UL Lafayette, USA and various tourism institutions and universities in Nepal is being developed, in which Dr. Poudel is working as a liaison and facilitator.

Dr. Poudel’s professional affiliations include membership in American Society of Agronomy, Soil Science Society of America, American Water Resource Association, and the Phi Beta Delta Honor Society for International Scholars, Alpha Beta Chapter, UL Lafayette. Awards and recognitions include the following: Coaches Sportsmanship Award, 2006, Lafayette Youth Soccer Association, Immigration and Naturalization Services, USA – Outstanding Professor or Researcher; College of Applied Life Sciences Dean’s Excellence Award, Spring 2001 “Greatest Impact on College by a New Faculty Member”; recognized as “Research Resourcefulness” by the Dept. of Renewable Resources, University of Louisiana at Lafayette, Spring 2001; South

Louisiana Mid-Winter Fair/BORSF Regents Professor in Applied Life Sciences, SLEMCO/BOR Professor in Applied Life Sciences, UL Lafayette, Fall 2000-2007; Carl Duisberg Gesellschaft Scholarship Award to participate on Coastal Zone Environmental Planning Short Course at AIT, Bangkok, Aug.-Dec. 1991; AIT Scholarship Award for M.Sc. Program at AIT, Jan. 1990-Aug. 1991; GTZ Scholarship Award for B.Sc. Program at the Univ. of Agriculture, Faisalabad, Pakistan, 1983-1987; and Merit Scholarship, 1978-1980. He serves as an Editorial Board member for the Journal of Agriculture Ecosystem & Environment.

Short Biography of Sloane A. Ritchey

Sloane Ritchey is an Environmental Research Scientist at the Eastern Kentucky Environmental Institute located at Eastern Kentucky University. She received her Ph.D. degree in Environmental Soil Chemistry at the University of Tennessee for her dissertation on "Potassium Dynamics and Exchange Equilibria in Loess Derived Soils." She also holds an M.S. degree from the Pennsylvania State University in Environmental Soil Chemistry. After completion of her Ph.D. degree, Sloane was a Post Doctoral Scholar at the University of Kentucky conducting research in mitigated wetland nutrient cycling in the Soil and Water Biogeochemistry Laboratory and microbial source tracking in the Soil Microbiology and Ecology Laboratory. Sloane is interested in improving techniques to identify source origin of non-point source pollutants. She is specifically utilizing *Bacteroides* and real-time PCR techniques to identify and quantify fecal contaminants as derived from human or non-human origin. Other areas of interest include investigating the fate and transport of fatty alcohol-based nanoparticles in the environment. She has also conducted TMDL water quality monitoring in eastern Kentucky in conjunction with the Kentucky Division of Water. Sloane was awarded a USDA National Research Initiative grant that was initiated July 2008. This research will focus on the characterization of a karst cattle-grazing area of rural, eastern Kentucky where traditional prescription best management practices were implemented to improve the impaired watershed. However, with no significant improvement of water quality, it was determined that additional monitoring techniques were necessary to adequately characterize the surface and groundwater interactions indicative of karst areas.

Biographical Sketch: DONNA M. RIZZO

Donna's research focuses on the development of new computational tools to improve the understanding of human-induced changes on natural systems and the way we make decisions about natural resources. She has over 10 years of experience with optimization methods and 15 years of groundwater remediation and computational modeling experience. Prior to joining UVM, she co-founded a small business to speed the diffusion of research and new technologies from universities and national laboratories into environmental practice. Activities focus on subsurface environmental solutions including: Interpreting/visualizing subsurface monitoring data; applying design optimization methods to groundwater and soil remediation systems; developing tools for rapid joint inversion and data assimilation of multiple geophysical and geotechnical data types, and devising integrated environmental education programs. More recently, she has used artificial neural networks to estimate key environmental variables (specifically canopy surface water duration) at local scales from local and regional GIS information, weather station data and site specific sensor data to predict risk of crop disease. She was one of 15 people selected in a national competition to attend a 12-week workshop at the Advanced Computing Laboratory at Los Alamos National Laboratory, has served as Vice Chair of the ASCE Task Committee on Long Term Monitoring Optimization, has developed multidisciplinary research programs for private high schools and has worked with the FEMA during 1998 Vermont floods.

Short Biography of **Chuck Somerville** for VT EPSCoR Water Dynamics Workshop

Full Name: Charles Campbell Somerville, PhD

Current Position: Professor and Head, Division of Biological Sciences, Marshall University, Huntington, West Virginia.

Education: BS in Microbiology, Pennsylvania State University, 1978
PhD in Microbiology, University of Maryland, College Park, 1989

Chuck Somerville graduated from Penn State in 1978 with a BS in microbiology. After stints as a research technician at the Virginia Institute of Marine Science (Gloucester Point, Virginia) and the US EPA Environmental Research Laboratory (Gulf Breeze, Florida), he entered the PhD program at the University of Maryland College Park under Dr. Rita R. Colwell. Upon completing his PhD in 1989, Chuck worked as a postdoctoral fellow at the Station Biologique de Roscoff (Roscoff, France). He returned to the US in 1991 to work as a Project Microbiologist at EPA ERL Gulf Breeze, and then moved to Panama City, Florida in 1993 to work as a microbiologist in the US Air Force Environics laboratory at Tyndall Air Force Base. In 1997, Chuck moved to Huntington, West Virginia to join the Department of Biological Sciences at Marshall University in West Virginia, where he now serves as Chair and Division Head. His research interests include the distribution of antibiotic resistant bacteria in surface waters, and primary productivity in large river systems.

Pamela Stephens currently serves as a Senior Advisor in the Office of Assistant Director for Geosciences at NSF. Much of her career has been spent at the Foundation, where she has held several positions, the first of which was as a program officer in the Division of Atmospheric Sciences. She is a meteorologist by training. Her current responsibilities include helping to coordinate a number of water-related activities within NSF and across federal agencies.

Austin Troy

Bio:

Dr. Troy is Associate Professor at the Rubenstein School of Environment and Natural Resources at the University of Vermont with a secondary appointment in Computer Science. He is also a fellow of the Gund Institute of Ecological Economics and a Co-Principal Investigator on the Baltimore Ecosystem Study, which is a long-term ecological research (LTER) project of the National Science Foundation. He teaches courses in Geographic Information Science, spatial statistics, and land use policy and economics. His research examines urban and suburban environmental management issues, using spatial analysis methods. He currently has research funding through the US Department of Transportation, the UVM Transportation Research Center, the USDA Forest Service, the National Science Foundation, and the Northeastern States Research Cooperative.

Dr. Troy has written a large number of journal articles and book chapters, and edited and co-wrote a book on wildfire management and policy in the urban-rural interface zone, published in 2007. He is currently working on a book on comparative urban energy footprints. He served for four years as a member of the Burlington Planning Commission. He has a bachelor's degree from Yale, a Master of Forestry degree from Yale School of Forestry and Environment Studies and a Ph.D. from the department of Environmental Science, Policy & Management at U.C. Berkeley.

BIO

Teferi Tsegaye
Alabama A&M University

Dr. Teferi Tsegaye is a Professor/Chairperson of the Department of Natural Resources and Environmental Sciences at Alabama A&M University. As a PI and Co-PI, he has received funding over $16,000,000.00. Dr. Tsegaye received a Bachelor of Science degree in Plant Science and a Master of Science degree in Agronomy (Irrigation water use) from Oklahoma State University, Stillwater, Oklahoma in 1984 and 1986, respectively. He also received a Ph.D. degree in Soil Physics/Geostatistics/GIS from University of Maryland at College Park, Maryland, in 1994. He served as a Research Associate from 1992 - 1995 at the University of Maryland/Cornell University. He received an outstanding Teaching Award for 1999 from the School of Agriculture and Environmental Sciences. *B.D. Mayberry Young Scientist Award* by the Association of Research Directors at the XII Biennial Research Symposium in Washington, D.C. April 21, 2000 for outstanding achievement in research among all 1890 Land Grant Universities; Outstanding Researcher of the Year Award from the School of Agricultural and Environmental Sciences at Alabama A&M University (2000); Who's Who in Science and Engineering 1999/2000; Outstanding Teacher of the Year Award from the School of Agricultural and Environmental Sciences at Alabama A&M University (1998); Researcher of the Year Award 2001-2002 2003-2004, and 2005-2006 from Alabama A&M University, Office of Research and Development Grants and Contracts Department; and Professional of the Year Award (2002) from Huntsville Association of Technical Society HATS). He is also serving as Soil Science Certification Exam Administrator for Soil Science Society of America. Dr. Tsegaye has served on numerous society committees which include the Book Series Committee of SSSA; the Southern Regional Information Exchange Soil Physics Group (IEG 73). He has served as a session moderator for S6 of the SSSA Annual Meeting. He has been a member of the ASA Committee on Minority Concerns (ACS-528) since 1996 (formerly the Ad Hoc Committee on Minority Concerns) and is the current Co-chair of Southern Region Water Quality Coordination Project supported by USDA-CSREES. He is also selected to be a **Fellow** by American Society of Agronomy (2007). Dr. Teferi Tsegaye has proven great initiative in bringing new research capabilities to Alabama A&M University (AAMU). Among his many accomplishments, he has been the driving force in establishing new environmental monitoring networks, principally the Alabama Mesonet (ALMNet) and the Wheeler Lake Basin Water Quality Network (WWQN). ALMNet is a key tool for monitoring a number of meteorological and hydrological variables needed to help predict surface and sub-surface water flows. The ALMNet currently consists of 11 near real-time stations and 12 non real-time stations, with more on the way. Dr. Tsegaye is currently developing a drought and flood forecasting tools for continental scale using research grants supported by USDA-NRCS-SCAN. Dr. Tsegaye taught environmental science institute to high school and middle school science teachers supported by Region IV Hazardous Waste Division and established a computer training center supported by Environmental Justice division Region IV, EPA in Dothan and Birmingham Alabama for under served communities two summer. Tsegaye has mentored and advised numerous undergraduate and graduate students in their research

in topics related to his own work. He has authored and co-authored over 135 publications in several scientific journals and presented at many meetings, a number of which he has helped organize.

SCOTT W. TYLER

Professor
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EDUCATION

Ph.D. Hydrology/Hydrogeology, University of Nevada, Reno, Nevada
Dissertation Title: *Fractal Applications to Soil Hydraulic Properties*. August 1990

M.S. Hydrology, New Mexico Institute of Mining and Technology; Socorro, New Mexico
Thesis Title: *Field Results of Borehole Infiltration Tests*. June 1983

B.S. Mechanical Engineering, University of Connecticut; Storrs, Connecticut. June 1978

Dr. Tyler's areas of focus span the wide range of arid region hydrology, with particular interest in bridging the gap between hydrogeology and soil physics in the newly emerging area of vadose zone hydrology. He is currently involved with studies of moisture flux and groundwater recharge in arid environments. He is a leader in bringing Raman spectra fiber optic temperature sensing to hydrologic systems, and has worked with collaborators from Switzerland, Germany, UC-Davis, UC-Merced, New Mexico Institute of Mining and Technology, the University of Delft, Oregon State University, Stanford and the University of Connecticut on a wide range of thermal sensing projects in the last 2 years. Other work includes the development of soil-atmosphere models of energy and water flux, the study of ground-water/brine interactions in terrestrial environments, the reconstruction of paleoclimates from soil water chemistry, and reactive transport of contaminants in fractured, dual porosity unsaturated media and mine waste materials.

Since 2004, Dr. Tyler has served as Editor of the American Geophysical Union's *Water Resources Research*, the internationally recognized leading journal for hydrologic sciences and engineering. I have also served as the 2007 Chair of the Hydrogeology Division of the Geological Society of America. Dr. Tyler is a fellow of the Geologic Society of America and the Soil Science Society of America.

Judith Van Houten, Ph.D.

Dr. Judith Van Houten, George H. Perkins Professor of Biology at the University of Vermont (UVM) and State Director of the Vermont Experimental Program to Stimulate Competitive Research (VT EPSCoR). In September 2008, she was inducted into the **Vermont Academy of Science and Engineering (VASE)** as a Full Member. The Academy was chartered by the State of Vermont to honor scientists and engineers for their achievements, promote the interests of science and engineering within the State, educate Vermont citizens about the importance of science and engineering, and to help the State of Vermont with regard to problems in science and engineering.

Appointed as the **EPSCoR State Director** in 2005, Dr. Van Houten also serves as the program's Principal Investigator. The EPSCoR Research Infrastructure Improvement (RII) award, funded by the National Science Foundation (NSF), builds science and engineering infrastructure in Vermont and promotes collaborative research at UVM and beyond. VT EPSCoR also supports the development of basic research programs for early career faculty at UVM, and for faculty at Vermont's baccalaureate institutions. The Tibbetts Award winning program for research and development in the private sector (SBIR Phase (0)) prepares businesses for submission of SBIR grant applications to federal agencies. Graduate, undergraduate and high school students also benefit from VT EPSCoR sponsored programs.

Dr. Van Houten also serves as the **Director of the Vermont Genetics Network** (VGN), a $16.5M program awarded in 2005 by the National Institutes of Health (NIH). This remains as the largest single investigator grant ever received at UVM. VGN is funded by a five year award from the National Center for Research Resources, and is part of the NIH initiative called IDeA Networks of Biomedical Research (INBRE). VGN is a collaboration among the University of Vermont, and five baccalaureate colleges throughout the state of Vermont to build critical mass and infrastructure in the broad area of genetics.

In addition, Dr. Van Houten is the **Director of the HELiX** (Hughes Endeavor for Life Science Excellence) Program, which supports undergraduate research at the University of Vermont. HELiX strives to encourage students to stay in science and consider careers in the sciences by involving them in research projects and informing and exposing them to as many opportunities as possible in the sciences.

Dr. Van Houten has a long record of administration and mentoring, including service as Director of the Cell and Molecular Biology Graduate Program for 6 years, Associate Dean of the College of Arts and Sciences for 5 years, Chair of Biology from 1995-2005. Perhaps most importantly, she has served as Associate PD of VT EPSCoR from 1996 –2005, and as Associate Director for research 1991- 1996. Dr. Van Houten has a record of extramural funding from NIH and NSF. She has received a 7-year Pepper award from NIDCD and the Manheimer Award for career achievements in Chemosensory Sciences. The University of Vermont has recognized her as a University Scholar and the George H. Perkins Professor. She is well regarded in her field, has been elected to offices, including President, in the Association for Chemoreception Sciences, and serves on editorial boards. She is familiar with federal funding mechanisms at NSF and NIH, has served for 6 years on the CMS study section (2 years as chair) and is currently a member of CMBK study section.

Dr. Van Houten's style of management is inclusive. In 2006 she received the **Jackie M. Gribbons Leadership award** from the Vermont Women in Higher Education. This award is

presented to a woman who has demonstrated leadership ability, served as a model and mentor, developed innovative programs, and contributed significantly to the institution and profession.

Dr. Van Houten received a BS from Pacific Lutheran University and her PhD from the University of California at Santa Barbara. Her research investigates the molecular mechanisms of how cells detect chemicals, and she uses organisms as simple as Paramecium and as complex as mice. Her work provides insights into the sense of smell. A full description of Dr. Van Houten's research areas may be found at http://www.uvm.edu/%7Ebiology/Faculty/VanHouten/VanHouten.html

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MARY CATHERINE WATZIN

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Education

1984 - University of North Carolina at Chapel Hill, Ph.D. in Marine Sciences.

1978 - University of South Carolina, B.S. in Marine Science.

Recent Professional Experience

2005 – Present - Professor, University of Vermont, School of Natural Resources, Burlington, VT 05405

1998 to present – Director, Rubenstein Ecosystem Science Laboratory, Burlington, VT 05401

1994 (September) - 2005 - Associate Professor, University of Vermont, School of Natural Resources, Burlington, VT 05405 and 1998 to present – Director, Rubenstein Ecosystem Science Laboratory

1990 (October) - 1994 - Assistant Unit Leader, Vermont Cooperative Fish and Wildlife Research Unit, U.S. Fish and Wildlife Service and Research Associate Professor, University of Vermont, School of Natural Resources, Burlington, VT 05405

1985 - 1990 - Ecologist, National Wetlands Research Center, U.S. Fish and Wildlife Service, Slidell, LA 70458

Selected Recent Awards

2006 – Teddy Roosevelt Conservation Award, Isle LaMotte Preservation Trust, Lake Champlain Land Trust, and Champlain Islands Chamber of Commerce, Isle LaMotte, VT

2003 – Ibakari-Kasumigaura Prize, International Lake Environment Committee, Japan

1998 - Lake Champlain Research Consortium, Distinguished Service Award (First given, for long term commitment and dedication to the development of research and education).

1997 - Shoemaker Communications Award, U.S. Geological Survey, for Excellence in Communicating Scientific Information (One given annually nationwide).

1996 - Kroepsch-Maurice Award for Teaching Excellence. University of Vermont. (One given annually to an Associate Professor).

Synergistic Activities

- Education – Part of team that developed interdisciplinary six-course undergraduate core curriculum in the Rubenstein School; teach integrative upper-level course in that major (Ecosystem Mangement). Funded program to recruit and mentor undergraduate and graduate students from underrepresented groups. Coordinated development of PhD in Natural Resources and oversaw program during first two years of implementation, currently graduate program coordinator for the Rubenstein School
- Collaborative Research and Problem-Solving – Since 1992, Chair of the Technical Advisory Committee to and serve on the transboundary Lake Champlain Steering Committee (USA and Canada). Provide technical review, research priority setting, and guidance to federal, state and provincial managers in management partnership. Led the special "Investigative Docket"

convened by the VT Water Resources Board, bringing diverse group to consensus on "A Scientifically Based Assessment and Adaptive Management Approach to Stormwater Management." New stormwater regulations based on these recommendations were passed by the Vermont Legislature in May 2004.

- Outreach – Regularly organize and conduct regional, national and international workshops for scientists and practitioners on phosphorus reduction, cyanotoxins, watershed management, and ecosystems ecology.

Thesis Advisor and Postgraduate-Scholar Sponsor (last 5 years)

N. Kammen (VT DEC), M. Kreider (Univ. of Vermont), V. Levesque (ME SeaGrant), A. Mahar (NY DEC), K. McKutcheon (Ohio DNR), E. Brines Miller (self-employed), Dean Olsen (Cawthron Institute, NZ), E. Royer (NE Water Suppliers), Mazeika S.P. Sullivan (Univ. Idaho), Robyn Smyth (Univ. California, Santa Barbara), Dalene Varney (MA DNR), S. Couture (GreenFuels). Over 25 total graduate students advised.

Recent Publications

Rogalus, M.A. and **M.C. Watzin**. 2008. Evaluation of sampling and screening techniques for tiered monitoring of toxic cyanobacteria in lakes. Harmful Algae 7; 504-514. .

Clark, J.S., D.M. Rizzo, **M.C. Watzin**, and W.C. Hession. 2008. Spatial distribution and geomorphic condition of fish habitat in streams: an analysis using hydraulic modelling and geostatistics. River Research and Applications 24: 885–899.

Jukosky, J.A. **M.C. Watzin** and J.C. Leiter. 2008 The effects of environmentally relevant mixtures of estrogens on Japanese medaka (Oryzias latipes) reproduction. Aquatic Toxicology 86: 323-331.

Watzin, M.C. 2007. The Promise of Adaptive Management. Pages 147-158 in: Managing Agricultural Landscapes for Environmental Quality: Strengthening the Science Base, M. Schnepf and C. Cox, eds. Soil and Water Conservation Society Press, Ankeny, IA.

Sullivan, S.M.P., **M.C. Watzin**, and W.S. Keeton. 2007. A riverscape perspective on habitat associations among riverine bird assemblages. Landscape Ecology 22:1169–1186.

Brines Miller, E. and **M.C. Watzin**. 2007. The effects of zebra mussels on the lower planktonic foodweb in Lake Champlain. Journal of Great Lakes Research.33:407–420

Smyth, R.L., **M.C. Watzin**, and R.E. Manning. 2007. Defining acceptable levels for ecosystem indicators: integrating ecological understanding and social values. Environmental Management. 39:301-315.

Watzin, M.C. 2006. The Role of Law, Science and the Public Process: Practical Lessons from Lake Champlain (USA and Canada) and Lake Ohrid (Macedonia and Albania). Global Business & Development Law Journal 19:241-258.

Sullivan, S.M. P., **M.C. Watzin,** and W.C. Hession. 2006. Influence of geomorphic condition on stream fish communities in Vermont, USA. Freshwater Biology 51, 1811–1826.

Sullivan, S.M. P., **M.C. Watzin**, and W.C. Hession.. 2006. Differences in the reproductive ecology of belted kingfishers (*Ceryle alcyon*) across streams with varying geomorphology and habitat quality. Waterbirds 29(3): 258-270.

Watzin, M.C., E. Brines Miller, A.D. Shambaugh, M.K. Kreider. 2006. Application of the WHO Alert Level Framework to Cyanobacteria Monitoring on Lake Champlain, Vermont. Environmental Toxicology 21(3): 278-288.

Kyriakeas, S.A. and **M.C. Watzin**. 2006. Effects of adjacent agricultural activities and watershed characteristics on stream macroinvertebrate communities. Journal of the American Water Resources Association 42(2): 425-441.

BEVERLEY C. WEMPLE is an associate professor of Geography at the University of Vermont. Her research interests lie in understanding the dynamics of hydrologic and geomorphic processes in upland, forested watersheds. She is particularly interested in using basic theoretical tools and simulation modeling, in conjunction with empirical field studies, to understand how management of forested, mountain landscapes alters the processes of runoff generation and sediment production. Dr. Wemple is a cooperator with the Long-term Ecological Research network, the Northeastern Ecosystem Research Cooperative, and the Vermont Monitoring Cooperative. She received her B.A. from the University of Richmond, and her M.S. and Ph.D. from Oregon State University.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Alaska

Name of PD and, if appropriate, designee who filled in the template
Peter Schweitzer, Alaska EPSCoR director and PI. Lilian Alessa, co-PI, and Anne Sudkamp, executive officer, filled in the template.

Contact information to field questions from those reading this document (i.e. not necessarily the PD): Lilian Alessa, afla@uaa.alaska.edu, 907.786.1507, Anne Sudkamp, anne.sudkamp@alaska.edu, 907.474.5880.

- **Please describe research on Water that is on-going in the jurisdiction: (< 1 page)**

We treat water as a social process as much as a biophysical one. Water research has an extensive legacy in Alaska as it is intimately linked to rapid climate change, resource management and socio-cultural identity. An example of one of the transformative products is the Arctic Water Resources Vulnerability Index, http://ram.uaa.alaska.edu/AWRVI.htm, a composite water index to evaluate the well-being of arctic communities with respect to fresh water, developed by Alessa and her colleagues at the University of Alaska. Some features of AWRVI include:

- The ability to integrate a range of existing and community-specific water-related data and information into a series of indicators to give an overall score.
- The ability to provide a holistic profile of a community's key water issues, allowing for intra-community and inter-community comparison and analysis.
- The ability of a community to use it to identify where strengths and weaknesses exist in water management.

In addition, Alaska EPSCoR is developing an agent-based model called "Forecasting Environmental Resilience of Arctic Landscapes" (FERAL), which can be used for developing water policies in the state.

The University of Alaska International Polar Year initiative, "North by 2020," a forum for local and global perspectives on the North, has a freshwater theme. Please see www.alaska.edu/ipy/north2020/water.xml

- **Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)**

- We are now moving beyond characterizing "climate change" to asking how we effectively **adapt** to rapid "global change.

- Water, energy and social dynamics leading to resilience or vulnerability in these systems have emerged as priority areas in Alaska, the U.S. and around the world.
- One of the greatest challenges facing us today is how to make 'good' decisions at various scales, from individuals to organizations to societies, under highly uncertain conditions.
- The number of biophysical datasets and models are increasing. Some, (e.g., climate models for the Arctic) are well developed. However, knowledge and detailed, accurate information about the environment, while important, does not explain risk perceptions and decision-making behaviors. In other words, the model of "elucidate and disseminate" is not working. We are now characterizing adaptation to changing water resources as largely a phenomenon of social dynamics.
- Several efforts are currently underway to address resilience, adaptation and community health as well as climate change, ecology and policy making at the University of Alaska. Our Water, Social Dynamics, Energy and Community Health initiative aspires to provide guidance to high-level decision makers for development activities in the Arctic.
- This initiative treats the Arctic as a social-ecological system and takes advantage of UA's growing capacity in climate change and adaptation science, as well as public outreach efforts.
- It focuses on three key emerging issues and priority areas: **Water, Social Dynamics, Energy Security and Community Health.**
- It brings the importance of Alaska's resources, location and social capital to the forefront of national and international security concerns.

- **Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)**

  Alaska EPSCoR organized a meeting in March 2008 of EPSCoR jurisdictions interested in ecosystems research. Twelve jurisdictions responded. That information will form the basis of knowledge about whom to collaborate with as opportunities, such as Track II, arise.

- **Funding sources for this research (not necessarily NSF EPSCoR) Please list:**

  Funding for Alaska's water-related research comes from diverse sources including the National Science Foundation, the state of Alaska, and state and federal resource-management agencies.

- **Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)**

  While our state science and technology plan does not focus on water, it stresses the importance of research on social-ecological systems. This issue relates directly to the ability

of such systems to sustain cultural, economic and functional network--all of which rely on water.

- **Facilities in your state that are useful for water research (1/4 page)**

  We have several key facilities that serve our water research needs. They include the Resilience and Adaptive Management (RAM) Group's agent-based modeling capabilities (http://ram.uaa.alaska.edu) and the Water and Environmental Research Center (WERC), housed within the Institute of Northern Engineering (http://www.uaf.edu/water/).

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Arkansas

Name of PD and, if appropriate, designee who filled in the template:

PD:
Gail Y. H. McClure, PhD
Vice President Research
Arkansas Science & Technology Authority
423 Main, Suite 200 (corner of Capitol & Main)
Little Rock, AR 72104
office: (501) 683-4407
Gail.McClure@arkansas.gov

Designee who filled in template:
Jeffrey S. Gaffney, Ph.D.
Chair and Professor of Chemistry
University of Arkansas at Little Rock
SCLB 451
2801 S. University Avenue
Little Rock, AR 72204
501-569-8840
jsgaffney@ualr.edu

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

Dr. Jerry Farris
Associate Dean of the College of Science and Mathematics
Professor of Environmental Biology
Arkansas State University
Jonesboro, AR
870- 972-2007
jlfarris@astate.edu

Dr. Ralph K. Davis
Professor and Chair, Department of Geosciences
113 Ozark
University of Arkansas
Fayetteville, Arkansas 72701
479-575-4515
ralphd@uark.edu

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Air and Water Research Center (AWRC), located at University of Arkansas, Fayetteville, pursues research in surface and groundwater systems examining pollution and hydrology including ecosystem interactions under the direction of Dr. Ralph Davis. Water resource management is also stressed that includes modeling, forecasting water resource availability, legal implications, as well as water management strategy development. AWRC maintains a water quality laboratory that allows water samples to be analyzed for the research community in Arkansas as well as agencies in the state. AWRC is also collaborating with the Center for Advanced Spatial Technologies and GIS labs at the University of Arkansas, Fayetteville to make use of spatial mapping of water resources in the state addressing water resource and agricultural applications related to water issues. AWRC is partnering with USGS and is part of the National Institutes for Water Resources as part of Land-Grant Research Activities in the state.

The Ecotoxicology Research Facility (ERF, see http://ecotox.astate.edu/) is part of the Arkansas State University's research efforts in water quality and ecological research under the direction of Dr. Jerry Farris. Currently, ERF personnel are involved in research evaluating Arkansas rivers and streams, as well as surface water systems in the Yazoo River basin in north Mississippi. ERF research also includes assessments of water and sediment toxicity by using standardized aquatic test organisms and EPA methodologies (i.e. aquatic invertebrates and fish). ERF personnel have gained national recognition for work on contaminant effects on freshwater mussels.

The University of Arkansas at Little Rock (UALR), USGS, and the Central Arkansas Water District have set up the "Central Arkansas Watershed Center of Excellence" (The Center) for educational and research collaboration in water resource studies. The Center will focus on science-based monitoring, research, and information-gathering to provide long-term observations of water quality and help to improve management strategies for surface and groundwater resource protection in central Arkansas. Scientific investigations of water quality and quantity issues related to source security of drinking, agricultural, and industrial water supplies, as well as the engineering processes that can be developed to enhance security are being planned that include watershed stewardship. One goal of The Center will be a community-based education program to improve the public knowledge base in water conservation, preservation, and ecosystem stewardship in central Arkansas. Research and educational outreach activities will use undergraduate and graduate students studying limnology, ecology, hydrology, and water chemistry to describe and share their research results to local schools and via workshops to enhance central Arkansas awareness of current and future water resource issues in the region.

Other research activities include collaborative work with the National Park Service on the Buffalo River (UAF, ASU, and UALR) making use of existing facilities for collaborative study. USDA and USGS collaborations are also underway that focus on water quality and pollution levels in agricultural areas and in Arkansas in general, respectively.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

- The importance of natural humic and fulvic acids as mobile colloid phases capable of transporting and binding metals (including toxics, radionuclides, and nutrient metals) as well as organic pollutants is of interest for research in ground and surface waters.
- Investigation into the ability of these natural chelating agents to reduce the bioavailability of toxic metals and radionuclides is of particular interest.
- The use of natural radioactivity, stable isotopic signatures, and biomarkers as means of probing specific chemical and physical processes in the regions surface and groundwater systems is also of interest.
- Research efforts into the use of biological markers and studies examining the development of improved analytical and bio-analytical methodologies for addressing water quality and pollutant impacts are also being pursued.
- Computational improvements including development of algorithms to describe water transport in the region are sought. Water resource modeling would also seek collaborative work that would include use of regional climate models for water resource management and resource prediction.
- Use of novel microorganisms to enhance water clean-up by reducing levels of pollutants in environmentally benign fashion are also of interest.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Past work has involved work in Mississippi. We are hoping to expand efforts to include work with Tennessee, Louisiana, Missouri, Illinois, and other states interested in similar watershed problems that Arkansas has. We are also seeking to make use of national laboratory facilities and high-end computational facilities to enhance and develop the state research capabilities.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

Arkansas does not have specific funds earmarked for water research at the present time. However, there are more generic resources that might be applied to water research. Most of the resources leverage intellectual property that creates new technology rich industries. Tax incentives allow Arkansas income tax credits for industries/companies that invest in or provide equipment to university campuses to pursue research. Arkansas highly values water because of its importance to the tourism industry and the agricultural industry of the state. Should university research efforts receive federal funding, it is likely that match monies from the state would be available.

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

The Arkansas S&T plan does not list water research per se. One focal area of the Arkansas S&T plan includes:

Environmental Sciences with emphases on:

- Advanced Thermal Technologies;
- Energy and Renewable Resources;
- Geosystems and Environmental Impacts; and
- Sustainability.

- Facilities in your state that are useful for water research (1/4 page)

Besides the centers and institutes mentioned above, Arkansas has the National Center for Toxicological Research and also has many state-of-the-art instruments for analytical chemistry available for joint research at the Arkansas State Public Health Laboratory in Little Rock.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction:
Kentucky NSF EPSCoR

Name of PD and, if appropriate, designee who filled in the template:
John W. Connolly, PD; Barbara A. Kucera; Deputy PD.

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

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Kentucky is a water-rich state. There are more miles of large rivers than any state in the contiguous 48, and the number of large reservoirs places Kentucky in the top five states. Large rivers include the Ohio (700+ miles in Kentucky), Mississippi, Tennessee, Cumberland, and Kentucky. Water resources within Kentucky range from the Appalachian streams in the east to lowland streams and swamps in the west. Comparatively little water research occurs in Kentucky, and the state has no Federal labs that focus on water.

The Kentucky Water Resources Research Institute www.uky.edu/WaterResources supports surface and groundwater related research primarily on restoration and management. These projects are generally small and scattered across the commonwealth. Each of the state supported universities and some private schools have at least one or more faculty with aquatic backgrounds and individual or small group research programs in water research (particularly in departments of biology, geosciences, and engineering), e.g. the Stream Institute at http://speed.louisville.edu/civil/research/si/ .

The University of Kentucky's Environmental Research Training Laboratories http://www.engr.uky.edu/~ertl/index.html supports water research by making state of the art analytical instrumentation available to researchers across the state. Eastern Kentucky University's Environmental Research Institute www.eri.eku.edu/summaries.php focuses largely on stream contamination, restoration, and education in the Appalachian and outer Bluegrass regions of the state, notably in the Kentucky River Basin, but also in the Big Sandy, and Upper Cumberland basins. These two units, along with Murray State University were part of a 2005 NSF EPSCoR grant that provided infrastructure and equipment for water research.

The primary water ecological research facility in Kentucky is located at the Hancock Biological Station on Kentucky Lake (HBS) www.murraystate.edu/hbs. In 1987, Murray State University was awarded one of 4 statewide Centers of Excellence, the Center for Reservoir Research (CRR) www.murraystate.edu/crr. HBS/CRR has had numerous state and federally funded research grants (KDOW, NSF, EPA, DOE, NASA, DHS) that have been collaborative among faculty and disciplines from across the commonwealth. A primary focus has been on watershed ecology, particularly in relation to changing land use and the region's streams and reservoirs. Some specific research areas include groundwater-surface water interactions (hydrology, ecology, geochemistry), reservoir primary and secondary production, ecology of invasive species, particulate and dissolved carbon dynamics, benthic ecology, food web dynamics (stable isotope studies), and bioturbation.

Research resources at HBS include monitored paired watersheds, 20 year long-term monitoring program on Kentucky Lake at its tributaries, real-time lake monitoring www.murraystate.edu/qacd/cos/hbs/wq.cfm, full analytical capabilities, cyberinfrastructure, full-time staff of 10, etc. At Murray State, there are 11 faculty members with active water related research programs. Present Kentucky collaborations include faculty from University of Louisville, University of Kentucky, Western Kentucky University, Eastern Kentucky University, Morehead University, and Berea College. Present external collaborations include faculty from universities in Illinois, Indiana, Montana, Missouri, Ohio, and Tennessee. HBS/CRR is a member of the Organization of Biological Field Station (OBFS), the Association of Ecological Research Centers (AERC), the National Ecological Observatory Network (NEON), and the Global Lakes Ecological Observatory Network (GLEON).

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

In 2007, a team of researchers from the University of Kentucky, University of Louisville, Eastern Kentucky University, Western Kentucky University, and Murray State University began to develop plans for collaborative water research using the strengths at each school. The team includes ecologists, hydrologists, engineers, carbon chemists, and environmental educators. One commonality has been the need to understand the present status of Kentucky waters and the trends expected particularly with climate change. To this end, we have discussed establishing real-time sensor networks, linking

sensors to cyberinfrastructure, and the development of new sensors. Sensors would be used to establish status and trends and provide the basis for experimental approaches. Some of these efforts would parallel the efforts of the National Ecological Observatory Network (NEON) www.neon.inc that is largely terrestrial and would be linked with the Global Lakes Ecological Observatory Network (GLEON) http://gleon.org/ and WATer and Environmental Research Systems Network (WATERS) www.watersnet.org/.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Kentucky NSF EPSCoR is presently collaborating with Montana NSF EPSCoR to develop comparative large lake studies using sensors and cyberinfrastructure. Research would focus on Flathead Lake through the University of Montana's Flathead Biological Station and on Kentucky Lake through the Hancock Biological Station. Both lakes would be monitored in real-time along with tributaries of differing land use/chemistry. Sensors would be used to measure primary productivity and potential changes in biogeochemistry over time. It is expected that the more oligotrophic and northern Flathead Lake would respond more quickly to climate change than the mesotrophic and southern Kentucky Lake. Further, Flathead Lake would be more sensitive to landuse changes and other perturbations. The collaboration involves researchers from four Kentucky universities and two Montana universities.

The Eastern Kentucky Environmental Research Institute is also participating in a multi-institutional partnership across the Appalachian region involving faculty from University of West Virginia, Wheeling Jesuit University, University of Virginia, Morehead State University, and others to investigate the linkages between ecological health and community health in the Appalachian region. Central to the ongoing discussions among the partners is the role of water and hydrologic systems in the transport of pathogens and pollutants.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

National Science Foundation (NSF regular grants programs)
U.S. Environmental Protection Agency (EPA)
Department of Energy (DOE)
National Aeronautics and Space Administration (NASA, LandSat-GIS)
Department of Homeland Security (DHS) (reservoir and water security)

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

While water quality and environmental concerns are treated very seriously, water and water research are not specifically parts of our state science and technology plans.

- Facilities in your state that are useful for water research (1/4 page)

The Hancock Biological Station on Kentucky Lake/Center for Reservoir Research, full laboratory and field facilities for water research (www.murraystate.edu/hbs, www.murraystate.edu/crr).

The University of Kentucky, Environmental Research Training Laboratories (http://www.engr.uky.edu/~ertl/index.html)
The University of Kentucky Experimental Flume, sensor testing.

Thomas More College, The River Station, research and education facilities on the Ohio River (www.thomasmore.edu/riverstation/research.cfm)/.

The Eastern Kentucky Environmental Research Institute particularly community-capacity building in Appalachian Kentucky (www.eri.eku.edu/summaries.php).

The University of Louisville Stream Institute, particularly engineering and restoration (http://speed.louisville.edu/civil/research/si/).

The Kentucky Division of Water, analytical labs (www.water.ky.gov/)

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Maine

Name of PD and, if appropriate, designee who filled in the template: Designee- John M. Peckenham, Director Maine Water Resources Research Institute, Assistant Director Senator George J. Mitchell Center for Environmental and Watershed Research, University of Maine, Orono, ME 04469

phone: 207 581 3254 email: jpeck@maine.edu

Contact information to field questions from those reading this document (i.e. not necessarily the PD): John M. Peckenham (address above).

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

The Water research being conducted in Maine is topically and spatial diverse. There is a particular interest in the function of aquatic ecosystems and how those systems respond to climate change and human derived stress. Other interest areas include water quality (with respect to human health risks), lake management, invasive species, and endangered aquatic species.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

Future interests include: the response of water supply or availability to future climatic conditions, resilience or recovery of fisheries, methods to maintain or improve surface water ambient quality, understanding and controlling the undesirable effects of urbanization, and the systematics of biogeochemical cycles. The Mitchell Center is leading an new EPSCoR project (proposal in progress) to establish a Center for Sustainability Solutions that will focus on understanding three pressing drivers of landscape change- urbanization, forest ecosystem management, and climate change.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Yes, The University of Maine is working with the University of New Hampshire and Plymouth State College on long-term monitoring of lakes (acid rain). The University is working with the New England Water Quality Extension (all of New England) on a private water well initiative. Other regional collaborations involve interactions with entities such as the New England Interstate Water Pollution Control Commission, the Conference of New England Governors and Eastern Confederation of Premiers,and the Northeast States for Coordinated Air Use Management.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

See funding sources on attached list.

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

The State Science and Technology Plan has identified environmental and aquaculture sectors as important for the state's development. Specific funds are available to promote work in these sectors through two vehicles. Basic research funding is available on a competitive basis from the Maine Water Resources Research Institute. Technology development (e.g. SBIR) funding is available from the Maine Technology Institute on a competitive basis.

- Facilities in your state that are useful for water research (1/4 page)

The University of Maine System supports water research, and specifically the University of Maine (Orono) serves as the primary research university for the state. Additionally, specific research centers serve either distinct sectors (Aquaculture) or general areas (Mitchell Center, Water Resources Research Institute). Vibrant water research activities also occur at the states's private colleges (Bates, Bowdoin, Colby, College of the Atlantic, Unity, and University of New England).

Freshwater Research Projects in Maine					
Project Director	**University or organization**	**Funding Sources**	**$ Amount**	**Dates**	**Description**
Milligan, P.	The Univeristy of Maine, Augusta, Department of Biology	Applied for USGS, UMA Department of Biology	Pending; $70,000	2005-09	Arsenic in drinking water and the Oxidation states of Arsenic; Arsenic Filtration processes (Osmosis)
Buckley, D.	The University of Maine Farmington, Dept. of Environmental Studies and Biology	Davis Foundation	$5,000	2001-09	A long term heat dist monitoring study in regards to climate change.
Buckley, D.	The University of Maine Farmington, Dept. of Environmental Studies and Biology	Lake Association and DEP	$1000; $800	2001-09	Distribution of invasive species in Maine lakes
Dailey, J.	The University of Maine Farmington, Dept. of Environmental Studies and Biology	University of Maine Farmington Chair Endowment	$1,000	2007-09	Climate interaction in high elevation ponds.
Borges-Therien, K.	The University of Maine Farmington, Dept. of Environmental Studies and Biology	UMFK Trustee Professorship Award; MEIF Small Campus Initiative	$12,500; $26,000	2004-09	Microbial source tracking of fecal contamination in Perley Brook, Aroostook County
Borges-Therien, K.	The University of Maine Farmington, Dept. of Environmental Studies and Biology	John Sage Fund; EPSCoR Educational Outreach Award	$1,300; $1,000	2005-09	Long-term monitoring of phosphorus and dissolved oxygen levels in Cross Lake, Aroostook County

Otto, W.	The University Maine Machias, Environmental Sciences	State Funded	$1,000	2002-09	Monitoring Water Quality
Springers, S.	The University Maine Machias, Environmental Sciences	Project Share	$0	2007-09	Long term Atlantic salmon habitat monitoring project on Lanpher Brook regarding macroinvertabrate populations collaborated with Project Share
Springers, S.	University Maine Machias, Environmental Sciences	Quoddy Regional Land Trust	$0	2005-09	Long term Atlantic salmon habitat monitoring project on Beaver Dam Stream regarding macroinvertabrate populations collaborated with Quoddy Regional Land Trust.
Springers, S.	University Maine Machias, Environmental Sciences	Denny's River Watershed Council	$0	2001-09	Long term Atlantic salmon habitat monitoring project on Venture Brook regarding macroinvertabrate populations collaborated with Denny's River Watershed Council.
Chai, F.	The University of Maine, Orono, Marine Sciences	National Science Foundation	$156,640	2008-09	Effect of Varying Freshwater Inputs on Regional Ecosystems in the No. Atlantic
Connell, L.	The University of Maine, Orono, Marine Sciences	US Dept. of Commerce	$291,221	2008-09	Spread of a Sodium Channel Mutation in Softshell Clam, Mya arenaria, Yr 3
Coghlan, S.	The University of Maine, Orono, Wildlife Ecology	Nat'l Fish & Wildlife Foundation; Umaine	$100,000; $170,535	2008-09	Brook Trout Conservation in Headwaters Streams
Nohe, A.	The University of Maine, Orono, Chemical and Biological Engineering	US EPA	$135,421	2007-08	Nanoparticle Toxicity in Zebrafish

Smorodin, V.	The University of Maine, Orono, Chemical and Biological Engineering	US EPA	$131,438	2007-08	Nanoparticle Toxicity in Zebrafish
Ashworth, E	The University of Maine, Orono, Natural Sciences, Forestry and Agriculture	US Dept. of Agriculture; Umaine	$15, 070; $5,275	2007-08	New England Plant, Soil, & Water Lab 2008
Ashworth, E	The University of Maine, Orono, Natural Sciences, Forestry and Agriculture	US Dept. of Agriculture; UMaine	$36,630; $12,821	2007-08	New England Plant, Soil, & Water Lab 2008
Ashworth, E	The University of Maine, Orono, University of New Hampshire, Plymouth State College	US EPA	$75,000/an.	2006-09	Regional Long-Term Monitoring (Acid Rain)
Kim, C.	The University of Maine, Orono, Biochemstry, Microbiology, and Molecular Biology	US Dept. of Health and Human Svcs.	$222,750	2007-08	TLR Signaling Pathways in the Zebrafish
Belknap, C.; Kelley, J.	The University of Maine, Orono, Earth Sciences	US Dept. of Commerce; Umaine	$41,943; $29,368	2007-08	Are Maine Marshes Drowning? Determining Life-Cycles of Salt-Marsh Pannes. Yr 2
Belknap, C.; Kelley, J.	The University of Maine, Orono, Earth Sciences	US Dept. of Commerce; Umaine	$10,000; $6,279	2007-08	Eco-geomorphology of Maine Salt Pools
Norton, S.	The University of Maine, Orono, Earth Sciences	National Science Foundation	$26,530	2007-08	LTREB: Biogeochemical Mechanisms/Bear Brook Watershed Maine Yr. 2

Fernandez, I.	The University of Maine, Orono, Plant, Soil and Environmental Sciences	National Science Foundation	$61,904	2007-08	LTREB: Biogeochemical Mechanisms/Bear Brook Watershed Maine Yr. 2
Perkins, B.	The University of Maine, Orono, Food Sciences and Human Nutrition	US Dept of the Interior; Umaine	$730; $7,397	2007-08	Development of a Non-lethal Biomarker of Contaminant Exposure for Fish Species
Elskus, A.	The University of Maine, Orono, School of Biological and Ecological Sciences	US Dept of the Interior; Umaine	$4,866; $49,314	2007-08	Development of a Non-lethal Biomarker of Contaminant Exposure for Fish Species
Elskus, A.	The University of Maine, Orono, School of Biological and Ecological Sciences	National Science Foundation	$6,719	2007-08	RCN: Diadromous Species Research Restoration Network (DSRRN)
Kinnison, M.	The University of Maine, Orono, School of Biological and Ecological Sciences	US Dept. of Commerce; Umaine	$15,995; $48,312	2007-08	Distribution and Abundance of Shortnose Sturgeon in the Penobscot River, ME
Kinnison, M.	The University of Maine, Orono, School of Biological and Ecological Sciences	US Dept. of Commerce; Umaine	$14,000; $4,007	2007-08	Ecology/Life History of Atlantic Salmon in a Tributary of the Narraguagus River
Kinnison, M.	The University of Maine, Orono, School of Biological and Ecological Sciences	US Dept. of Commerce; Umaine	$51,373; $42,383	2007-08	Investigation into the Distribution and Abundance of Shortnose Sturgeon

Kinnison, M.; Simon, K.	The University of Maine, Orono, School of Biological and Ecological Sciences	US EPA; Umaine	$23,318; $4,550	2007-08	Lake Foodweb Responses to the Biomanipulation of East Pond
Kinnison, M.	The University of Maine, Orono, School of Biological and Ecological Sciences	National Science Foundation	$106,476	2007-08	Linking Genes to Ecosystems: How Do Ecological & Evolutionary Processes Int Yr 2
Simon, K.	The University of Maine, Orono, School of Biological and Ecological Sciences	US Dept of the Interior; Umaine	$4,900; $93,851	2007-08	Linked Lake-stream System to Dam Removal and Restoration of Mirratory Fish
Webster, K.	The University of Maine, Orono, School of Biological and Ecological Sciences	US EPA; Umaine	$7,773; $1,517	2007-08	Lake Foodweb Responses to the Biomanipulation of East Pond
Webster, K.	Umaine, Orono, School of Biological and Ecological Sciences	US EPA	$77,718	2007-08	Recovery of Surface Waters in Northeastern U.S. after the Clean Air Act
Coughlan, S.	The University of Maine, Orono, Wildlife Ecology	US EPA; Umaine	$3,000; $585	2007-08	Aquatic Invertebrate Abundance in Headwater Streams
Coughlan, S.	The University of Maine, Orono, Wildlife Ecology	US Dept. of the Interior; Umaine	$28,200; $6,826	2007-08	RWO54: Changes in Fish Community Structure & Function after Dam Removal
Zydlewski, J.	The University of Maine, Orono, Wildlife Ecology	US Dept. of the Interior; Umaine	$40,000; $11,652	2007-08	Investigations on Declining Populations of Whitefish in Maine Yr 3
Zydlewski, J.	The University of Maine, Orono, Wildlife Ecology	US Dept. of the Interior; Umaine	$28,200; $6,826	2007-08	RWO54: Changes in Fish Community Structure & Function after Dam Removal

Jemison, J.	The University of Maine, Orono, Cooperative Extension	US Dept. of Agriculture	$80,002	2007-08	New England Water Quality Program Yr. 6
Saros, J.	The University of Maine, Orono, Climate Change Institute	National Science Foundation	$17,391	2007-08	The Response of Lakes to Disturbance and Climate Change
Nelson, S.,. et al.	The University of Maine, Orono, Mitchell Center	US Dept of the Interior; Umaine		2007-08	Assessment of Natural and Watershed Conditions in and Adjacent to ANP +$
Hart, D., Vaux, P., et al.	The University of Maine, Orono, Mitchell Center	National Science Foundation	$53,752	2007-08	RCN: Diadromous Species Research Restoration Network (DSRRN)
Peckenham, J.	The University of Maine, Orono, Mitchell Center	US Dept of the Interior; Umaine	$11,812; $31,428	2007-08	2008 Maine Water Resources Research Institute Program - Mgmt
Putnam, D.	The University of Maine at Presque Isle, Dept. of Science and Math	UMPI	$4,500	2007	Brook remediation recommendations pertaining to Boork Tout in Alder Brook.
Putnam, D.	The University of Maine at Presque Isle, Dept. of Science and Math	UMPI Faculty Development;	$1,800	2003-09	Deboullie Ecological Reserve Rock Glacier Research
Lichter, J.	Bowdin College Dept. of Environmental Studies	Luce Foundation Grant; Merck/AAAS Undergraduate Science Research Grant; NSF, NE Wildflower Society	365000, $30,000, $4000	2003-09	Merrymeeting Bay/ Kennebec Estuary Research Program
Gastaldo, R.	Colby College, Dept. of Environmental Studies	NSF MRI 0115900	$99,760	2001-02	Eutrophication Study on Maine Lakes in the Belgrade area.

Green, M.	St. Josephs College, Dept. of Enviromental Sciences	US Fish and Wildlife Appropriations	$350,000 (Pending)	Pending	Best management practices regarding Variable Leas Milfoil
Morgan, P.	The University of New England; Dept. of Environmental Studies	US EPA	$73, 601	2007	A Comprehensive Wetland Program for Fringing Salt Marshes in the York River, Maine.
Morgan, P.	The University of New England; Dept. of Environmental Studies	UNE	Ukn.	2001-06	Monitoring the Impacts of a New Dock on a Fringing Salt Marsh on the Saco River, ME:
Morgan, P.	The University of New England; Dept. of Environmental Studies	ME DEP	$23,530	2005	Assessing the Health of the Fore River and its Tributaries.
Morgan, P.	The University of New England; Dept. of Environmental Studies	Maine Oil Spill Advisory Committee	$79,000	2005	Ecological Functions and Values of Fringing Salt Marshes Susceptible to Oil Spills in Casco Bay, Maine.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: **Mississippi**

Name of PD and, if appropriate, designee who filled in the template:
EPSCoR PD: Dr. Sandra Harpole
Template Designee: Dr. Teresa Gammill

Contact information to field questions from those reading this document (i.e. not necessarily the PD):
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Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Watershed Assessment and Education: The Coles Creek Watershed, located in the southwestern quadrant of the state of Mississippi, is listed under the US EPA impaired water section 303(d). Degradation of the ponds/lakes and streams/creeks in this watershed is caused mostly by biological impairment, followed by nutrients, organic enrichment or Low Dissolved Oxygen, sediment/siltation, pesticides, and pathogens (US EPA, 2007). These impairments cause the degradation of water quality thus causing euthrophication or algal bloom that can lead to fish kills and can also adversely affect human health. Community participation is much needed to improve, maintain, and restore the quality of water in this area. Thus, educational materials are necessary to engage the community in protecting the quality of water in this area. Results of this study will be beneficial to the community in that rural land owners with private ponds in the area will be able to adopt and implement best management practice(s) suitable for their environment. The results of the study will be documented in the form of bulletins or fact sheets that will be distributed to the public and community. Information will be tailored so that communities will be able to adopt and implement the identified best management practices in their own environment. Information will also be posted on the Mississippi River Research Center's website for accessibility and continuous support and assistance to the public.

Monitoring and Modeling Water Pollution in Mississippi Lakes: Many important recreational waters, such as lakes and coastal beaches, suffer from fecal pollution. Studies have shown that swimmers become ill or avoid these recreational waters as a result of pollution. This research takes steps towards understanding and preventing fecal pollution in a largely ignored type of recreational waterbody-- lakes. The approach to this type of research includes monitoring surface waters and then developing mathematical and statistical models to understand and predict pollution. The objective is to research the water and sediments of the Sardis Lake System (including Lower Lake and a tributary), in Mississippi, to understand and mathematically model fate and transport.

Southeastern Regional Small Public Water Systems Technical Assistance Center (SE-TAC)

The WRRI continues to recognize the need for assisting small public water systems in Mississippi and the southeastern United States to provide safe, clean drinking water to the public. The Southeastern Regional Small Public Water Systems Technical Assistance Center (SE-TAC) funded by the Environmental Protection Agency was established in 2000 and is administered by the Mississippi Water Resources Research Institute at Mississippi State University. SE-TAC works with state and regional agencies to assist small public water systems in acquiring and maintaining the technical, financial, and managerial capacity to provide safe drinking water and meet the Safe Drinking Water Act's public health protection goals. SE-TAC has adopted an applied approach to directly and meaningfully support small public water system issues in the southeastern United States. Throughout its existence, SE-TAC has provided nearly $2 million on over 40 projects that have directly assisted small drinking water systems across the southeast region of the United States. Hundreds of small water systems have received training and assistance with technical, financial and managerial issues through SE-TAC funded projects.

Aquatic Plant Management Support for the Pearl River Valley Water Supply District

This is an ongoing project conducted with MSU's GeoResources Institute to monitor and map the distribution of aquatic vegetation throughout the Ross Barnett Reservoir. The 'Rez', at 33,000 acres, is Mississippi's largest surface water impoundment and serves as the drinking water supply for Jackson, Mississippi. The Pearl River Valley Water Supply District (PRVWSD) manages the Ross Barnett Reservoir, its recreational amenities, and water and sewer

services for approximately 50 subdivisions surrounding the Reservoir. In recent years, invasive species have become an increasing problem in the Reservoir, clogging navigation channels, reducing recreational opportunities, and limiting access for users of the Reservoir. The PRVWSD requested the MWRRI's assistance in assessing the distribution of aquatic vegetation, monitoring the spread of invasive species, and evaluating ongoing treatment efforts throughout the Ross Barnett Reservoir. During the first plant survey in 2005, 19 plant species were observed. Alligator weed was the most frequently detected species in 2005, and the native plant American lotus was the most frequently detected species in both the 2006 and 2007 surveys. However, alligator weed was the most frequently detected exotic invasive plant species in both 2006 and 2007. Due to lack of rainfall, water levels have decreased in 2006 and 2007, limiting access to shallow water areas of the Reservoir and thus reducing the number of data points. We are exploring the use of remote sensing to examine areas that are currently inaccessible by boat and validate estimates of certain species such as alligator weed. This project is continuing to monitor the aquatic plant distribution in the Reservoir and assess any changes or spread of nuisance species populations, with particular focus on hydrilla, which was first detected in the Reservoir in 2005. Management efforts by the PRVWSD are continuing to control nuisance species and promote the growth of more desirable native species.

Grenada Lake Economic Development Project

The Grenada Chamber of Commerce contacted the MWRRI for assistance in promoting economic development around Grenada Lake, a U.S. Army Corps of Engineers lake. The operation of the lake began in 1954 to help control flooding in the Yazoo River Basin. The 90,000-acre multi-use project is managed through the Corps' Vicksburg District for flood control, public recreation, conservation of fish and wildlife, and public forests. Grenada Lake is also home to Hugh White State Park and a recently constructed 18-hole golf course. The Chamber sought help in working with the Corps to promote economic development based on the lake's numerous recreational opportunities and bountiful natural resources. The MWRRI led two public meetings to obtain feedback on amenities and opportunities Grenada's citizens would like to see around the lake. The MWRRI then teamed with MSU's Departments of Landscape Architecture and Finance and Economics to develop a preliminary master plan and conduct economic and marketing feasibility studies, respectively.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)
  Not at this time.

Funding sources for this research (not necessarily NSF EPSCoR) Please list:

Environmental Protection Agency, Office of Ground Water and Drinking Water

Grenada County Chamber of Commerce

Mississippi Department of Environmental Quality

Mississippi Engineering Group

National Oceanic and Atmospheric Administration, Coastal Services Center

Pearl River Valley Water Supply District

Pickering Incorporated

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

  No, the S&T Plan is very outdated.

- Facilities in your state that are useful for water research (1/4 page)

The **Mississippi Water Resources Research Institute** provides a statewide center of expertise in water and associated land-use and serves as a repository of knowledge for use in education, research, planning, and community service.

The Mississippi **Department of Environmental Quality, Office of Land and Water Resources (OLWR)** is charged with conserving, managing, and protecting the water resources of Mississippi. The agency regulates water quantity issues affecting the beneficial use of these resources in the best interest and welfare of the citizens of the state.

GeoResources Institute at Mississippi State University conducts and coordinates research and educational activities in resource management within our environment - particularly in areas relating to agriculture, forestry, water resources, meteorology and oceanography.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Nevada EPSCoR

Name of PD and, if appropriate, designee who filled in the template:
Gayle Dana (filled in with assistance of Laurel Saito (UNR), Tom Piechota (UNLV), and Michael Young (DRI))

Contact information to field questions from those reading this document (i.e. not necessarily the PD): Gayle Dana, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512; 775-674-7538; email: gayle.dana@dri.edu.

Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Water resources research at the University of Nevada Las Vegas (UNLV) include analysis of groundwater and contaminant transport, surface water hydrologic analysis, evaluation of surface and subsurface hydrologic processes, water systems analysis, evaluation of past droughts, international water policy, and water quality for natural and manmade systems. Specific initiatives relevant to the State include the quantification of evapotranspiration rates, analysis of water conservation measures, urban flood forecasting, nonpoint source runoff, and water impacts due to quagga mussels.

Research themes at the Desert Research Institute (DRI) related to climate change include regional groundwater hydrology; watershed hydrology in both surface and subsurface pathways; aquatic biology and chemistry; environmental processes within snow and ice; the causes, mechanisms, and history of landscape change over a range of spatial and temporal scales; and, regional-scale atmospheric modeling of precipitation patterns, especially in mountainous areas like the Sierra Nevada Mountains.

The University of Nevada, Reno (UNR) has faculty working in the following water resources related research: detection of pathogenic Leptospira spirochetes in water; evaluation of metals mobilization following shock chlorination of private wells; arsenic speciation along an unconfined groundwater flow path; survival of fecal contamination indicator organisms associated with water potential and environmental stresses; investigation of potential spill dynamics in the Truckee River; investigation of the best means by which to get additional water to Walker Lake while maintaining the Basin's economy and ecosystem (collaboration with DRI); determination of episode duration, magnitude, and peak in long paleo records.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

  UNLV: Adaptive management of surface and ground water systems; use of remote sensing of soil moisture and use in forecasting water supplies; urban stormwater control; sustainable water infrastructure; water conservation and water treatment technology.

  DRI: Improved use of distributed sensor networks, including QA/QC automation and databasing of information for decision making; isotopic analyses for identifying source water in groundwater/surface water environments, and soil/water/plant systems; impact of climate change on recharge/discharge relationships in the Great Basin and Mojave Deserts, and on the overall water resources in the State of Nevada; examination of high elevation precipitation patterns; influence of limnological and environmental processes on surface water quality and ecosystems.

  UNR: Nonpoint sources and microbial contamination; application of sensor networks to determine changes in gradients (temperature, precipitation, vegetation) associated with orographically controlled weather within the context of global climate change

  Statewide: Should our RII proposal get funded (still pending), we will be pursuing research on the influence of climate change on water resources. A primary research question of our proposal is: How will climate change affect water resources and linked ecosystem services and human systems?

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

  UNLV: We will be submitting a joint proposal with Arizona State University to NOAA on use of system dynamics models for water decision making.

  DRI: Two DRI faculty are currently involved in the SAHRA program, a NSF Science and Technology Center based at University of Arizona. DRI faculty are likely to be involved in the Biosphere2 project as it modifies its mission to include hillslope hydrology. Ongoing water resources related research involving eastern Nevada will involve collaboration with the State of Utah and their scientists.

  UNR: We tried to become part of the WATERS network, which would involve working with researchers from UC Merced.

  Statewide: As part of our RII proposal we plan to have three tri state conferences (NV, NM, ID) on climate change. A dominant theme in all three states is the influence of climate change on water resources.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

  UNLV: NOAA, NASA, EPA

  DRI: NSF; local stakeholders

  UNR: USDA-CSREES; USEPA; NSF

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

Water Resources and Policy is a priority research area in Nevada's Science and Technology Plan with primary goals of:

- Facilitating the education of scientists and engineers in Nevada who understand water-related challenges in our arid State.
- Creating a clearinghouse of information for school districts and UG students interested in educational opportunities in water/water-policy related disciplines.
- Widening the number of water and water-policy related courses in NV and to increase access to those courses through technology (AGN, WebX, etc.).
- Creating broader opportunities for HS and community college science instructors to train-up on water-related issues.

Our pending RII proposal has many elements that will address some of these goals. Ongoing, specially funded water initiatives in the state of Nevada that address these goals include:

DRI: Though DRI does not have an explicit educational mission (which is left to UNR and UNLV), many DRI faculty are involved in curriculum development, teach UG/G level courses and advise students. Both campuses have AGN technology and other video conferencing resources. Their involvement in the Graduate Program for Hydrologic Sciences (at UNR) and the Water Resources Management Program (at UNLV) is substantial and facilitates the training of (mostly) graduate students in water resources-related topics.

UNR: Walker River project

- Facilities in your state that are useful for water research (1/4 page)

  UNLV has faculty in the Colleges of Science, Engineering, Urban Affairs, the Division of Health Sciences working in water resource issues for Nevada, National Supercomputer Center for Energy and the Environment, Urban

Sustainability Initiative, Southern Nevada Water Authority Research and Technology Center.

DRI has faculty and researchers in three Divisions (Hydrologic Sciences, Earth and Ecosystem Sciences and Atmospheric Sciences) working in water resources issues. The Institute has a wide range of facilities that are currently being used for examining water resources inside and outside of Nevada, including: state-of-the-art analytical and ultra-trace chemistry laboratories, organic and environmental analysis laboratories for trace elements in air samples, large weighing lysimeters for examining soil/water/plant processes in arid settings, fully enclosed and controlled ecological chambers, a high-elevation laboratory in Colorado for in-cloud measurements of water and chemistry, to name a few facilities. In addition, DRI houses the Western Regional Climate Center, which in addition to their responsibilities to NOAA, works with faculty state-wide on database and web interfacing aspects of cyberinfrastructure. Several projects centered at DRI currently push data from sensor networks in near-real time, to archival and communications resources that post data to the Internet and that actively contact researchers regarding changes/problems to the sensor network.

UNR has faculty working in the Colleges of Science, Engineering, Liberal Arts, Health Sciences, and Agriculture, Biotechnology and Natural Resources that are involved with water issues in Nevada. In addition, the UNR's Cooperative Extension office works with many water issues throughout the state. Aside from disciplinary graduate degrees, UNR also offers interdisciplinary graduate degrees in Hydrology, Hydrogeology, Environmental Science, and Ecology, Evolution, and Conservation Biology that all deal with water-related issues. UNR has several field stations where water-related research is undertaken, including Sagehen Creek, Jay Dow Wetlands, and Main Station Farm.

Additional facilities in Nevada that are useful for water research include several SNOTEL observation sites, USGS surface water stations, and the Western Regional Climate Center.

THE POWER OF PARTNERSHIPS

NSF EPSCoR
Description of Research on Water
Jurisdiction: New Hampshire

Contact Information

Name: **William H. McDowell** Title: **Professor, and Director of NH Water Resources Research Center**

Address: **38 Academic Way** **Spaulding 238**
Street Address *Bldg./Rm.*

Durham **NH** **03824**
City *State* *ZIP Code*

Phone: **(603) 862-2249** Cell Phone: **(603) 781-3561**

Email: **bill.mcdowell@unh.edu**

College or University: **UNH Durham**

Questions

Please describe research on Water that is on-going in New Hampshire (< 1 page):

see attached

Areas (water related) in New Hampshire that you may be interested in moving toward or enhancing at this time – future directions (1/2 page):

see attached

Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Partnering with the Ipswich River project in NE Massachusetts; with the Maine Saco River Watershed Association on water quality in Saco River headwaters.

Funding sources for this research (not necessarily NSF EPSCoR). Please list:

USGS, EPA, NOAA, and local watershed groups.

Facilities in New Hampshire that are useful for water research (1/4 page):

see attached

SUBMISSION:
Please email this completed document to nh.epscor@unh.edu by August 29, 2008.

1. Current: Long-term research on controls on water quality in the Lamprey, Ossipee, and Oyster River drainage basins. In the Lamprey River, a detailed hydrologic and biogeochemical assessment of long-term water quality trends, drivers of these trands, and implications for management are underway in my lab group. This includes sampling along the main stem and tributaries monthly, weekly sampling of the main stem near the mouth, and event-based sampling of nutrient inputs to the basin in rain. Full chemistry (nutrients, organic matter, cations, anions, and sediments) on the main stem, all of these parameters less sediments and DIC on monthly samples.
2. Future Directions: Assessment of long-term increases in nitrogen inputs, and their possible negative impacts on Great Bay estruary. Studies of the effects of urbanization and suburbanization on stream ecosystem function (productivity, community composition, leaf decomposition) and understanding the ultimate causes of these ecosystem-level effects. All of these issues would be greatly facilitated by better availability of sensors and automated data management for the sensors. Sensors for nitrate, organic matter, and specific conductance are most need, with only specific conductance readily available commercially.
3. Facilities: **Lamprey River Hydrologic Observatory,** site of coordinated research on hydrology and biogeochemistry by faculty in Natural Resources and the Environment, Earth Sciences, and Civil Engineering. Long-term sampling of precipitation chemistry, three stream gauging sites, and water quality sampling. **Water Quality Analysis Laboratory,** with state-of-the-art instrumentation for ion chromatograpy (Dionex), robotic nutrient analysis (Wesco Smartchem), high-temperature combustion for DOC and DON (Shimadzu), elemental analysis for particulate C and N (Perkin-Elmer), and HPLC for optical properties and amino acids in water (Shimadzu). Services provided to on- and off-campus clients.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: New Mexico

Name of PD and, if appropriate, designee who filled in the template:

NM-EPSCoR Director: William K. Michener, PhD
Director, New Mexico EPSCoR State Program
Associate Director, LTER Network Office
NM EPSCoR, MSC05 3180
1717 Roma, NE
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Template completed by: Robert S. Bowman
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http://www.ees.nmt.edu/bowman/

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

William Michener or Robert Bowman

- Please describe research on Water that is on-going in the jurisdiction:

SAHRA Thrust Area 2: Basin-Scale Water and Solutes Balances (http://www.sahra.arizona.edu/research/TA2/index.html) - dynamics of water and solutes balances in semiaridregions at different spatial and temporal scales.

New Mexico Water Resources Research Institute (http://wrri.nmsu.edu/research/seedmoneygrants.html - various water-related projects within the state.

New Mexico Bureau of Geology and Mineral Resources Aquifer Mapping Project (http://geoinfo.nmt.edu/geoscience/projects/aquifers.html) – high resolution mapping to identify ground-water aquifers, locate water supply wells, and site potential polluting operations away from aquifers.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions

Large-scale climatic influences on the Southwest: Understanding the hydrologic response to climate change requires the characterization of large scale climatic variability—observed and projected—and its relationship to regional climate variability affecting mountainous regions in southwestern North America.

Linking climate to hydrologic variability: Meaningful quantification of streamflow projections is needed by policymakers. Hydrologic information is derived from observations and simulation of climate variability and change. We propose transdisciplinary and potentially transformative efforts to understand and simulate physical processes that couple large-scale climate fluctuations with watershed-scale hydrology.

Coupled Climate—Hydrological Models: The local expression of large-scale climate change exerts a primary control on the hydrologic response of basins. In mountainous regions like NM, orographic precipitation is one of the main local modulators of global climate change.

Climate change effects on water quality and solute fluxes: Water quality and solute fluxes are critical components of water supply and the economic and

social impacts of climate-induced changes. Snowmelt mobilizes and transports dissolved solutes such as dissolved organic carbon (DOC), nitrate, phosphate, and iron that are determinants of ecosystem function and the ultimate suitability of water for human use.

Evaluation of socioeconomic impacts of water management strategies. Improving the design and facilitating the transfer of information between hydrologic models (e.g., tRIBS, SRM, SLURP) and socio-economic models to enhance water management, allocation, and use policy development.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

SAHRA Thrust Area 2 - http://www.sahra.arizona.edu/research/TA2/index.html)

New Mexico Office of the State Engineer/Interstate Stream Commission - http://www.ose.state.nm.us/index.html

Bureau of Reclamation Upper Colorado Region - http://www.usbr.gov/uc/

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

Funding sources include the NSF, USGS, the New Mexico Interstate Stream Commission, the New Mexico Office of the State Engineer, the U. S. Bureau of Reclamation and other agencies.

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan?

A priority area identified in the NM S&T plan is Energy, Environment, Water - renewable energy sources, socio-economic research, impact of global climate change on NM, clean water, remote sensing, modeling of biosystems, impact of forest thinning, atmospheric modeling, soil, air, ands water remediation, groundwater issues, hydrology, sensors, modeling, watershed sustainability, conservation, water quality, desalination, use of

brackish water, use of oil and gas field water.

An initiative relevant to the S&T plan established a Water Innovation Fund that follows Governor Richardson's focus on State water reform legislation, which named 2007 as the "Year of Water."

- Facilities in your state that are useful for water research (1/4 page)

NM EPSCoR Fluxnet - http://epscorhydro.unm.edu/
EDAC Data Archive - http://edac.unm.edu/clearinghouse.htm/
University of New Mexico Rio-ET Lab - http://bosque.unm.edu/~cleverly/
Middle Rio Grande Flux Network - http://bosque.unm.edu/~cleverly/MRG.html
New Mexico Upland flux Network - http://biology.unm.edu/Litvak/Upland.html)
Valles Caldera Experimental Observatory - http://www.sahra.arizona.edu/valles/
LANL Weather Network - http://www.weather.lanl.gov/
Sevilleta LTER Network - http://sev.lternet.edu/
NMSU Agriculture Experiment Station - http://cahe.nmsu.edu/aes/
Brackish Groundwater National Desalination research Facility - http://www.usbr.gov/pmts/water/research/tularosa.html
INRAM - http://nmbiodiversity.org/

Description of Water Research in North Dakota
September 27, 2008

Jurisdiction: North Dakota

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

G. Padmanabhan, Ph.D., Director, North Dakota Water Resources Research Institute, North Dakota State University (701 231 7043), G.Padmanabhan@ndsu.edu

- Please describe research on Water that is on-going in the jurisdiction: (short, bulleted items)

  - Agricultural run-off and concentrated animal feeding operations (nutrients and trace elements)
  - Characterizing tile drainage quantity and quality
  - Effectiveness of local water institutions for water management
  - Pathogens in water
  - Nanotechnology applications to water and wastewater treatment
  - Nanotechnology applications to groundwater treatment and remediation
  - Entrapped Cell Permeable reactive biobarriers for in situ remediation
  - Chemical fingerprinting of stream sediments and water
  - Plant species composition in wetlands
  - Detection, fate and transport of estrogens in subsurface waters
  - Transfer of mercury from benthic macroinvertebrates into game fish
  - Estimation of natural organic matter in drinking water source waters
  - In situ denitrification and glyphosate transformation in groundwater

- Total Maximum Daily Load development for watersheds
- Urban storm water runoff
- Discharge measurements with acoustic Doppler technologies
- Flood and drought modeling

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions

  - Energy-water nexus
  - Climate change impact on water resources
  - Water availability
  - Hydrologic cycle: e.g., wetland contaminants transport, nutrient inputs
  - Nanotechnology applications
  - Sensor development
  - Oilfield wastewater disposal

- Joint projects or plans with other jurisdictions or neighboring states?

  - None

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

  - MN Department of Natural Resources
  - ND State Water Commission
  - ND State Department of Health
  - Natural Resources Conservation Service
  - NSF EPSCoR
  - USDA
  - US EPA
  - US Fish & Wildlife Service
  - USGS

Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan?

- No

- Facilities in your state that are useful for water research (1/4 page)

  - Bio imaging and Sensing Center NDSU
  - Center for Nanoscale Science and Engineering, NDSU
  - Center for High Performance Computing NDSU & UND
  - Center for Natural Resource and Agroecosystem Studies NDSU
  - Electron Microscopy Center NDSU
  - Environmental Analysis Research Lab UND
  - Environmental Engineering Lab, NDSU
  - Geographical Analysis and Remote Sensing Lab UND
  - Energy and Environmental Research Center UND
  - ND Department of Health Water Quality lab
  - Biosciences Research Laboratory, NDSU
  - U.S. Geological Survey Water Science Center
  - U.S. Geological Survey Northern Prairie Wildlife Research Center

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Puerto Rico

Name of PD and, if appropriate, designee who filled in the template:
Brad Weiner/Rafael Rios

Contact information to field questions from those reading this document (i.e. not necessarily the PD): Rafael Rios/787-764-0000 x 4718, rafaelrios00936@yahoo.com

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Most of the on-going research in PR is of the applied nature. Work is on-going in the following areas:

1. Natural-Human Systems in the Urbanizing Tropics
2. Long-Term Ecological Research
3. Onsite Wastewater Disposal Systems Outreach and Demonstration
4. Comprehensive Approach for Flood Hazard Mitigation
5. Removal of Inorganic, Organic and Antimicrobials Contaminants from Aqueous Solutions by Waste Tire Crumb Rubber
6. Wetland evaluations and dynamics
7. Water treatment systems for small communities
8. Study of stream metabolism, carbon biogeochemistry, dissolved oxygen dynamics, hydrology, and water quality of inland waters in the tropics
9. Ecology of aquatic insects and the role they play in ecosystems and their productivity
10. Resilience thinking for the sustainable management of watersheds: The use of a spatially explicit framework for understanding responses to perturbations

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

1. Studies of the water cycle in tropical areas using modeling and satellite remote sensing

2. Forecasting resilience in tropical watersheds
3. Socio-Ecological Models and Ecological Informatics
4. Water and Wastewater treatment processes

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)
  Yes, with the US Virgin Islands

- Funding sources for this research (not necessarily NSF EPSCoR)
  Please list:
  The Puerto Rico Water Resources and Environmental Research Institute

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)
  None

- Facilities in your state that are useful for water research (1/4 page)

1. The Institute for Tropical Ecosystem Studies
2. The Luquillo Experimental Forest
3. Jobos Bay National Estuarine Reserve
4. Laboratories and water and wastewater treatment facilities of the Puerto Rico Aqueducts and Sewers Authority
5. The Puerto Rico Water Resources and Environmental Research Institute

Description of Research on Water in Rhode Island NSF EPSCoR Jurisdiction

Jurisdiction: State of Rhode Island

Name of PD:

Dr. Jeffrey R. Seemann, Dean
College of Environment and Life Sciences
University of Rhode Island
Woodward Hall
Kingston, RI 02881

Designee who filled in this template:

Dr. Arthur J. Gold, Professor
Department of Natural Resources Science
University of Rhode Island
110 Coastal Institute
Kingston, RI 02881

Contact information for this document:

Dr. Arthur J. Gold, Professor
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401-87402903

Research on water in jurisdiction

- Water Quality: Fate and transport of nutrients in coastal watersheds; managing denitrification in human dominated ecosystems
- Climate change and estuarine biota
- Instream flows: aquifer withdrawals and biological integrity
- Induced aquifer recharge: implications for groundwater quality.
- Use of geospatial data for modeling and targeting hydrologic and water quality behavior in watersheds.
- Estuarine primary productivity and hypoxia
- Aquaculture and pathogens
- Communicating water quality data to local decision makers through geospatial data and volunteer monitoring data

Areas that Rhode Island is interested in moving towards or enhancing – future directions

- Watershed dynamics –understanding hot spots and hot moments in the watershed hydrology (scale issues)
- Communicating geospatial and monitoring data to the public and private section to improve decision making
- Pathogen tracking
- Climate change and estuarine biota – implications for ecosystem services

Joint Projects or Plans with other jurisdictions or neighboring states?

- URI directs and hosts the multi-state Northeast States and Caribbean Islands Integrated Water Program that is funded by USDA CSREES. This is a $4.3 million, 4 year program (2008-20011). Includes the following EPSCoR Jurisdictions: Maine; Vermont, New Hampshire; Puerto Rico and Virgin Islands.
- URI will host the 2009 NSF Denitrification Research Coordination Network Conference on Managing Denitrification in Human Dominated Landscapes.

Funding Sources for Research:

- CSREES-USDA
- EPA
- Dept of Interior
- NOAA-SeaGrant
- NSF

Are water initiatives or problems regarding water specifically part of the RI State Science and Technology Plan?

- Marine Life Sciences is included in the plan

Facilities in Rhode Island useful for water research

- URI Watershed Hydrology Lab (watershed biogeochemistry)
- Environmental Data Center (Geospatial Research)
- URI Watershed Watch Lab (Volunteer Monitoring Center)
- Marine Life Research Facility and Research Aquarium

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction:
South Dakota
Name of person who filled in the template:
David Clay

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Research is being conducted to develop management practices and genetic improvements that will increase water use efficiency.

Research is being conducted to develop techniques to increase the adoption of best management practices in production fields.

Research is being conducted to determine the impact of management practices on water quality

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

Increasing agricultural intensification in the state will have impacts on both water supply and quality. Techniques to increase agriculture productivity need to be developed that will not have negative impacts on water quality

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

We would like to conduct collaborative projects, however at this time funding for such projects is very limited.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

SD 2010 initiative
EPA319
USDA-CSREES

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

The State Drought Center has received funding through SD 2010 initiative

- Facilities in your state that are useful for water research (1/4 page)

There are several core laboratories facilities that can assist on molecular and water samples. We rely on our own laboratory resouces.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction:
South Dakota
Name of person who filled in the template:
Todd P Trooien, Agricultural and Biosystems Engineering, South Dakota State University, Brookings, SD 57007

Contact information to field questions from those reading this document (i.e. not necessarily the PD):
Trooien
Or
Jennifer Pickard, Water Resources Institute, Box 2120, South Dakota State University, Brookings, SD 57007

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

1. Quantification of the performance of vegetated treatment systems (VTS's) for handling runoff from beef feedlots. VTS's are hoped to be an alternative to a holding basin for CAFO's. We are measuring the hydrologic, nutrient, vegetative, soil, and economic performance of VTS's at 5 sites across SD and one in MN. Testing is also taking place in neighboring states of IA, NE, and IL as part of a multi-state project.
2. Reducing the water application to lawns by scheduling irrigations based on evapotranspiration (ET) rather than based on time (e.g. irrigate every Monday, Wednesday, and Friday). The new generation of landscape irrigation controllers now allows us to control irrigations based on ET. We will be auditing the irrigation systems then installing ET-based controllers in cooperating homeowner lawns. Water use information provided by the city water utility will be used to evaluate the water use by irrigation systems (ET-based or time-based) and calculate water savings (if any) due to use of ET-based controllers.
3. Automation of center pivot irrigation using monitoring and control hardware and simulation software to optimize crop yield.
4. Soil water response to different biomass crops (corn harvested for biomass, switchgrass, or prairie cordgrass) and different landscape

positions. Monitoring is weekly or biweekly with neutron probe and continuous with installed capacitance sensors and data loggers.

5. Monitoring the hydraulic gradients into spring-fed Oak Lake.
6. Development of a decision support system for water resources management of shallow glacial alluvial aquifers: a laboratory proof of concept study with the goal of constructing the laboratory apparatus and acquire data for various flow and stream bed conditions to verify the existing GIS model.
7. Simulating the soil erosion from land removed from CRP to determine how a land-use change could have large effects of the quality of the state's waters.
8. Determining soil moisture and temperature condition effects on potential run-off for applying manure to frozen soil.
9. Microbial indices of soils and water associated with vegetated treatment areas (VTAs) from five animal feeding operations (AFOs) in South Dakota will be measured by sampling inflows and outflows from vegetated areas. Data from these samples will allow calculation of water and salt balances, loss or gain of nutrients, removal of sediment, and fecal coliform numbers. Data will be compared to measured VTA performance.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

We will continue our current emphases for the foreseeable future.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Currently cooperating with MN, IA, NE, IL in the VTS research.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

Currently: EPA Section 319 (via SD DENR), USDA CIG, USDA NRI Extension grant, USGS WRI 104b, US Bureau of Reclamation, SD Ag Experiment Station

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

Not to our knowledge

- Facilities in your state that are useful for water research (1/4 page)

Much of our research is field-based and takes place in cooperator fields. We have the instrumentation (neutron probes, tensiometers, Isco samplers, etc.) for field-based water monitoring. The Olson Biochemistry lab on the SDSU campus does routine general water quality analyses. Other, smaller, labs across campus perform targeted water quality analyses. Oak Lake Field Station is an outdoor lab with interesting hydrology.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction:
South Dakota
Name of person who filled in the template:
Tom E Schumacher

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

  Examining soil – water interactions with topography, plant species, and management practices

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

  Ecological impacts of future bioenergy industry on water resources.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

  US Department of Energy
  US Department of Agriculture – NRCS
  NASA - EPSCOR

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

- Facilities in your state that are useful for water research (1/4 page)
-

  Soil Physics Laboratory with equipment to measure water infiltration, soil water storage capacity and retention, soil pore size distribution, and soil structure related to soil water storage and run-off.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Vermont

Name of PD and, if appropriate, designee who filled in the template:

Judith VanHouten, PD
Beverley Wemple, Associate Professor, Geography, UVM
Mary Watzin, Professor, RSENR, UVM

Contact information to field questions from those reading this document (i.e. not necessarily the PD):

Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Vermont has an active research program in water-resources research. Information on a number of recently completed and on-going projects is available through our EPSCoR-supported Integrated Research on Water and the Environment (iRWE) web site, located at http://www.uvm.edu/~irwe/ (see link to "Projects").

Our USGS-supported Water Resources and Lake Studies Center supports water resources research on major issues of concern to the state, by disseminating and distributing information on water resources throughout Vermont, and by helping to educate students about the various aspects of water resources. Recently funded projects through this initiative are described at http://www.uvm.edu/envnr/vtwater/?Page=projects.html .

UVM is also the home of the Lake Champlain Sea Grant program. This funding also supports research on water resources issues of major management concern. Sea Grant also supports an active program of outreach to take research results to the broader management and stakeholder community. Recently funded research projects, as well as other activities, are described at http://www.uvm.edu/~seagrant/

Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

Despite huge investments in improving water quality in Lake Champlain, water quality goals have not yet been met. One of the highest priority research needs in Vermont is to develop a quantitative understanding of phosphorus dynamics in the waters and be able to

use that understanding selcting those management strategies most likely to result in improvements in water quality. The manifestation of too much phosphorus is toxic cyanobacteria blooms in Lake Champlain. Another priority is to develop a predictive understanding of the multiple cause and complex behavior of bloom dynamics.

A high priority for state water resource managers in managing the impacts of stormwater runoff in an increasing urbanized watershed. The state is in the process of revising its approach to stormwater regulation, and is actively seeking additional information on hydrologic responses of streams to development, and the links between hydrologic change, geomorphic changes in stream channels, water quality, and biodiversity. Vermont is one of the few states whose water quality criteria are biocriteria, so information about linkages between pollution and biodiversity are critical to predicting responses to regulatory approaches based on controlling hydrology.

Finally, the Governor of Vermont and the President of the Unveristy of Vermont recently signed the "Vermont Climate Collaborative." The State is striving to be a leader in developing innovative solutions to climate challenges. These may include innovative approaches to biofuels development, carbon accounting, and a variety of greem business inititiaves, many of which involve and have implications for water resources.

Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

There are strong collaborations in place between Vermont and New York and Vermont and the province of Quebec, Canada. The collaborations address a number of priority research areas, including understanding watershed process and sediment and pollutant transport to Lake Champlain, transport vectors for invasive species in the broader Hudson River- Lake Champlain – St. Lawrance – Great Lakes linked ecosystem, and understanding toxic cyanobacteria blooms and a variety of biodiversity questions in the Lake Champlain ecosystem.

Currently, there is a special interest in developing stronger collaborations with Quebec to improve the science associated with nonpoint source pollution management and control. Scientists from UVM, McGill Universities, and other institutions are interested in developing approaches to critical source area identification in watersheds, understanding how climate change may alter nutrient loading to Lake Champlain, and in developing innovative approaches to managing nonpoint source pollution in agricultural and mixed use watersheds.

Funding sources for this research (not necessarily NSF EPSCoR) Please list:

U.S. Geological Survey, through the State Water Resources Research Institute (WRRI) Program, provides funding in annual cycles to water-resources research in Vermont.

Individually lead projects are funded competitively through federal, state and private foundation sources. Funding sources for Vermont projects include, but are not limited to:

- National Science Foundation
- Environmental Protection Agency
- Lake Champlain Basin Program
- Lake Champlain Sea Grant
- The Northeastern States Research Consortium
- USDA CREES and NRI
- National Oceanic and Atmospheric Administration
- The Lintilhac Foundation of Vermont

For examples of Vermont water-resources research projects and their funding sources, visit http://www.uvm.edu/~irwe/?Page=projects/index.html.

Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

Facilities in your state that are useful for water research (1/4 page)

- The Rubenstein Ecosystem Science Laboratory is an extension of the Aiken Center and Rubenstein School of the Environment and Natural Resources at The University of Vermont (UVM) located at the Leahy Center for Lake Champlain on the Burlington waterfront. The laboratory houses state-of-the-art research and teaching facilities for the Aquatic Ecology and Watershed Science program, including laboratories for the study of water and sediment quality, contaminants, and aquatic biota including fish, invertebrates and algae. The laboratory provides researchers with the tools necessary to investigate and understand the ecosystem processes that determine ecological health and influence the quality of life for the human community in the Lake Champlain basin. The UVM research vessel Melosira[2] is docked adjacent to the facility, providing access for research and teaching on Lake Champlain. For more information visit http://www.uvm.edu/~envnr/?Page=rubenstein/default.html

- The Microbial Geochemistry Lab, housed in the department of Geology at the University of Vermont, is supported in part by the Vermont EPSCoR program. Rsearchers utilize a number of instruments and techniques to characterize both the geochemistry and microbial community in a range of aqueous environments. For

more information visit
http://www.uvm.edu/%7Egdrusche/Druschel%20Lab%20Facilities.html

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: West Virginia

Name of PD and, if appropriate, designee who filled in the template: PD – Dr. Paul L. Hill, Vice Chancellor for Science and Research, WV Higher Education Policy Commission; Dr. Chuck Somerville (designee), Head of the Division of Biological Sciences at Marshall University, Huntington, WV

Contact information to field questions from those reading this document (i.e. not necessarily the PD): contact information for Dr. Chuck Somerville; somervil@marshall.edu, 304-696-2424, One John Marshall Drive, Huntington, WV

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page). There are several faculty members at Marshall University, West Virginia University, and West Virginia State University who are working on issues related to water resources. I can offer some detail about those here at Marshall, and broader information about the activities at WVU and WVSU. Marshall faculty members in Biological Sciences (C. Somerville) and Integrated Science and Technology (T. Jones) have a long-standing collaboration with faculty members at Northern Kentucky University (M. Kannan, R. Evans), Thomas More College (J. Hageman) and the University of Cincinnati (M. Miller) to study biotic and abiotic conditions in the Ohio River and major tributaries. Data (except for fish, mussel and crayfish distributions which are collected at randomly selected locations) are collected every five miles within the mainstem of the river (981 miles long) and above the debris line at all major tributaries. Data include fecal indicator bacteria, total cultivable bacteria, antibiotic resistant bacteria, algae, fish, native mussels, invasive mussels, native crayfish, invasive crayfish, chlorophyll, and dissolved and particulate nitrogen and phosphorous. We also log temperature and pH data continuously during sampling trips. Other MU projects include studying the release dynamics of combined sewer systems, assessment of habitat improvement structures in navigable rivers, distribution of toxin producing *E. coli* in the Kanawha River, association of heavy metal

concentrations with antibiotic resistant bacteria, and the presence of antibiotic resistant bacteria in drinking water. WVU has a Water Research Institute (WRI) which is associated with the National Research Center for Coal and Energy in Morgantown, WV. Research priorities at the WRI include acid mine drainage, nutrient reduction and control, mercury contamination, valley fills, flooding, and aquatic ecosystem integrity. WVSU is working to help mitigate nutrient inputs in agricultural areas of the state. WVSU researchers are working with anaerobic composting processes to produce environmentally sound soil additives from feedlot wastes.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page). WV is moving toward a focus on mitigation of existing problems as well as technologies that will help avoid further deterioration of statewide water resources. For example, researchers at WVU are studying ground-water recharge, storm water applications, and alternative uses for mine water discharge. Researchers at Marshall University are partnering with industry to work on carbon sequestration, biological removal of nitrogen and phosphorous from wastewater treatment plant outfalls, reduction of acidity in mine water discharge, and soil improvement at surface mine sites. WVSU faculty members, as mentioned above, are working on the remediation of agricultural wastes and the production of safe soil additives.
- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit) In addition to the collaboration mentioned under on-going research, MU is working with partner institutions in Pennsylvania (Carnegie Mellon University), Ohio (Ohio State University, University of Cincinnati), and Kentucky (Thomas More College, Northern Kentucky University) to propose an NSF Science and Technology Center focused on studying and modeling complex biotic and abiotic processes in the Ohio River at multiple spatial and temporal scales.
- Funding sources for this research (not necessarily NSF EPSCoR) Please list: NSF-EPSCoR has, in part, supported some of the ongoing projects. Other funding has come from the WV Space Grant Consortium, the DoD-EPSCoR program, the State of West Virginia, private industry and individual donations.

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit) West Virginia has identified environmental research as a target area for research and development emphasis in the West Virginia Vision 2015 document.

- Facilities in your state that are useful for water research (1/4 page). There are 20 four-year colleges and universities in West Virginia, and all are located on or near rivers. WVU is located on the Monongahela River in a coal-rich region of the state. WVSU is located on the Kanawha River near several chemical manufacturing sites. Both the Monongahela and Kanawha Rivers are major tributaries of the Ohio River, which is adjacent to the Marshall campus. WVU, WVSU and MU all have infrastructure for the study of water resources, as do many of the other colleges and universities in the state. All but one of those institutions lies within the Ohio River drainage basin. Perhaps our best "facility" is our potential to establish a web of collaborators that can study this large watershed from headwater streams through navigable rivers.

Template for Description of Research on Water in your NSF EPSCoR Jurisdiction

Jurisdiction: Wyoming

Name of PD and, if appropriate, designee who filled in the template:
PD: Randy Lewis.
Template completed by Barbara L. Kissack, PA, Wyoming, 307-766-2033, bkissack@uwyo.edu.

Contact information to field questions from those reading this document (i.e. not necessarily the PD): Greg Kerr, Director - Office of Water Programs, University of Wyoming, Dept. of Civil and Architectural Engineering, Ph: (307) 766-6656, Fax: (307) 766-2221, Email: rrek@uwyo.edu.

- Please describe research on Water that is on-going in the jurisdiction: (< 1 page)

Please see the following link for information on Wyoming Water Research: http://uwacadweb.uwyo.edu/research/UW_Water_Research.asp. Click on "Survey Results" for a listing of researchers and their areas.

Also please see the Wyoming Water Research Program:
http://wwweng.uwyo.edu/civil/research/wwrp/

The National Institutes for Water Resources (NIWR)/State of Wyoming Water Research Program (WRP), placed at the University of Wyoming, oversees the coordination of Wyoming's participation in the NIWR program. The primary purposes of the program are to support and coordinate research relative to important water resources problems of the State and Region, support the training of scientists in relevant water resource fields, and promote the dissemination and application of the results of water-related research.

Federal support for the WRP is received from the NIWR program as authorized by the Water Resources Research Act. State support for the research program includes direct funding through the Wyoming Water Development Commission and active State participation in identifying research needs and project selection and oversight. Primary participants in the WRP are the USGS, the Wyoming Water Development Commission, and the University of Wyoming. A Priority and Selection Committee (P&S Committee)--consisting of representatives from State and Federal agencies involved in water related activities--solicits and identifies research needs, selects projects, and reviews and monitors progress. The Director serves as a point of coordination for all activities and serves to encourage research by the University of Wyoming addressing the needs identified by the P&S Committee. The State also provides direct funding for the administration of the WRP through the Office of Water Programs which was established in 2002 by the State Legislature. The duties of the Office of Water Programs are to identify research needs regarding Wyoming's water resources, including funding under the NIWR, and to serve as a point of coordination for and to encourage research activities by the University of Wyoming to address the water-related research needs.

The WRP provides for interaction from all the groups involved, rather than being solely a University of Wyoming research program. The WRP supports faculty and students in University of Wyoming academic departments. Faculty acquire funding through competitive, peer reviewed proposals, upon recommendation by the P&S Committee and approval by the NIWR program. Since its inception in 2000, the WRP has funded researchers in ten academic departments and has supported a total of twenty-two research projects. Summaries of all projects funded to date and a copy of the most recent RFP can be viewed by using the links at the top right-hand side of this web page: http://wwweng.uwyo.edu/civil/research/wwrp/.

- Areas (water related) that your state may be interested in moving toward or enhancing at this time – future directions (1/2 page)

Those are described in the above websites.

- Are there joint projects or plans with other jurisdictions or neighboring states? (1/2 page limit)

Wyoming participates in the National Institutes of Water Resources, NIWR: http://niwr.montana.edu/.

- Funding sources for this research (not necessarily NSF EPSCoR) Please list:

Funding sources include but are not limited to NSF, the U.S. Geological Survey and the State of Wyoming Water Development Commission, the University of Wyoming, and other agencies.

- Does your jurisdiction have specially funded water initiatives or problems regarding water that are specifically part of your State Science and Technology Plan? (1/2 page limit)

Not at this time.

- Facilities in your state that are useful for water research (1/4 page)

Please see the Water Facilities link on the University of Wyoming Water Research web site: http://uwacadweb.uwyo.edu/research/Water%20Research%20Facilities.asp.

Participant List*

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Weiner	Brad	Dr.	University of Puerto Rico	P.O. Box 23334	San Juan	PR	00931
Wemple	Beverley	Dr.	University of Vermont	201 Old Mill, 94 Univ. Place	Burlington	VT	05405
White	David	Dr.	Murray State University	561 Emma Dr.	Murray	KY	42071
Wilcox	Andrew		University of Montana	32 Campus Dr. 1296	Missoula	MT	59812
Wilson	John	Dr.	New Mexico Tech	801 Leroy Place	Socorro	NM	87111
Wollheim	Wilfred	Dr.	University of New Hampshire	211 Morse Hall	Durham	NH	03824
Young	Eric	Dr.	University of Vermont	Hills Agricultural Science Bldg., 105 Carrigan Drive	Burlington	VT	05405
Yu	Jun		University of Vermont	16 Colchester Ave	Burlington	VT	05401

***As of 3 November 2008**