Idaho Water Resources Research Institute
Annual Technical Report
FY 2011

Introduction

The Idaho Water Resources Research Institute (IWRRI) is housed at the University of Idaho. IWRRI is dedicated to supporting and promoting water and water–related research, education, and information transfer throughout Idaho. IWRRI collaborates with researchers and educators from all Idaho state universities; staff of local, state, and federal agencies; and private water interests.

The IWRRI is the only mechanism in the state that provides an autonomous statewide source of support for water research and training without regard to specific topic or discipline area. This is important because Idaho's water problems cross multiple topics and disciplines and compartmental approaches to these problems are less effective. IWRRI is relied upon by state and federal agencies and private water interests to provide the objective expertise to address the needs of the state and region.

The Institute has been a strong proponent of education and outreach for both youth and adult audiences. It is through education that the public can make informed public policy decisions concerning water. It is also through education that individual citizens become engaged in the process through adjustments of their own attitudes and lifestyles.

Research Program Introduction

The Idaho Water Resources Research Institutes research program is comprised of the following objectives: (1) To work with state and federal agencies and non−government organizations to identify water research needs of the state and region; (2) To promote water−related research relevant to state and regional needs; (3) To stimulate, coordinate, and provide leadership for water resources research within Idaho universities and collaborate with sister institutions in adjoining states; (4) To cooperate with and assist state and federal agencies and non−governmental organizations for the benefit of the citizens of Idaho and the region; (5) To encourage and facilitate public involvement in water resource programs within the state; (6) To promote water education within the state at the K−12, undergraduate and graduate levels; and (7) To develop funding for needed research and encourage cooperation with other research organizations.

The projects funded during the 2011 104B Program Fiscal Year spanned a variety of water resource issues that are important to maintaining Idaho's most precious resource. These projects include: understanding the economics of conjunctive surface water-groundwater management of our river basins; investigating the role that sediment transport in high-gradient streams has on sustaining Idaho's water resource infrastructure; and developing a better understanding of one of Idaho's most valuable groundwater resources by creating a meteoric water line for the Treasure Valley.

Improving Idaho Infrastructure through Long-term Monitoring of Sediment Transport

Basic Information

Title:	Improving Idaho Infrastructure through Long-term Monitoring of Sediment Transport
Project Number:	2011ID165B
Start Date:	3/1/2011
End Date:	2/28/2012
Funding Source:	104B
Congressional District:	2
Research Category:	Climate and Hydrologic Processes
Focus Category:	Surface Water, Ecology, Geomorphological Processes
Descriptors:	
Principal Investigators:	Elowyn Yager

Publications

There are no publications.

Project Summary

Mountainous channel networks comprised of topographically complex and high gradient streams offer significant challenges to predicting bedload transport. Improving these predictions in steep streams will enhance our ability to plan and design infrastructure and restoration projects across entire stream networks. One reason for the inaccuracy of these predictions is the rarity of bedload flux measurements made in steep streams. We designed, constructed and tested eight modified Birkbeck-style bedload pit traps to collect continuous bedload flux measurement at the Reynold's Creek Experimental Watershed, Idaho.

Our traps differ from the traditional Birkbeck design by using a series of three submersible load cells in each trap to detect changes in weight rather than a hydrostatic pressure pillow system. The Birkbeck pit trap design is generally accepted to be accurate, however little field or flume testing has occurred on the design. We calibrated (to yield the correct weight) and tested (load cell stability and accuracy) the traps in the laboratory to ensure the robustness of the design. Using a model trap installed in the bed of an indoor hydraulic flume, we measured detailed 3-D flow velocities using particle image velocimetry above the trap aperture to determine the effects of the trap on near-bed velocities and bedload transport at various fill levels (Figure 1). Measurements show that there is little variation in Reynold's stress or in velocity under empty conditions or with changing trap fill levels (Figure 2). This indicates that the

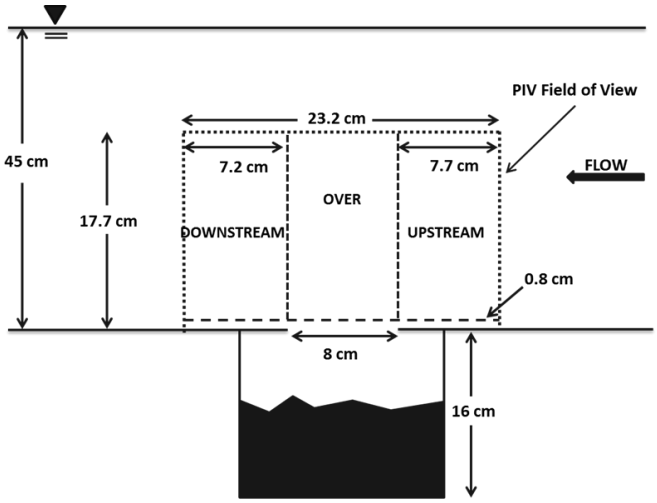

Figure 1 Schematic of the experimental setup for the flume testing of a sediment trap model *(not drawn to scale).*

presence of the trap should not result in interactions between the free flow and the recirculating flow in the trap cavity to affect bedload transport, and that field measurements obtained using this design will be accurate. This is the first time a set of bedload traps have been systematically tested hydraulically and our results demonstrate that a trap lid and moderate trap size are needed to minimize effects on bedload transport.

We also proposed to install traps in the Reynold's Creek Experimental Watershed. Limited access and bedrock in our original proposed reach caused us to switch locations and to survey (cross-sections, long profiles and pebble counts) a new site downstream. To remove sediment for trap installation and to empty the traps in the future, we designed a suction dredge system utilizing a centrifugal trash pump connected to a large venture nozzle in a setup similar to dredge mining. We obtained permits and attempted trap installation but several design flaws (lip hasp weakness, viewing window attachment, and wire conduit design) were discovered that would have

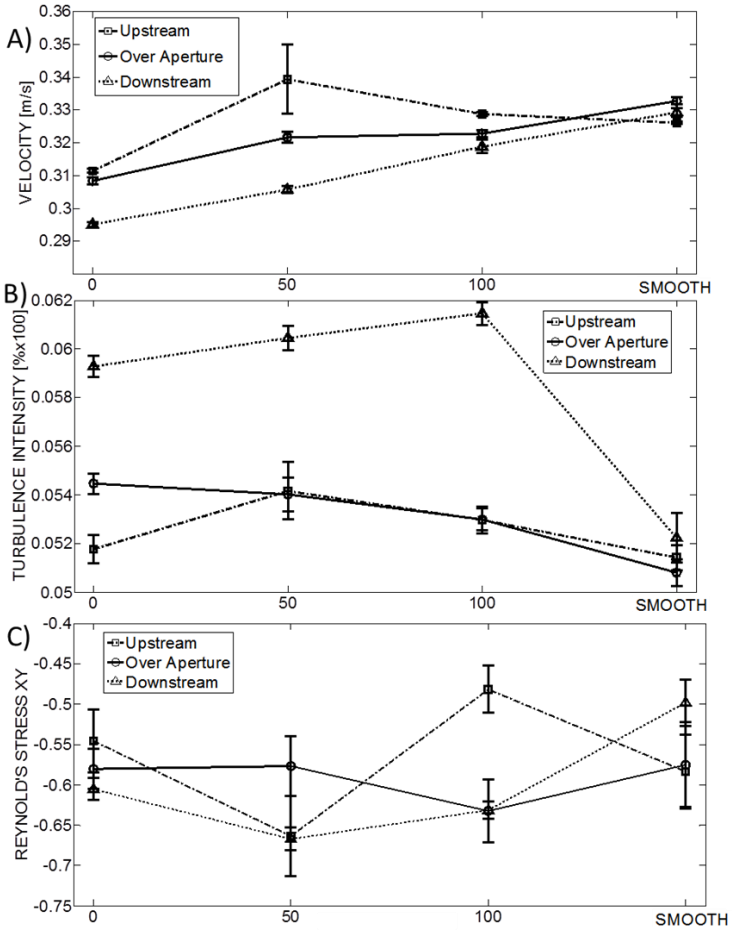

Figure 2. Average values of A) velocity magnitude, B) turbulence intensity in the downstream direction, and C) Reynold's stress 0.8 cm from the bed in the upstream, over, and downstream areas outside the aperture at sediment trap fill levels of 0%, 50%, 100%, and along a smooth bed. Error bars represent the fluctuation in the velocity values averaged in each section, not the error of the instrument.

jeopardized trap operation. Leveling the traps to prevent overloading of a single load cell proved to be extremely difficult on the irregular cobbles at the bottom of the stream. To address these issues, we redesigned and reconstructed parts of the traps and designed a method to level the streambed for the next installation attempt, which will occur in August 2012. Unfortunately high flows and winter weather at the field site prevented another installation attempt before the end of our funding. With the exception of trap installation, all other portions of the project were completed within the reporting period.

Constructing a local meteoric water line for the Treasure Valley, Idaho

Basic Information

Title:	Constructing a local meteoric water line for the Treasure Valley, Idaho
Project Number:	2011ID166B
Start Date:	3/1/2011
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	1
Research Category:	Climate and Hydrologic Processes
Focus Category:	Hydrology, Methods, Climatological Processes
Descriptors:	
Principal Investigators:	Alejandro Flores, Shawn Benner

Publication

1. Tappa, D. J., J. P. McNamara, S. G. Benner, M. J. Kohn, and A. N. Flores, Stable isotope compositions of precipitation in a semi-arid climate: variations from the global meteoric water line, AGU Fall Meeting, San Francisco, CA, 5-9 December, 2011.

Project Summary

Because the graduate student supported through this grant (Daniel Tappa, see below) was awarded an NSF GK-12 Fellowship for the 2011-2012 academic year, we were able to make significant progress toward the project objectives and are able to extend the project without cost through 2012-2013. During the project reporting period we have continued our sampling and analysis of the liquid water stable isotopes in precipitation and the snowpack. We have performed sampling along gradients in elevation within the Dry Creek Experimental Watershed northwest of Boise, and improve the spatial collection by engaging elementary schools in the Treasure Valley to assist in collection of precipitation samples during the 2011-2012 school year. This latter effort was enabled by the GK-12 fellowship, which allowed Mr. Tappa to use the WaterShed outreach facility in Boise as a platform to train elementary school teachers to properly collect and preserve samples of precipitation water from the 2011-2012 school year.Those samples were recently collected and are being analyzed. The grant also enabled us to process a very large number of precipitation samples (~500) that had been collected prior to the initiation of the project but had not been analyzed. Based on analysis of these data, as well as further data collection that the project has enabled, we have been able to construct a more robust local meteoric water line (LMWL) for theTreasure Valley area. The revised LMWL is shown in **Figure 1**.

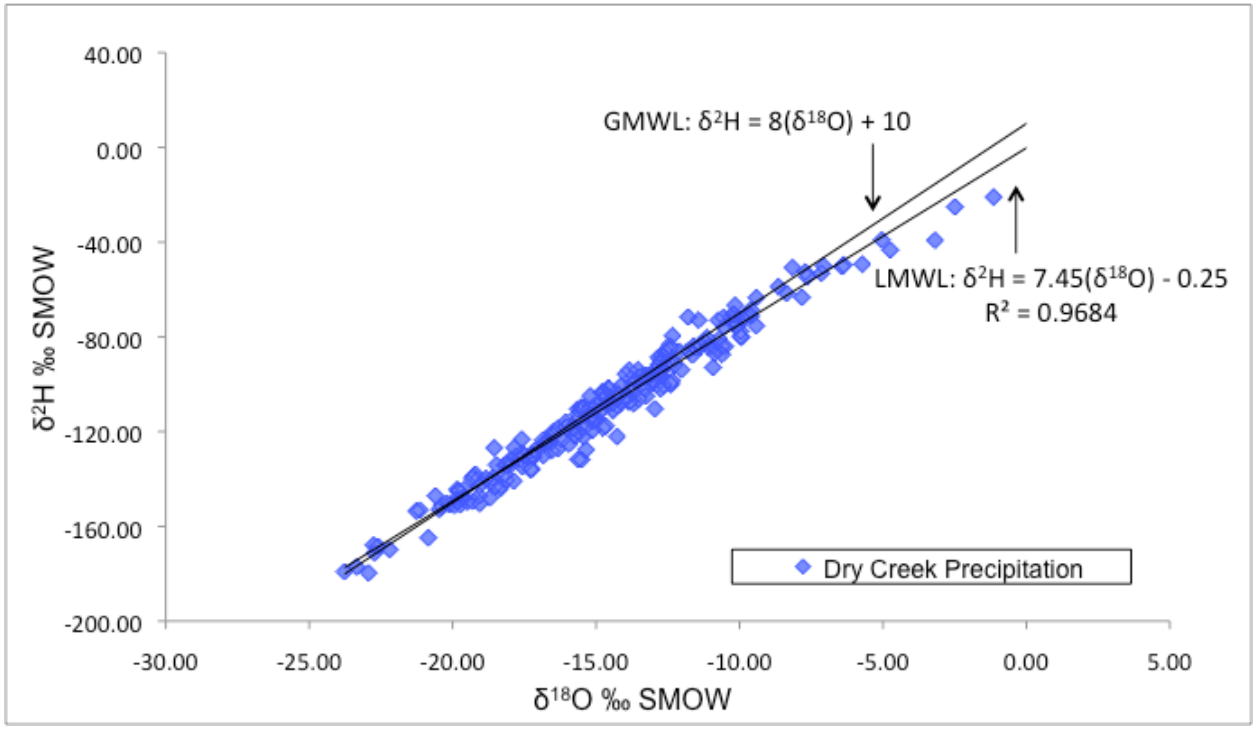

Figure 1: Revised LMWL for the Treasure Valley of Idaho.

Analysis of this data has also shown a significant elevation effect during particular 2 storms (**Figure 2**). Specifically, the heavy stable isotope of oxygen (i.e., *δ18O*) is significantly (i.e., more than the sensitivity of the liquid water isotope analyzer) enriched during most storms.

Interestingly, there are events when this elevation effect is reversed and significant enrichment with elevation occurs.

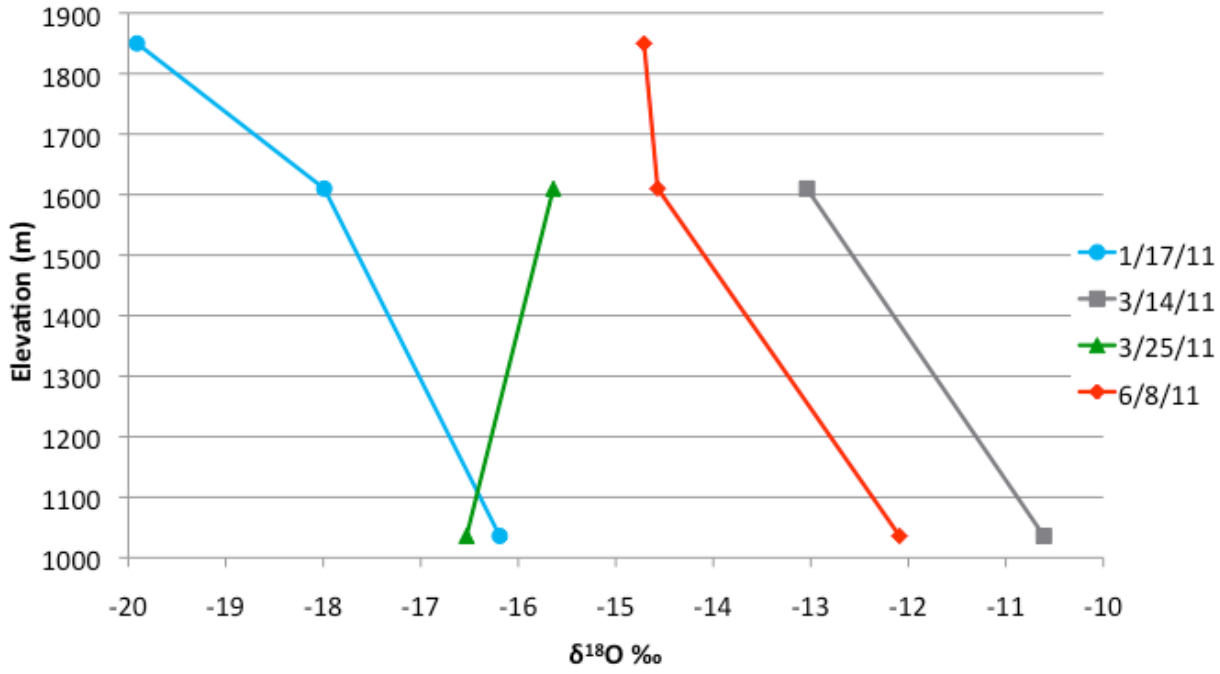

Figure 2: A general elevation effect is seen in the trend of δ18O with elevation.

To better understand the controls on the elevation effects as well as the wide between storm variability in δ18O seen at all elevations, we have attempted to better constrain the source regions associated with particular meteorological storm events. To accomplish this we have conducted a preliminary investigation using the NOAA Air Resources Laboratory HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) model to perform back-trajectory analysis of air masses associated with significant precipitation during different seasons of the year. This preliminary investigation seems to indicate that potential meteorological storm tracks may play a significant role in the stable isotope concentrations in precipitation as well as the presence of elevation effects. Specifically, the March 14, 2011 precipitation event shown in Figure 2 is associated with significant depletion in the concentration of with elevation. The back-trajectory analysis of this event shows that the air mass most likely originated from the North Pacific region off the Gulf of Alaska (**Figure 3**). The meteoric origin of the moisture associated with the March 25, 2011 precipitation event is, however, much more uncertain (**Figure 4**). The ensemble of back-trajectories shows far less consensus regarding the origin of air parcels, with some travelling long distances over land prior to arriving in the Treasure Valley region. These preliminary studies are suggestive of ongoing research needs that will be addressed in the coming year. Specifically, in the coming year we will sample along a more refined elevation gradient to better resolve the elevation effect.

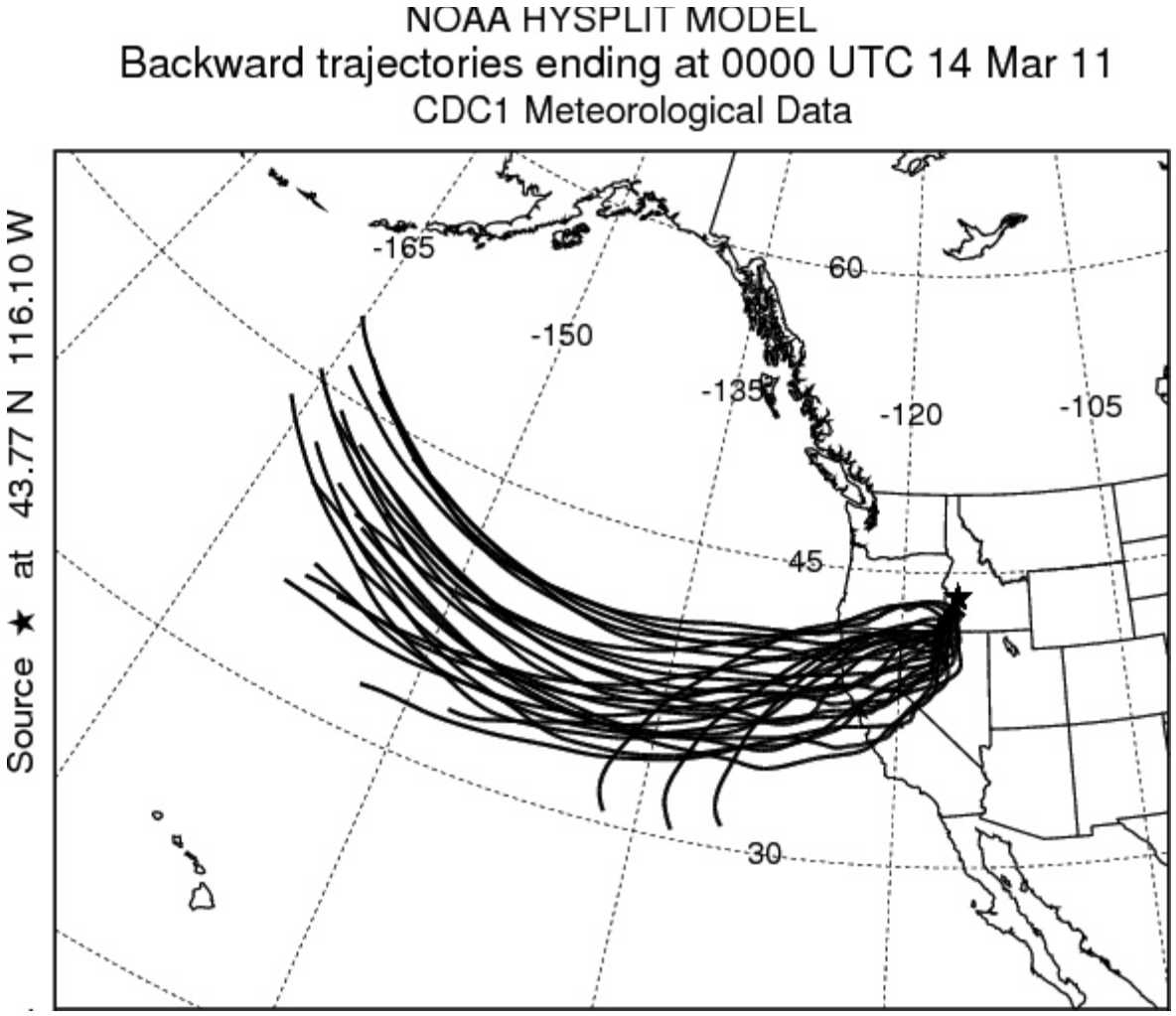

Figure 3: Back-trajectory analysis for the March 14, 2011 precipitation event. Each trajectory is an equiprobable trajectory of an air parcel that arrives in the Treasure Valley region on March 14, 2011. Most ensemble members originate in the North Pacific.

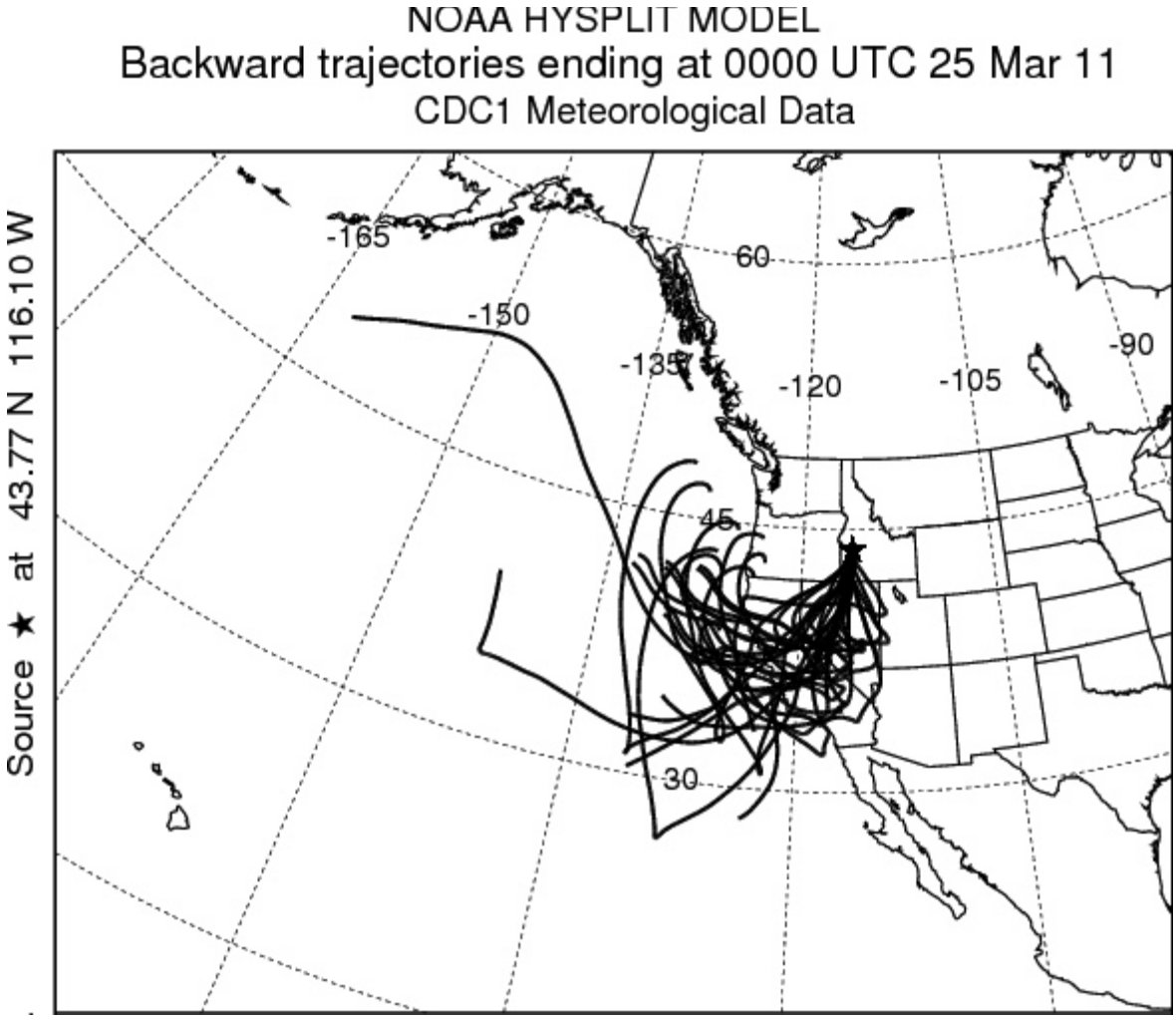

Figure 4: Back-trajectory analysis for the March 25, 2011 precipitation event. Each trajectory is an equiprobable trajectory of an air parcel that arrives in the Treasure Valley region on March 25, 2011.

Modeling Dynamic Feedback between Surface and Groundwater Systems: Implications for the Economics of Conjunctive Management

Basic Information

Title:	Modeling Dynamic Feedback between Surface and Groundwater Systems: Implications for the Economics of Conjunctive Management
Project Number:	2011ID168B
Start Date:	3/1/2011
End Date:	2/28/2013
Funding Source:	104B
Congressional District:	1
Research Category:	Social Sciences
Focus Category:	Management and Planning, Economics, Water Use
Descriptors:	
Principal Investigators:	Kelly Cobourn

Publication

1. Cobourn, K.M., Crescenti, N.F. 2011. The implications of surface-groundwater hydrology for optimal conjunctive management. Western Economics Forum, 10(2): 50-63.

Project Summary

Substantial progress was made on this project during the reporting period (3/1/11-2/29/12). Investment was undertaken in background research and data collection, which yielded one publication in Fall, 2011, and is now being used to support the development of two additional manuscripts. Four undergraduate research assistants have been supported by the project, one of whom authored an award-winning essay based on a unique empirical analysis.

Two lines of inquiry have been pursued to date. One focuses on the development of a dynamic mathematical programming model that describes the hydraulic relationship between surface and groundwater stocks. The objective of doing so is to describe the impacts of diversions from each stock on the natural system and the implications for the economic welfare of agricultural irrigators. A modeling framework has been developed that illustrates that the returns to conjunctive management are on the order of seven times greater in a hydraulically connected system than in a disconnected system. This is a novel result that contrasts with the economic literature to date. Studies of conjunctive water management in the economic literature have found little in the way of benefits to managing ground water withdrawals. The results of this project demonstrate that this is a function of failing to recognize the bi-directional movement of water between the surface water and groundwater stocks.

Work on this first line of inquiry to date has involved: (1) specifying a theoretical economic framework, (2) writing a dynamic programming model in the software package GAMS (General Algebraic Modeling System) and (3) collecting information to parameterize a simulation model for the Eastern Snake River Plain. Tasks (1) and (3) are complete as of the end of the reporting period. One paper based on this analysis has been published to date in the *Western Economics Forum*. One working manuscript (#2 below) has been presented at two professional conferences and is posted online. The working manuscript is slated for submission in late July, 2012.

The second line of inquiry on the project involves a data-driven approach to estimate the externalities generated by groundwater users for surface water users and vice versa. This builds on the theoretical economic framework developed under the first line of inquiry. During Fall, 2011, PI Cobourn worked with undergraduate research assistant Benjamin Schmidt to collect surface and groundwater monitoring data for the Eastern Snake Plain between 1956 and 2011. The data collection effort yielded a substantial dataset that has been used to support an empirical analysis that was presented at the American Economic Association Annual Meeting in January, 2012. That work combines data on water rights, crop production, and irrigation technologies with data on ground and surface water levels to econometrically estimate a system of simultaneous equations describing the dynamics of both water stocks. The associated paper is posted online and has been accepted for presentation at three additional professional conferences during Summer, 2012. The manuscript is slated for submission in June, 2012.

The results from this second line of inquiry indicate that although groundwater pumping does play a role in decreasing surface water flows over time, the relationship between the two has become less salient over time. This result coincides with that of the simulation analysis: As groundwater levels have fallen from increased pumping and reduced incidental recharge, a greater proportion of the Eastern Snake River Plain has become perched, as opposed to hydraulically connected. Under those circumstances, the gains from conjunctive management

decline. The implications of these results for the design of effective conjunctive surface-ground water management policy are currently being explored.

Originally, the proposal included an extension considering the spatial aspects of ground and surface water hydrology. The PI instead chose to pursue the aforementioned data-driven analysis. Given the level of interest in the empirical paper, this promises to be a more fruitful avenue of inquiry.

Information Transfer Program Introduction

During the 2011 Program Year, 104B program and state funds were used to support the Idaho Water Resources Research Institute Information and Technology Transfer Program. This program includes efforts to reach all water resource stakeholders in the state, from K to Grave. These efforts included; Water Education Workshops for Teachers (225 teachers were trained in 16 accredited workshops across Idaho) and participated as an i-STEM provider at the Idaho i-STEM summer institutes in Twin Falls and Boise; continued coordinated efforts with the Boise WaterShed, Idaho Water Education Foundation and the Idaho Department of Environmental Quality on various outreach efforts. Youth outreach across the state including included Water Awareness week (over 10,000 attendees) events and materials, Youth Water Festivals in Moscow and Weiser. Beyond K-12 education IWRRI provides a state wide water resources seminar series delivered via a compressed video system to Boise, Moscow, Pocatello, Idaho Falls and Coeur d'Alene (13 seminars during the year with an average attendance in all locations of 25 people per seminar). IWRRI planned and is currently implementing an increased presence and expanded activities in education, outreach and research through the UI, Coeur d'Alene Center.

In addition, during the 2011 Program Year, training opportunities for water professionals were continued through interactions with the Boise Watershed Center. The Institute has continued its support of the annual Idaho Environmental Education Conference. IWRRI also has the capacity to provide statewide distribution of professional short courses and professional development workshop as available to statewide water professionals. IWRRI continues to network and coordinated to work on a regional level with other institutes and water research entities. Finally, the IWRRI continues its support of the Idaho State Chapter of the American Water Resources Association by recruiting members and providing sponsorship and publicity for several of its events.

In addition, during the 2011 Program Year, training opportunities for water professionals were continued through interactions with the Boise Watershed Center. The IWRRI also developed or sponsored five water resources workshops, conferences and symposia focusing on specific water resources issues of interest across the state, region and nation. These meetings were two joint conferences with the Oregon and Washington Water Research Institutes in May and November of 2011 respectively entitled Exempt Wells: Problems and Approaches in the Northwest and Water in the Columbia Basin: Sharing a Limited Resource; the Palouse Water Summit, held in Moscow, ID, in October 2011; the 2012 Western States Remote Sensing of ET Workshop held in Boise in October and sponsored by NASA; and the Idaho Water Users Conference, held in Boise, ID in January 2012. IWRRI is also collaborating with the Water Research Institutes in Oregon and Washington in the planning of a regional water resources conference focusing on the issues associated with the development of geothermal resources. This conference will be held during the FY 2013 project period.

In addition to these activities, one Information Transfer activity was to be initiated in 2011, this being an effort to create a virtual watershed library system for Idaho's river basins. However, due to delays in receiving funding during the past fiscal year, the initiation of this project's activities was delayed until March 1, 2012.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	5	0	0	0	5
Masters	2	0	0	0	2
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	7	0	0	0	7

Notable Awards and Achievements

For Project 2011ID168B, Eric Schuler, one of the students working with PI Cobourn on the project, won the College of Business and Economics (COBE) Wallace G. Kay Student Writing Competition. His essay, Spatial Externalities among Groundwater Users in the Eastern Snake Plain, was nominated by PI Cobourn and selected by a panel of faculty judges.

For Project 2011ID166B, Undergraduate student Kimberly Smith was awarded a NASA Student Airborne Research Project (SARP) fellowship for summer of 2012 to participate in airborne meteorological remote sensing research. She will be based out of NASA Dryden Flight Research Center at Edwards Air Force Base in California.

For Project 2011ID166B, Graduate student Tappa was awarded a NSF GK-12 fellowship during the 2011-2012 academic year. He was paired with the Boise WaterShed outreach facility and was able to leverage this collaboration to expand our data collection program and engage the broader Treasure Valley community.

For Project 2011ID166B, PI Flores was Co-PI on a successful NSF RAPID grant that is significantly related to this research. The NSF RAPID proposal (NSF Award # 1235994, $19,912, April 15, 2012-March 31, 2013, An unusual opportunity to track snow ablation using stable isotope evolution of the 2011-2012 snowpack near Boise, Idaho; new project, no publications or data products to date) was awarded funding through the Hydrologic Sciences Program and commenced on April 15, 2012.