Utah Center for Water Resources Research
Annual Technical Report
FY 2014
Introduction

The Utah Center for Water Resources Research (UCWRR) is located at Utah State University (USU), the Land Grant University in Utah, and is administered by the Utah Water Research Laboratory (UWRL). It is one of 54 state water institutes that were authorized by the Water Resources Research Act of 1964. Its mission is related to stewardship of water quantity and quality through collaboration with government and the private sector.

The UCWRR facilitates water research, outreach, design, and testing elements within a university environment that supports student education and citizen training. The UCWRR actively assists the Utah Department of Environmental Quality (UDEQ), the Utah Department of Natural Resources (UDNR), the State Engineers Office, all 12 local health departments, and several large water management agencies and purveyors in the state with specific water resources problems. In FY 14, the UWRL expended a total of almost $10 million in water research support. Federal funding from USGS Section 104 grants administered through the UCWRR accounted for about one percent of this total. These funds were used for research addressing water management problems, outreach, information dissemination, strategic planning, water resources, and environmental quality issues in the State of Utah. Four research projects were funded in FY14 with USGS 104 funds. These projects are respectively entitled, (1) "Estimating Crop Water Use with Remote Sensing: Development of Guidelines and Specifications," (2) “Capturing Aerial Imagery on the San Rafael River, Utah, Using an Unmanned Aerial Vehicle (UAV) to Monitor and Assist in Evaluating Restoration Efforts,” (3) “Influence of Groundwater/Surface Water Interactions in High Gradient Mountain Streams,” and (4) “Managing Western Irrigation systems in the Face of Urbanization.”

These projects dealt with the following water management issues: (1) Developing a framework for estimating crop water use using remote sensing through a standardized approach, thus providing guidelines and specifications for applying certain evapotranspiration (ET) models and producing ET products that are acceptable to the USGS WaterSmart program and the scientific and user community; (2) Using an inexpensive unmanned aerial vehicle (UAV) to provide high resolution, up to date aerial imagery in support of restoration schemes ongoing in the San Rafael River in South Central Utah and determining the accuracy and limitation of this platform for providing digital elevation and terrain models in place of more conventional, and more expensive, approaches; (3) Investigating groundwater/surface water interactions, quantified as net gains and losses, to determine spatial trends in flow over time in three high mountain streams in northern Utah in support of iUTAH efforts to interpret the biochemical properties in those watersheds and understand the implications of climate change on hydrology within Utah; and (4) Identifying key opportunities and challenges faced by irrigation companies as they adapt to changes in land use and urban pressure and helping them understand and adapt to changes associated with the urbanization of an irrigated agricultural landscape. These projects all involved collaboration of local, state, and federal water resources agency personnel.
Research Program Introduction

Irrigated agriculture is the largest consumptive water user in the western United States. Estimates of crop water use can be improved through more accurate evapotranspiration (ET) estimates. A USGS-supported research project developed a framework for estimating crop water use using remote sensing through a standardized approach that provided guidelines and specifications that, if followed in order, could be applied to certain models and produce ET products that are acceptable to the USGS WaterSmart program and the scientific and user community. This research reviewed and tested candidate remote sensing–based ET models to establish model performance and determine the uncertainty associated with the application of these models. A set of study sites was selected from within the 17 western United States representing different climatic regions, and a variety of spatial and point datasets were utilized. A meeting was held with USGS personnel to discuss the findings. This work could benefit many hydrological modeling and water resources management applications.

Another USGS funded project is using AggieAir high-resolution multi-spectral imagery (RGB, NIR, and thermal imagery) of the lower San Rafael River to provide valuable information to the San Rafael Restoration Committee and the Utah Division of Wildlife Resources in support of ongoing river restoration projects. The imagery will provide spatial information regarding thermal refugia and detailed channel information for restoration projects in this region including efforts to restore the river to a more ecologically acceptable state, provide more comprehensive complex native fish habitat, encourage change in channel morphology through Tamarisk removal, and remove man-made barriers to enhance and encourage fish movement/passage throughout the entire drainage. Temperature probes will be installed to assist in calibrating the thermal imagery. This project has been delayed due to severe low flow conditions in the San Rafael River for several months in the summer 2013 and then higher than expected flows during the summer of 2014. River levels are expected to return to semi-normal levels in 2015, and the project will be completed at that time.

Sources, sinks, and residence times of heat and solute mass within stream networks are critical to characterize and quantify because of their role in biogeochemical processes and water quality. One of the biggest challenges associated with understanding and predicting heat and solute movement within a river or stream is attempting to estimate each physical process individually. A key process in many stream systems is the spatially and temporally variable groundwater exchanges, which are particularly important in heat and solute transport. However, groundwater exchanges are not clearly defined and are widely recognized in many situations as being complex and difficult to understand. The exchange interactions between stream flow and subsurface flow are difficult to characterize and exchange flow paths and residence times can vary dramatically, making locations, quantities, and distributions difficult to anticipate and measure. This USGS project used collection strategies to provide an initial understanding of groundwater exchanges within reaches in three high gradient mountain streams in northern Utah.

Our final USGS-funded project was designed to help local canal and irrigation companies in Northern Utah better understand and adapt to changes associated with the urbanization of an irrigated agricultural landscape. The project objectives included documenting the diverse characteristics of representative shareholders of irrigation companies along a gradient of urbanizing environments, investigating the ways farmer and non-farming shareholders manage secondary water allocations, and identifying the key opportunities and challenges faced by irrigation companies as they adapt to changes in land use and urban pressure. Initial qualitative information has been gathered from irrigation companies across Northern Utah regarding the impacts of urbanization on irrigation companies and the ways they are responding. Once agreements with collaborating companies are signed, a survey instrument will be implemented within these groups, and the results will be published and shared with the collaborating irrigation companies.
These projects involved collaborative partnerships throughout the state with various local, state, and federal agencies.

Basic Information

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Publications

1. Introduction

Irrigated agriculture is the largest consumptive water user in the western United States. Improved estimates of crop water use through evapotranspiration (ET) estimates are important because of the diminishing water resources and competition for water in the 17 western states. Several programs have been established by states and federal government agencies to help monitor water resource in the western US including programs such as WaterSmart by the US Bureau of Reclamation. The key element in estimating crop water use is ET estimates. Also, knowledge of ET is useful for many applications including hydrological modeling and water resources management.

As indicated by the USGS, the aim of this work is to solve the water balance at the 12 digit HUC watersheds scale and eventually the 8 digit HUC level.

2. Statement of Work

Estimating crop water requirements that are acceptable by the community of users and water agencies in the western states, as well as by the USGS WaterSmart, for reporting purposes is a challenging problem. A wide range of ET models are available in the literature, providing different approaches and estimates. The application of some of these models, in particular the remote sensing-based models, can be considered subjective because some of them rely on modeler perception, experience, and understanding on the selection of inputs.

The main research objective is to develop a framework for estimating crop water use using remote sensing through a standardized approach. This framework will provide guidelines and specifications that would need to be followed by different states in order to apply certain models and produce ET products that are acceptable to the USGS WaterSmart program and the scientific and user community. To achieve the main objective the following activities will be followed:

1. Review currently available ET estimation models
2. Perform models intercomparison scheme on candidate models
3. An overview of the candidate models sensitivity to input data.
4. Use or remote sensing data from multiple sensors including the recent Landsat 8.

A conceptual diagram of the statement of work with the suggested activates of the remote sensing of ET framework shown if Figure 1.
3. Methodology

The approach followed to achieve the project objectives include review of ET models and intercomparison scheme. This review considered most of the currently available remote sensing of ET models that can potentially be utilized to account for agricultural consumptive water use. The review will provide the most up-to-date models parameterizations, their potential application, report on their use of currently available and standardized remote sensing and other forcing data at local to regional scales, summarizes the reported accuracies for each model. This review report consists of two parts with Part 1 dedicated for providing information about available models and details on their application. The second part will discuss sensitivity analysis of the models input on the estimated actual ET as well as summarizing the results of the model intercomparison scheme.

Conduct model intercomparison scheme to evaluate a subset of these models. For a consistent and fair intercomparison scheme, unified set of input data was considered as possible including the use of multiple testing sites with different land use characteristics and climatic region, remote sensing and weather forcing data, and availability of ground-based observation for model evaluation purposes. The results of the intercomparison and the related sensitivity analysis will be provided in part 2 of the report.

3.1. Review of ET Models

Some of the currently available remote sensing of ET models have been reviewed for their applicability and use for agriculture consumptive water use. This review considered identification of models types, intended use, parameterization and level of complexity, input data requirements, and reported accuracies. The models were categorized into three
different types including physically-based, empirical, and mixed physically-based and empirical approaches. The reviewed models include

7. MODIS Evapotranspiration (MODIS ET) model by Mu et al. (2011)

3.2. Models Intercomparison Scheme

3.2.1. Study Sites

Three study sites were selected to test the candidate models. These sites represent different climate regions and land use surface characteristics. These sites are from within the 17 western United States and are representative of the different irrigated and rainfed agricultural areas as well as natural vegetated surfaces. The sites described in Figure 2 include

- The Palo Verde Irrigation District (PVID), California. The data for this site were collected by the remote sensing services lab at USU and the Alliance of Universities – Central State University through a project funded by the USBR. The data spans about 3.5 years from 2006 to 2009. It includes flux measurements, irrigation canal and drainage flows, and airborne and satellite images. The main crops are alfalfa and cotton crops. Data are also available for Salt Cedar forests in the riparian zone of the Colorado River.
- Walnut Gulch Experimental watershed, AZ. The area is naturally vegetated covered mostly with desert shrubs and grassland. Flux and satellite remotely sensed imagery will be used to conduct the analysis.
- Agricultural area in Mead, Nebraska. The area contains irrigated and rainfed soybean and corn fields.

List of remote sensing input data used for PVID and Mead is summarized in Table 1 and 2, along with layout of the site in Figures 3 and 4 respectively. For the PVID site data from Landsat 5 where used during the analysis. For the Mead site data from Landsat 7 and 8 where used.
Figure 2: the selected testing sites for the model intercomparison task.

Figure 3: Map of the study area, PVID agricultural fields and the location of the meteorological and flux towers.
Table 1: List of Landsat 5 scenes provided in the study

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Figure 4: Map of the study area, Mead agricultural fields and the location of the meteorological and flux towers.
Table 2: List of Landsat scenes provided in the study

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3.2.2. Preliminary Results

Estimates of actual daily ET maps for PVID (Site 1) during one of the satellite overpass dates are shown in Figure 5. A plot of estimated and measured ET are shown in Figure 4 for all satellite overpass dates. These preliminary results for PVID site are currently being updated. Participants are currently working on the data from Mead, Nebraska (Site 3).

Figure 5:
Preliminary results of estimates of actual daily ET for 5 models including DisALEXI, METRIC, ReSET, SEBS, and SSEBop during May 17th 2002.
4. List of Papers and Presentations

Some of the preliminary results and findings of the project were presented during professional meetings. A list of these presentation provided below


2. Geli, H. M. E., Neale, C. M. U., and Verdin, James, 2014: Intercomparison of remote sensing models for Evapotranspiration, presented at the ASA-CSSA, & SSSA international annual meeting, Long Beach, California, Nov 2-5


5. Summary of Progress

Dissemination of some of the project results was achieved during a workshop. The workshop was organized on July 31st, 2014 titled USU/USGS Workshop on “Estimating Crop Water Use with Remote Sensing: Development of Guidelines and specifications” Organized by Hatim M.E. Geli and Christopher M. U. Neale. The workshop was held at Utah State University, Logan, UT 84322. The workshop agenda is shown in Figure 5.
Figure 6: Snapshot of the USU/USGS workshop flyer and agenda.

References


Capturing Aerial Imagery on the San Rafael River, Utah, Using an Unmanned Aerial Vehicle (UAV) to Monitor and Assist in Evaluating Restoration Efforts

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Publications

There are no publications.
Problem and Research Objectives:

The San Rafael River is recognized as being in a severely degraded state and is on the 303D list of degraded waters in the state of Utah. Current river restoration projects are aimed at restoring the river to a more ecologically acceptable state, providing more comprehensive complex habitat to the native fish, encouraging change in channel morphology through removal of Tamarisk, planting more native riparian species along the river corridor, and removing man-made barriers to enhance and encourage fish movement/passage throughout the entire drainage. For this project, an unmanned aerial vehicle (UAV) will be used to provide high resolution, up to date aerial imagery to assist in evaluating restoration schemes that are ongoing on the San Rafael River, South Central Utah.

Methodology:

The AggieAir Flying Circus, a service center at the Utah Water Research Water Laboratory will provide high resolution multispectral aerial imagery using a UAV. This work was contracted in 2011 by the Utah Division of Wildlife Resources and includes flying the lower 50 miles of the San Rafael River and providing RGB, NIR, and thermal imagery after a high river flow event. Using these data, the San Rafael Restoration Committee expect to use the resulting high resolution imagery to obtain spatial information regarding thermal refugia and detailed channel information integral for baseline information needed within the San Rafael restoration effort. Temperature sensors will also be positioned within the entire study reach to help calibrate the thermal imagery.

Principal Findings and Significance:

Due to higher than expected flows during the summer of 2014 it was decided to postpone all UAV flights by the AggieAir Flying Circus until 2015, when it is anticipated the river levels will return to a semi-normal state.

In June 2015, the temperature sensors will be installed along the entire 55 river miles of the San Rafael River to assist with calibration of the thermal imagery, which we plan to capture in late June/July 2015.
It is expected that the data and analyses provided by the AggieAir Flying Circus will significantly improve the information content of the entire data collection effort for the San Rafael restoration process and will help to answer significant research questions on the effects of tamarisk control on river morphology. The thermal imagery captured by Aggie Air will support efforts to address the thermal regime within the San Rafael River.

The project will also yield significant research results on the accuracy and limitations of the use of inexpensive UAV platforms to provide data such as digital elevation and terrain models in place of more conventional—and much more expensive—approaches, such as LiDAR.

**Partners/Collaborators:**

*State: Dan Keller – Utah Division of Wildlife*
*State: Paul Birdsey – Utah Division of Wildlife*
*Federal: Justin Jimenez – Bureau of Land Management*
Influence of Groundwater/Surface Water Interactions in High Gradient Mountain Streams

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Publication

Problem and Research Objectives:

Sources, sinks, and residence times of heat and solute mass within stream networks are critical to characterize and quantify because of their role in biogeochemical processes and water quality [e.g., Covino and McGlynn, 2007; Harvey et al., 2005]. One of the biggest challenges associated with understanding and predicting heat and solute movement within a river or stream is attempting to estimate each physical process individually. A key process in many stream systems is the spatially and temporally variable groundwater exchanges [Becker et al., 2004; Cey et al., 1998; Payn et al., 2009; Woesner, 2000], which are particularly important in heat [Conant, 2004; Constantz, 1998] and solute transport [e.g., Harvey et al., 1996]. However, groundwater exchanges are not clearly defined and are widely recognized in many situations as being complex and difficult to understand. The exchange interactions between stream flow and subsurface flow can occur in the hyporheic zone [Bencala and Walters, 1983; Harvey et al., 2005; Kasahara and Wondzell, 2003], deeper groundwater, the parafluvial zone, the riparian zone [Boulton et al., 1998], and the alluvial plain [Covino and McGlynn, 2007]. Exchange flow paths and residence times can vary strongly [Harvey et al., 2003], ranging from centimeters to hundreds of meters and minutes to years [Harvey et al., 1996], making locations, quantities, and distributions difficult to anticipate and measure. While some have used modeling calibration approaches to indirectly estimate groundwater influences on heat [Becker et al., 2004] and solute transport [Gooseff and McGlynn, 2005; Runkel and Bencala, 1995], data collection strategies can be used to provide an initial understanding of groundwater exchanges within reaches of interest.

Recent groundwater exchange studies in Northern Utah have focused efforts on reach scales by using a wide variety of data types [Schmadel et al., 2010; Schmadel et al., 2013], but there is a need for a variable scale investigation of the importance of groundwater gains and losses within additional high gradient streams in the region. As part of a recently awarded Utah EPSCoR Track 1 National Science Foundation project (iUTAH - innovative Urban Transitions and Aridregion Hydro-Sustainability), the ecologic/climate/hydrologic system in Utah watersheds are being monitored to better understand biophysical and hydrologic processes. As part of this effort, three different watersheds along the Wasatch Front were instrumented longitudinally from mountain unimpacted areas to urban areas with flow gaging stations, multi-probe water quality sondes, and weather stations. Additionally, samples are being routinely collected to establish representative biogeochemical conditions throughout each watershed. Groundwater/surface water gains and loss data within the study watersheds will complement iUTAH efforts by providing information longitudinally within each system during different seasons. These data support: 1) the interpretation of the biochemical data collected longitudinally within the iUTAH study watersheds; and 2) other variable scale water balance modeling efforts within iUTAH that are being conducted to understand the implications of climate change on hydrology within the state of Utah.
Methodology:

We estimated net groundwater gains and losses longitudinally by obtaining a flow balance through flow measurements of the stream/river of interest as well as additional surface inflows and outflows. Two primary stream gauging approaches, the velocity area method and dilution gaging, were applied. Specific conductivity measurements were also taken at each site to determine if there were longitudinal gradients in simple chemical indicators.

First, discharge measurements were completed using a YSI FlowTracker that measures velocities at numerous locations and allows for depth and width locations to be stored for an entire cross section. Discharge calculations were completed instantaneously and all data were downloaded post data collection. Second, dilution gaging was conducted in Red Butte Creek during the lowest of flow conditions. Stream discharge was estimated by: 1) injecting an instantaneous tracer slug just upstream from a measurement location, 2) measuring the response of the injection downstream with specific conductance, 3) correcting background concentrations to zero [Gooseff and McGlynn, 2005; Payn et al., 2009], 4) correlating the specific conductance response curve to chloride concentrations with calibration regressions, 5) integrating the correlated response curves, and 6) dividing the mass of tracer injected by the integrated curve. Using this procedure, stream discharge can be calculated as follows [Kilpatrick and Cobb, 1985]:

\[
Q = \frac{M}{\int_0^t (C(t) - C_b(t))dt} = \frac{M}{\int_0^t C(t)dt}
\]

where \( Q \) is the calculated stream flow (L s\(^{-1}\)), \( M \) is the known mass of the tracer slug (mg), \( C(t) \) is the measured solute tracer concentration (mg L\(^{-1}\)), and \( C_b(t) \) is the measured solute background concentration (mg L\(^{-1}\)) (considered zero). Refer to Schmadel et al. [2010] for additional information regarding the development of calibration regressions and assumptions.

Principal Findings and Significance:

As stated above, the overall focus of this research was to investigate groundwater/surface water interactions, quantified as net gains and losses, within northern Utah high gradient watersheds. This includes portion of the watersheds in more pristine mountainous areas to urban areas. We collected the first year of data necessary to begin understanding summer and fall gaining and losing conditions within each key watershed (e.g., Logan River, Provo River, and Red Butte Creek). All tributaries, inflows, and diversions were gaged in order to obtain the portion of the flow that was being gained from or lost to groundwater longitudinally. Figure 1 provides a summary of the information gathered for the three primary study areas. These data were used to determine the spatial trends in flow over time as illustrated for the Logan River in Figure 2. Overall, we have found the gaining and losing patterns in Red Butte Creek and the Logan River to be significant and likely to influence water quality trends throughout both watersheds. Similar data collection within these watersheds will continue. The Provo River gains and losses were found to primarily be due to complex human influences on surface water inflows/diversions within the watershed that were not completely captured within the measurements obtained.
Figure 1. Longitudinal changes in percent difference of discharge (%ΔQ), discharge (ΔQ), and specific conductance (ΔSC) for all three watersheds in 2014. Data points shown are in order of reach segment from upstream to downstream. Vertical dashed lines indicate reservoirs or dams.

Figure 2. Reaches along the ~74 km of the Logan River identified as net gaining, losing or alternating based on data collected during 2014. Lines indicate notable features.

The data collected from this project provide the foundation for future data collection and will be used as part of an undergraduate honors thesis (Hyrum Tennant, BS, CEE), an MS thesis (Trinity Stout, MS, CEE), and a PhD dissertation (Michelle Barnes, PhD, CEE).
Partners/Collaborators:

State: Additional faculty within the University of Utah and Utah State University involved in the Utah EPSCoR Track 1 National Science Foundation project (iUTAH - innovative Urban Transitions and Aridregion Hydro-Sustainability)

Federal: Matt Miller–United States Geological Survey, Utah Water Center

References


Conant, B. J. (2004), Delineating and quantifying ground water discharge zones using streambed temperatures, *Ground Water*, 42(2), 243-257.


Managing Western Irrigation Systems in the Face of Urbanization

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Publications

There are no publications.
Problem and Research Objectives:

Most irrigation water in the Intermountain West region is managed, distributed, and delivered to individual farmers by thousands of local irrigation or canal companies who operate an estimated 72,000 km of main irrigation canals (and much larger amounts of minor canals and ditches) in mountain valleys across the West. While much less studied than the much larger federal dam and water distribution systems in the West, these organizations remain a vital link in the agricultural irrigation systems throughout this region. In recent decades, the growth of residential settlement in the Intermountain West is occurring mostly on formerly irrigated agricultural lands. The shifts in the socio-demographic characteristics of shareholders and changes in land use patterns associated with urbanization pose new challenges to the performance and long-term viability of local irrigation systems. This project will provide irrigation and canal companies in Northern Utah with scientifically-based data on the characteristics, behaviors, attitudes, and information needs of their shareholders. Since most contemporary shareholders do not actively participate in company planning or decision-making processes, these companies have few opportunities to learn about many of their members. In this project, we are collaborating with leaders of three irrigation companies in Northern Utah to develop, distribute, and analyze results from a mail survey instrument to be sent to a sample of their shareholder members representing a diverse set of land use contexts along the gradient of urbanization. Results will be useful to the participating companies as they make plans for future investments in new infrastructure and/or operating procedures.

This project is designed to help local canal and irrigation companies in Northern Utah better understand and adapt to changes associated with the urbanization of an irrigated agricultural landscape. The specific objectives that guide project activities include:

- document the diverse characteristics of representative shareholders of irrigation companies located along a gradient of urbanizing environments
- better understand the ways that farmer vs. non-farming shareholders of irrigation companies manage their secondary water allocations
- identify the key opportunities and challenges faced by irrigation companies as they adapt to changes in land use and urban pressure

Methodology:

Project Activities:

- Beginning in Spring 2014 we identified a group of irrigation companies in landscapes across Northern Utah with different levels of urbanization pressure. Ann Armstrong (a PhD student in Sociology) carried out detailed semi-structured interviews with managers of 10 companies in the summer of 2014. (Under approved IRB Protocol #5614). These interviews provided rich qualitative information about the impacts of urbanization on irrigation companies, and the various ways they were responding to growth pressures. These data
were intensively processed and analyzed during winter 2014/15 and serve as the basis for
two dissertation chapters (see below).

- During the spring of 2015 we worked to develop a survey instrument, secure USU
  Institutional Review Board approval for data collection (approval granted on 2/17/15
  Protocol # 6457). We also initiated discussions with several local irrigation companies to
  secure their support for implementing the survey with random samples of their
  shareholders. This process has taken longer than anticipated, and we have held off
  finalizing the instrument and initiating data collection until we have secured agreements
  with all of our collaborating companies. We are very close to finalizing these agreements
  and expect to be initiating the survey in mid-June 2015, with data collection, processing, and
  reporting to be completed by August 29, 2015.

Principal Findings and Significance:

- The qualitative interviews with irrigation managers in 2014 have served as the basis for two
  empirical chapters in Ann Armstrong’s dissertation (which was successfully defended on
  April 20, 2015). These chapters will each be submitted as academic articles to peer-
  reviewed journals over the coming month. Key findings include:
  - **Irrigation companies are facing many challenges associate with urbanization.** The
    most-frequently cited challenges were increased demand for their water
    (particularly for residential purposes); the increasingly more common connections
    between their irrigation conveyance network and urban runoff drainage systems,
    and a change in the makeup of their shareholders (with a shift towards more
    residential or hobby farm water uses).
  - **Irrigation companies are very interested in converting their delivery systems from
    open ditches or canals to buried pipes.** Company representatives cited two reasons
    for their interests: more efficient water conveyance, and decreased liability for
    canal failures (also noted as fewer risks to public safety and property damage.
  - **Irrigation companies are interested in piping their systems for liability reasons
    based upon 1) increased state government oversight on canal safety, and 2) increasing urban
devolution around their conveyance infrastructure.
  - **Some irrigation company leaders cited the recent drought as a motivation for
    more efficient infrastructure systems.** With less water lost to evaporation in open
  conveyance systems, irrigation company leaders saw buried pipes as a way to
  provide more water to more of their shareholders. This was a concern even in
  predominantly residential irrigation systems.
  - **Some irrigation companies in urbanizing areas were currently collaborating with
    municipalities with overlapping jurisdictions, while other irrigation groups were
    more leery of municipal interactions.** The variation in the company’s attitudes
  towards collaborations with city governments seemed to be positively related to the
  level of representation that cities had on irrigation company boards.
  - **Irrigation company leaders were longstanding members of the irrigation group,
    with leadership roles often going back many generations.** Few, if any, irrigation
  company leaders expressed that organizations’ decision-making processes, or
  leadership composition, was changing to reflect a shift in shareholder composition
  (i.e., from agricultural to more urban water users).
The survey will be implemented in the next month and survey data will serve as the basis for a technical report to be shared with our collaborating irrigation companies and made available on USU’s Digital Commons. We anticipate these data to also contribute to at least one peer reviewed paper and professional meeting presentation by the end of 2015.

The project has resulted in two research presentations at professional conferences:


In addition, a PhD student has prepared two papers that are nearly ready for submission, with intended journal outlet and will be submitted for publication in the coming year:


PhD student Andrea Armstrong, PhD, Sociology, Utah State University, will complete her dissertation based on this research in Summer 2015.
The individual research projects documented in the Research Project section of this report have information and outreach components integrated within them. These include research findings published in the technical literature and findings and water management models and tools provided on the web pages of the Utah Center for Water Resources Research (UCWRR) and individual water agencies. Beyond this, Information Transfer and Outreach activities through the UCWRR, the Utah Water Research Laboratory (UWRL), and Utah State University (USU) have had an impact on the technical and economic development of the State of Utah. As part of the UCWRR outreach activities supported by USGS 104 funds, there continues to be a vigorous dialogue and experimentation with regard to the efficiency and effectiveness of outreach activities of the UCWRR. Faculty are engaged in regular meetings with State of Utah water resources agencies, including the Department of Environmental Quality (DEQ), the Department of Natural Resources (DNR), the State Engineer's Office, and numerous municipal water supply and irrigation companies to provide assistance in source water protection, on-site training, non-point source pollution management, technology transfer, development of source water protection plans (SWPPs), and efficient management of large water systems within the context of water-related issues in Utah. UCWRR staff, through the facilities at the UWRL, provides short courses both on- and off-site within the State of Utah, regionally, and internationally. Generally offered from one to five days in duration, short courses are tailored to meet the needs of the requestor. The following is a partial list of information transfer and outreach activities, short courses, and field trainings that involve UCWRR staff.

**Principal Outreach Publications**

Principal outreach items include our newsletters and other reports, including:

1. “The Water bLog” (http://uwrl.usu.edu/partnerships/ucwrr_newsletter), which highlights research projects and their findings;
2. "The Utah WaTCH" (http://uwrl.usu.edu/onsite_utahwatchnewsletter), which addresses on-site and wastewater issues; and

Additional publications from the UCWRR and UWRL appear regularly as technically-reviewed project reports, professional journal articles, other publications and presentations, theses and dissertation papers presented at conferences and meetings, and project completion reports to other funding agencies.

**Short Courses**

None of the short-courses conducted were related to USGS funded projects in FY 14.
Information Transfer in Support of the Utah Center for Water Resources Research (UCWRR)

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Publications

Information Transfer in Support of the Utah Center for Water Resources Research (UCWRR)

Problem

The Water Resources Research Act of 1964 established the Utah Center for Water Resources Research (UCWRR). The Center is housed at Utah State University in Logan, Utah. The general purposes of the UCWRR are to foster interdepartmental research and educational programs in water resources, administer the State Water Research Institute Program funded through the U.S. Geological Survey at Utah State University for the State of Utah, and provide university-wide coordination of water resources research.

Objectives

The center plays a vital role in the dissemination of information. Utah is home to approximately 50,000 miles of rivers and streams and 7,800 lakes. This water is an essential resource for the economic, social, and cultural well-being of the State of Utah. As one of 54 water research centers, the UCWRR works to "make sure that tomorrow has enough clean water."

A major component of the information transfer and outreach requirements of the UCWRR is the development of appropriate vehicles to disseminate information produced by research projects conducted at the Center. This project provides on-going updates of the UCWRR web page, with information transfer specifically identified as the key objective. This project disseminates semi-annual newsletters for the Utah Center that feature research projects and their findings, water-related activities in the state, and on-going work by researchers affiliated with the Center.

Methods

Web Pages

A vital objective to accomplish information dissemination for the UCWRR was the development of an up-to-date web page. The UCWRR web pages have been developed to make information available, thus creating a tool wherein interested parties can find solutions to water-related problems. To improve information timeliness and accessibility, we have implemented a content management and redesigned the web pages over the past year. After considering several programs, we selected Drupal, which is a free open source platform written in PHP. Its content management/database format will allow us to better manage information access, keep the web pages up to date, and archive older information while keeping it available to users.

The UCWRR website address is http://uwrl.usu.edu/partnerships/ucwrr/. Figures 1 and 2 show two of the pages from our web site. The web pages are works-in-progress, especially since we have so recently adopted a new CMS platform. The major sections of the website are as follows:

1. The “Home” page explains the center’s purpose.
2. The “About Us” page gives an overview of the center and its affiliations.
3. The “People” page gives an overview of the governing body of the center as well as key contact staff.

4. The “Research and Publications” page guides you to the various projects and reports. This page is updated periodically.

5. “The Water bLog” page provides access to current and past issues of the Center’s newsletter (described in the next section)

6. The “Contact” page has the center’s address and mode of contact.

Figure 1. Home page for the UCWR.
Figure 2. Research and Publications page for the UCWRR.

Newsletter

A semi-annual newsletter, *The Water bLog*, continues to be published, generally twice each year. *The Water bLog* is disseminated electronically by email and through the UCWRR web site:

[http://uwrl.usu.edu/partnerships/ucwrr_newsletter](http://uwrl.usu.edu/partnerships/ucwrr_newsletter)

The newsletter is e-mailed to approximately 350 readers. The main purpose of the newsletter is to highlight research projects and their findings. These will be of great interest and value to the State of Utah, as well as nationally and internationally.
A recent copy of the newsletter was sent out November 2014, and a new one will go out in summer 2015. One of the research projects featured in the November 2014 newsletter was “Release of Arsenic from Aquifer Solids.” UCWRR researchers are gaining an improved understanding of the biogeochemistry governing the behavior of arsenic in subsurface environments undergoing reducing conditions that may lead to groundwater contamination.

UCWRR researcher Joan McLean and her graduate students are investigating conditions that lead to arsenic release to groundwater at a sampling location in the Cache Valley Basin (see picture below).

Another research project featured in the November 2014 Newsletter was “Water Allocation and Salinity Impacts in the Sevier River Basin” where UCWRR researchers are working on a three-phase project to improve water management in the Sevier River Basin:

- **Phase 1** is developing a reliable hydrologic model to predict water availability and expected reservoir volumes using prior year information and measured snow data.
- **Phase 2** is developing an efficient and low-cost approach to validate FAO’s AquaCrop model using remote sensing (RS) estimates instead of crop ground measurements. This approach uses Landsat images and regional crop information to predict canopy cover (CC) and above-ground biomass (AGB) and identify the impacts of salinity on crop yield.
- **Phase 3** will use the forecasted water availability to identify the optimal surface water / groundwater use that will maximize farmers’ profits.

Utah’s many rural agricultural communities could benefit from this research.
Utah’s Sevier River Basin relies on spring runoff from winter snowfall to provide water for the region’s agricultural, domestic, and industrials water needs.

In the past year our UCWRR faculty members and researchers have traveled around the globe conducting and presenting their research and enhancing and sharing their extensive water resources expertise.

- Dr. Jagath J. Kaluarachchi, Senior Associate Dean of the College of Engineering at USU, and other UCWRR faculty recently collaborated with US and Egyptian government and education leaders to address the future of water management in Egypt.

- Part of an NSF-funded project, the workshop addressed existing and future water-related issues facing the country. The team shared known research strategies for working with non-conventional water resources, remote sensing in irrigation water management, impacts of climate change, and transboundary issues.

For an electronic copy of current or past newsletters, please go to:

http://uwrl.usu.edu/partnerships/ucwrr_newsletter

Data Base

Another concern at the UCWRR is making available electronic copies of previous research projects and reports. These are being converted to PDF format and are being added to an online database to make them more available.
Welcome!

The Water bLog is the semi-annual newsletter of the Utah Center for Water Resources Research (UCWRR), housed at the Utah Water Research Laboratory. The center supports the development of applied research related to water resources problems in Utah and promotes instructional programs that will further the training of water resource scientists and engineers. Each issue of The Water bLog reports on a small selection of the current or recently completed research projects conducted at the center. More information is available online at:

http://uwrl.usu.edu/partnerships/ucwrr

Message from the Director

Water doesn’t just run through our lives, it interacts in myriad ways, receiving and releasing, eroding and extending, impeding and empowering.

At the UCWRR we work every day to better understand water’s many interactions and find solutions to difficult environmental and social challenges. The more we understand about the processes involved, the more we can improve our interactions with this critical natural resource. This issue of the Water bLog highlights two current projects that explore some of the ways surface water and groundwater interact. The first looks at the biogeochemical processes that govern the release of arsenic to groundwater from natural geologic formations. The second explores ways to better forecast water availability in the Sevier River Basin, while maximizing agricultural and other benefits and minimizing resulting soil and water salinity.

These projects represent only a small fraction of the active research ongoing at the UCWRR that are finding practical solutions to natural resources challenges throughout the state. ■

INSIDE:

Research Highlights:

- Release of Arsenic from Aquifer Solids
- Water Allocation and Salinity Impacts in the Sevier River Basin

In the News

- Peruvian Ambassador signs agreement with Utah State University to work with the Utah Water Research Laboratory
- Far Afield
  - Water Workshop in Cairo

Figure 3. The Water bLog, the Newsletter for the UCWRR
USGS Summer Intern Program

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Notable Awards and Achievements

Bethany T. Neilson was recipient of a University of Copenhagen IGN International Academy award in 2014. This award provided funding for a 4-month sabbatical stay in Copenhagen, Denmark, where she was able to research groundwater/surface water interactions.

In April 2014, UCWRR faculty member Bethany Neilson, Associate Professor in Civil and Environmental Engineering, received the 2014 Graduate Student Mentor Award in the College of Engineering Awards Ceremony at Utah State University.
Publications from Prior Years

