The Oregon Water Conference 2011: Evaluating and Managing Water Resources in a Climate of Uncertainty

Oregon State University – CH2M Hill Alumni Center – Corvallis, Oregon

OR Section, American Water Resources Association and OR Section, American Institute of Hydrology

Poster Session

Antonius Laenen, Chair

Reception: Tuesday, May 24

5:00 PM – 6:30 PM

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POSTER

Enhancing Prediction of Streamflow in Snowmelt Dominated Basins through Assimilation of Remotely Sensed Data

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ABSTRACT

Accurate estimation of the quantity of water stored in seasonal snow cover and the streamflow resulting from snowmelt, particularly in the mountainous Western United States, is very important information for water resources managers. Challenges in the estimation of Snow Water Equivalent (SWE) arise from uncertain model forcing data, model structure/parameter error, poor spatial resolution of in-situ measurements and uncertainties in remotely sensed observations. In order to overcome these issues, this study implements data assimilation techniques to show the usefulness of remotely sensed passive microwave (PM) data for the improvement of snow water equivalent and streamflow prediction.

Through the use of a coupled Land Surface Model (LSM) and a PM radiative transfer model (RTM), data assimilation is performed to sequentially improve model estimates of SWE through the use of remotely sensed PM radiance data. This study is motivated to use PM data because of its sensitivity to snowpack properties. Through the use of a RTM to predict microwave emission from a given snowpack, assimilation can be performed in the observational space, removing the need to invert PM data into SWE data. Though this method for data assimilation has been studied by many researchers for SWE prediction, the effects of this assimilation on streamflow estimation needs further examination. This study extends previous work on radiance data assimilation in LSMs to determine the extent to which streamflow can be improved. By examining the streamflow over an entire melt season, this study examines how prediction of the quantity of available fresh water held in a snowpack can be improved.

Keywords: Estimating snow-water equivalent; Land surface model (LSM); Passive microwave (PM); Radiative transfer model (RTM)

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POSTER

Bedrock Groundwater Contributions to Hillslope Runoff Processes: A Comparative Analysis

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ABSTRACT

Bedrock groundwater dynamics in headwater catchments are poorly understood and poorly characterized. Direct hydrometric measurements have been limited due to the logistical challenges associated with drilling through hard rock in steep, remote and often roadless terrain. Here develop and use an inexpensive, safe, and portable bedrock drilling system to explore bedrock groundwater dynamics aimed at quantifying bedrock groundwater contributions to hillslope flow and catchment runoff. We present results from Watershed 10 (WS10) at the HJ Andrews Experimental Forest in Oregon and at the Maimai M8 research catchment in New Zealand. WS10 is underlain by weathered and fractured tuff and breccias, while Maimai is underlain by a moderately weathered conglomerate composed of clasts of sandstone, granite and shist in a clay-sand matrix. Analysis of bedrock groundwater levels at the Maimai through a range of flow conditions showed that the bedrock water table remained below the soil-bedrock interface, suggesting that bedrock groundwater contributes minimally to direct hillslope runoff. However, groundwater levels did respond significantly to storm events indicating that there is direct communication between soil water and continued vertical movement into underlying bedrock. WS10 groundwater dynamics were dominated by fracture flow. Preliminary findings show a highly fractured and transmissive region within the upper 1 meter of bedrock that acts as a corridor for rapid subsurface stormflow and lateral discharge. The interaction of subsurface storm flow within bedrock has implications on hillslope response, mean residence time and solute transport. This research shows bedrock groundwater to be an extremely dynamic component of the hillslope hydrological system and comparative analysis demonstrates the hydrological and geological controls on runoff generation in headwater catchments.

Keywords: Hillslope runoff; Bedrock groundwater; Groundwater level response to stormflow

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POSTER

Capitalizing on Uncertainty: Use of Scenario Development and Planning in Regional Dialogues of the Columbia River Treaty

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[1]Anthropology Department; [2]Water Resources Program; [3]Department of Geosciences; Oregon State University, Corvallis, OR

ABSTRACT

In 2014, the United States and Canada have the opportunity to give notice to end aspects of the Columbia River Treaty. As the Treaty enters this period of flux and uncertainty, stakeholders are presented with an opportunity to examine the Treaty and determine if it addresses the changing values of the Columbia River Basin. When enacted in 1964, hydropower and flood control were the only two benefits included in the Treaty. Today, stakeholders are faced with several additional values and laws not considered by the original Treaty, such as the Native American Tribes and First Nations, recreational and environmental concerns, and the Endangered Species Act. The Universities Consortium on Columbia Basin Governance is conducting a series of symposia to facilitate a regional dialogue on the Treaty. In preparation for the next symposium in September 2011, a group of graduate students is preparing several scenarios for discussion. These scenarios will address some of the values and benefits identified at the two previous symposia, theories of transboundary water management, and lessons from previous transboundary water management case studies. This poster will describe the scenario building process and its potential contributions to the regional dialogue.

Keywords: Columbia River Treaty; Re-examination; Water management scenarios

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POSTER

Building a Database on Best Management Practices for Pesticide Applications to Aquatic Environments and NOAA Trust Species

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ABSTRACT

Pesticides are widely used to control undesirable pests and may be applied directly to water or lands directly adjacent to water. Pesticides are an option for habitat restoration but there can be unintended consequences to native, threatened and endangered species. There is very little information on the impacts of pesticides and best management practices (BMPs) on NOAA Trust Species. The purpose of this project is to develop a comprehensive report of pesticide best management practices for use in aquatic environments and relate these BMPs for the protection of aquatic species, specifically NOAA Trust Species. The project focuses on aquatic pesticides including insecticides, fungicides, algaecides, herbicides, piscicides, molluscicides and mosquitocides. The final product will include a database of pesticide label information, empirical data on the acute and chronic toxicity of each pesticide and its formulations, identify gaps in knowledge to pesticide use, trends, fate in aquatic systems, synergistic effects and best management practices for NOAA Trust Species. Life history and biogeography data for each NOAA Trust Species will be used along with toxicity data to determine the greatest risk for exposure/impact to help inform BMPs. NOAA needs this information to develop a pesticides general permit application as it relates to NOAA Trust Species. Challenges of this project include addressing NOAA Trust Species when there is very limited direct impact data as well as extrapolating data from surrogate species which may have more toxicity and impact data. Another challenge is creating a database that is intuitive and useful for managers in making decisions about pesticide use and restoration for NOAA Trust Species.

Keywords: Best Management Practices (BMPs); Pesticides management practices; Aquatic environments; Database; NOAA

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POSTER

Assessment of Climate Change Impacts over the Willamette River Basin Using NARCCAP Dynamically Downscaled Datasets

Andrew Halmstad, Mohammad Reza Najafi, Hamid Moradkhani

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ABSTRACT

One important aspect related to the management of water resources under future climate variation is the occurrence of extreme precipitation events. In order to prepare for extreme events, namely floods and droughts, it is important to understand how future climate variability will influence the occurrence of such events. Recent advancements in regional climate modeling efforts provide additional resources for investigating the occurrence of these extreme events at scales that may be useful for regional watershed modeling. This study utilizes data provided by the North American Regional Climate Change Assessment Program (NARCCAP) in order to investigate the occurrence of extreme precipitation events. The NARCCAP program utilizes six regional climate models (RCMs) driven by multiple atmosphere-ocean general circulation models (AOGCMs) focusing on the North American continent. Currently data from five RCM-AOGCM combinations is publicly available from NARCCAP. A comparison between observed (via TRMM satellite and in-situ data) historical precipitation events and NARCCAP modeled historical conditions was performed in order to investigate the reliability of the regional modeling efforts. Future scenarios provided by NARCCAP efforts, forced using the A2 SRES scenario, were also investigated in order to capture the expected variation of these events under future climates.

Keywords: Climate change; Willamette River Valley; North American Regional Climate Change Assessment Program (NARCCAP)

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POSTER

Simulation of Ground-Water Flow in the Willamette Basin and Central Willamette Sub-basin, Oregon

Nora B. Herrera, Erick R. Burns, Terrence D. Conlon

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ABSTRACT

The demand for water in the Willamette basin due to an increasing population and irrigation, and the full appropriation of tributary stream flow during the summer months creates an increasing demand for ground water in the region. An increase in ground water use potentially creates further depletion of stream flow, seasonal and long-term declines in ground water levels, and limitations due to low-permeability aquifers suitable for low demand uses only. In 1996, the U.S. Geological Survey and the Oregon Water Resources Department began a cooperative study to develop a quantitative conceptual understand of the ground water flow system of the Willamette River basin and central Willamette valley sub-basin. Regional and local models of the Willamette basin, and central Willamette sub-basin show a significant amount of discharge to the Willamette River is captured by wells located throughout the basin. Transient modeling of the central Willamette sub-basin indicate a buffering effect on smaller streams in the basin from the lower permeability Willamette silt unit when pumping from the lower sedimentary unit; however, this effect is diminished when pumping from the middle or upper sedimentary units. Temporal effects of pumping are demonstrated with most summer pumping initially being supplied by water released from aquifer storage; however, average annual discharge from and recharge to storage will go to zero over time, and total stream capture will equal average annual pumping. Aquifer geometry and stream incision control the ultimate effects of well pumpage on streams in the Willamette basin.

Keywords: Ground water; Willamette River basin; modeling

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POSTER

Comparison of Discharge in the Smith River and Siuslaw River: an Investigation into Preparing Hydrologic Data for Comparison with Coho Salmon Run-Timing Data

Rachel LovellFord, Becky Flitcroft, Mary Santelmann

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ABSTRACT

Coastal Oregon streams are home to coho salmon (*Oncorhynchus kisutch*), a federally listed species (Endangered Species List-threatened). Coho life strategies, genetically passed from one generation to another, have been shaped by the unique geomorphology and hydrology of streams in the Pacific Northwest. Understanding the plasticity of spawning coho run-timing can assist in planning for effective conservation and, restoration. It is common practice to assume that adult spawner run-timing, although genetically determined, is signaled by the onset of winter precipitation and associated increases in stream discharge. However, this has not been quantified in a manner that can be used predicatively. We are working to compare long-term run-timing and spawning data with stream discharge and temperature in the Oregon Coast Range. Several data sets have been identified, but there exist large gaps in discharge and temperature data spatially and temporally. To remedy this data gap, we will explore several established model techniques for ungauged systems, (Wiginton et al. 2003, EPA techniques). Preliminary exploration of model techniques will be presented to compare approaches and describe the effectiveness of modeling several ungauged streams in the Oregon Coast Range.

Keywords: Endangered species; Coho salmon; Run-time; Spawning; Stream discharge; Smith River; Siuslaw River

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POSTER

Improving the Ensemble Streamflow Forecast Using a New ESP Adjustment Method

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ABSTRACT

The quality of Ensemble Streamflow Prediction (ESP) produced by any hydrological model is affected by various uncertainties in model structure and parameters, meteorological forcings, and initial conditions. To improve the forecast skill of ESP, the bias correction methods such as quantile mapping are applied to streamflow hind-casts without any knowledge of uncertainty sources. Using the Precipitation-Runoff Modeling System (PRMS), a distributed parameter hydrologic model, this study simulates the streamflow timeseries for Sprague River Basin, a sub-basin of the Upper Klamath basin, in southwestern Oregon. A bias correction method is then proposed and applied to the ensemble of streamflow forecasts for the region. The proposed method produces multiple ESPs for a series of years preceding the forecast date, and then probability distributions associated to any particular forcing are generated. The underlying procedure implicitly pronounces the impacts of initial conditions in bias correction of forecast traces. Probabilistic assessment of forecast skill demonstrates the effectiveness of proposed method with a significant improvement comparing to conventional bias correction techniques. The Ranked Probability Skill Score (RPSS) enhances from 0.28 for conventional ESP to 0.4 for bias corrected traces using the new method which implies 43% improvement in forecast skill.

Keywords: Ensemble Streamflow Prediction (ESP); Improved forecasting; Sprague River Basin

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POSTER

Incorporating Climate Signals for Improved Ensemble Streamflow Prediction

Mohammad Reza Najafi, Hamid Moradkhani

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ABSTRACT

Ensemble Streamflow Prediction (ESP) provides the means for statistical post-processing of the forecasts and estimating the inherent uncertainties. On the other hand large scale climate variables provide valuable information for hydrologic predictions. In this study we propose a post-processing procedure that assigns weights to streamflow ensemble members using these large scale climate signals. Analysis is performed over the snow dominated East River basin in Colorado to improve the spring ensemble streamflow volume forecast. We employ Fuzzy C-Means clustering method for the weighting and it is found that Principle Component Analysis (PCA) improve the accuracy of the weighting scheme considerably. The presented objective method can be applied to enhance the final ESPs; nevertheless the user expertise may change any of the process steps. The current predictions based on simple average or the median of the ensemble members may come with the weighted ensemble forecasts to better provide possible ranges and uncertainty bounds.

Keywords: Ensemble Streamflow Prediction (ESP); Large-scale climate variables, East River Basin

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POSTER

Floodplain Groundwater Levels and River Restoration: Middle Fork John Day River, Oregon

Tara O'Donnell

Water Resources Program, Oregon State University, Corvallis, OR

ABSTRACT

Floodplain groundwater levels have received attention in the field of river restoration, particularly for restoration projects which aim to raise streambed elevation or "reconnect" rivers with their floodplains. The Middle Fork John Day River in eastern Oregon has been the subject of several such river restoration projects, and floodplain groundwater levels have been monitored continuously there for three years. This poster presentation presents an analysis of this groundwater level data and examines the significance of floodplain aquifers for stream temperature and restoration goals.

Keywords: Groundwater; River restoration; Middle Fork John Day River

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POSTER

Climate Warming, Soil Moisture Dynamics, and Water Budget Partitioning: Experimental Results from a Willamette Valley Ecosystem

Luke Pangle

Oregon State University, Corvallis, OR

ABSTRACT

There is reasonable expectation that climate warming will accelerate the hydrologic cycle, resulting in greater evapotranspiration (ET) and reduced groundwater recharge (R) (or stream flow). Though qualitatively intuitive, quantifying these potential shifts in water budget partitioning is a contemporary challenge in hydrology, because the linkage between ET and R is strongly mediated by rainfall periodicity, vegetation, and soil moisture dynamics. This challenge has been accentuated by the Intergovernmental Panel on Climate Change, and is now being addressed primarily through model simulations, which have outpaced experimental efforts due to the overwhelming challenge of measuring the entire water budget in systems with known boundary conditions, and under forecasted alterations in surface air temperatures. We present new data from a controlled-chamber experiment that examines the combined responses of ET, soil moisture (θ), and R to imposed temperature alterations in a Willamette Valley grassland ecosystem. Temperature treatments include an average increase of 3.5˚C, applied both symmetrically throughout the day, and asymmetrically such that daily minimum temperature is 5˚C greater than ambient and daily maximum temperature is 2˚C greater than ambient. Given the Mediterranean climate of this region, where rainfall and ET occur largely out of phase, we hypothesized that increasing surface air temperatures would accelerate and enhance plant growth and ET during the spring season, abbreviating the period when R occurs. Counter-intuitively, over a three year period we observed only modest enhancements of ET during the spring period under 3.5˚C warming. The most salient effect was observed during the 2008 water year, when average-cumulative ET was 26-44% and 32-41% greater on April 30 under symmetric and asymmetric warming scenarios, respectively, than under ambient climate conditions. Corresponding acceleration of θ depletion was also observed, although there was no immediate effect on R. The cumulative effect of accelerated ET and θ depletion on R only became evident during late spring rain events (May-June), when average R generated under ambient climate conditions was 160-190% greater than under either warming scenario, although these events accounted for less than 6% of total R in any year. Collectively, the results demonstrate that annual water budget partitioning in Willamette Valley grasslands is unaltered by a 3.5˚C increase in average air temperature. The temperature-driven enhancement of ET is modest and inconsequential for R during the short inter-storm time intervals typical during the spring. The contrasting seasonality of rainfall (and resulting R) and ET is the dominant climate feature determining annual water budget partitioning in the Willamette, and is here shown to effectively ameliorate the potential impact of a 3.5˚C warming signal on the annual water budget.

Keywords: Willamette Valley; Water budget; Soil moisture; Climate warming

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POSTER

Development of a Numerical Model for the Walla Walla Basin using IWFM

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ABSTRACT

The Walla Walla basin lies in an arid region on the border of Eastern Washington and Oregon. A large portion of the area is devoted to agricultural production, relying on irrigation water diverted from the Walla Walla River and underlying aquifers occurring within Quaternary gravel and Mio-pliocene basalt formations. Heavy water demand over summer months has resulted in a fully allocated surface water supply and significant drawdown in groundwater levels. This has led to several proposals for water management aimed at increasing the efficiency of water use and the potential for seasonal storage using shallow aquifer recharge. Specific research questions relate to the interaction between surface and groundwater with regard to agricultural use, aquifer recharge, and factors such as leakage through permeable canal beds. There is currently an ongoing effort to develop a hydrologic model using Integrated Water Flow Model (IWFM) software to simulate surface and subsurface flows over a portion of this watershed. This work is a collaborative effort between a research team from Oregon State University and the Walla Walla Basin Watershed Council (WWBWC). The modeling process includes model setup, data collection and input, parameter estimation, estimation of initial and boundary conditions, model calibration, error analysis, and validation. This application of IWFM uses grid with average spacing of 100 * 100 meters. Data sources include federal and state agencies as well as WWBWC staff. Parameters have been determined with field measurements when possible, and otherwise are estimated using established methods of hydrologic analysis or values drawn from previous studies within the region.The model is being developed using data from 2007 through 2009. Analysis using the Nash-Sutcliffe method yields a value .75 for surface. Simulated groundwater elevations at 88 well locations show a mean discrepancy of 2.9 meters, with a standard deviation of 4.2 meters, when compared to recorded data. Upon validation of this model, it is intended as a tool for informing decisions related to water resource management in this region. Hypothetical scenarios may include the further development of aquifer recharge sites, lining or piping of irrigation canals, and systemic responses to climate change.

Keywords: Walla Walla River; Integrated Water Flow Model (IWFM); Watershed management

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POSTER

Using Partnership and Prioritization to Achieve Whole Watershed Restoration in the Pacific Northwest

Lauren Senkyr, Megan Callahan Grant

NOAA Restoration Center, Portland, OR

ABSTRACT

The goal of the Whole Watershed Restoration Initiative (WWRI) is to restore natural functions of whole watersheds in Oregon, Washington, and Idaho, while amplifying community-based partnerships focused on the strategic restoration of Pacific salmon and steelhead ecosystems. The WWRI partners (Ecotrust, NOAA Restoration Center, the U.S. Forest Service's Pacific Northwest Region, and Oregon Watershed Enhancement Board) are shifting the project selection and funding paradigm within our region from *opportunistic* to *strategic* by identifying "priority basins" and "focus watersheds" that represent shared regional priorities. Partnership funds are targeted to these areas in order to produce meaningful, measurable progress toward whole watershed restoration and salmon recovery. The collaborative identification of priorities is based on the convergence of several prioritization approaches: 1) Ecotrust's Conservation Opportunity Area modeling tool; 2) the Forest Service's Aquatic Restoration Strategies; and 3) NOAA-approved salmon recovery plans. Overlain together this prioritization approach identified 9 priority basins containing 28 focus watersheds throughout Oregon, Washington and Idaho. In the past 3 years the WWRI has provided over $5 million to 80 salmon and watershed restoration projects in the area. The proposed poster will focus on the technical framework for identifying priority basins and focus watersheds, and on the partnership's approach to measuring progress toward completion of major restoration priorities on a watershed scale.

Keywords: Whole Watershed Restoration Initiative (WWRI); Oregon; Washington; Idaho; Pacific salmon and steelhead

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POSTER

A Hydroecology Investigation of Two Incised Riparian Wet Meadows Relating Change in Vegetation Communities with Headcut Incision and Soil Properties, Ochoco Mountains, OR

Jamie Sheahan

Resource Management, Central Washington University, Ellensburg, WA

ABSTRACT

The inter-relationships of vegetation, soils, and stream channel erosion characteristics were examined in two riparian meadows of the Ochoco National Forest where progressive stream headcut incision is a critical resource management issue and restoration priority. Scientific literature establishes that headcut incision leads to lower groundwater tables, with corresponding shifts in neighboring vegetation from communities tolerant of wetter conditions to those of drier conditions, yet further research is needed in examining the degree headcut height and soil properties control this relationship. By incorporating headcut incision height and soil properties (particle size distribution, percent organic matter, percent soil moisture, and pH) as additional drivers of soil moisture availability, and thus vegetation change, fieldwork included extensive sampling of soils, vegetation, and stream characteristics. Percent canopy cover by vegetation species was surveyed in systematically placed Daubenmire plots along cross-valley transects. Each plot was later assigned a hydric rating score based on weighted percent cover by hydric indicator status (OBL, FACW, etc). Due to the greater degree of water table drawdown associated with more pronounced incision, I hypothesized that change in hydric rating scores of vegetation communities downstream of the headcuts will be positively correlated with the height of headcuts, and less so with change in soil texture. Preliminary results will be highlighted.

Keywords: Ochoco Mountains; Hydroecology; Headcut incision; Riparian vegetation; Wet meadows

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POSTER

Processing of Sediment Pulses Following the Removal of Three Small, Gravel-Filled Barriers

Cara Walter

Oregon State University, Corvallis, OR

ABSTRACT

The decommissioning of dams, as an approach to restoring longitudinal connectivity and to managing aging infrastructure, presents valuable opportunities for organized study of channel responses to sediment pulses. Experiments with physical and numerical models suggest that rivers process coarse sediment pulses primarily through dispersion. In contrast, translation appears to be a more important process when the sediment pulse consists of finer material, particularly when the grain sizes are finer than is typically present in the river. While the reported physical and numerical experiments have provided valuable insight into expectations channel dynamics, they are largely unconfirmed by field observations. To explore whether dispersion dominates the processing of gravel pulses in natural rivers, we investigated channel changes associated with three barrier removals in Oregon, ranging from very small (Oak Creek culvert, height = 1.5m), small (Brownsville Dam, height = 2.5m), to medium (Savage Rapids Dam, height = 12m) in size. Each trapped coarse sediment initially after construction, after which bedload passed over or through the barriers. Material behind the barriers was finer than the dominant grains downstream at Oak Creek and Savage Rapids, but was coarser than dominant channel grains at Brownsville. We present results from post removal bathymetric and substrate surveys for two years at Brownsville and Oak Creek, and one year at Savage Rapids.

Net deposition and scour, with error estimates, were calculated from surface differencing, both in the reservoir and downstream of the former barriers. We also characterized features of the stored sediment (e.g. ratio of reservoir D50 to averaged surface D50 in downstream reach, sediment volume) and the channel (e.g. Froude number, slope) to place these sites in context with other analyses of sediment pulses. Our results suggest that, at all sites, sediment is processed by both dispersion and translation, though dispersion appears to be the more dominant process. Further, the channels processed sediments rapidly, eroding substantial portions of reservoir material within the first two years following removal. These results suggest that, in the case of small to medium reservoirs filled with non-cohesive material, substantial aggradation will likely be limited to local areas directly downstream of the dam.

Keywords: Dam removal; Sediment pulses; Oak Creek

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POSTER

Using Local Citation Data to Develop a Locally Relevant Water Resources Information Guide

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ABSTRACT

Citation analysis can inform many aspects of information science and can support research endeavors in a discipline as well. Citation analysis in librarianship often addresses either collection development and management issues or information literacy aspects of students' information resource use. A basic benefit for librarians doing local citation analysis is tracking specific ways information resources are being used. This type of analysis can be shared with researchers who want to know about valuable resources their colleagues are using. One method of sharing this information is through online subject guides. Developing research guides for specific subject areas is a common practice for academic subject librarians. The guides highlight resources available locally and regionally (print and digital) and often highlight selected relevant free internet resources (such as government agency information). The purpose of the guides is to help scholars navigate the complex web of resources available to them. Research guides are typically developed for a specific audience – primarily researchers at a university. Populating a research guide with content relevant to undergraduate and graduate students, and faculty, and that is also freely accessible to the general public can be challenging. The authors of this poster session will demonstrate the value of a local citation analysis (in this case on Water Resources Program theses and dissertations published from 2004-2009) in the creation of a well-rounded water resources subject guide. The authors will overview the citation analysis findings, apply those findings to development of the guide, and highlight aspects of the guide improved by the citation data. The authors anticipate that commonly referenced books, journals, and web resources will be integrated into the guide as a result of their analysis.

Keywords: Water resources information guide; Citation analysis; Oregon State University