MAY 24-25, 2011 | CH2M HILL ALUMNI CENTER
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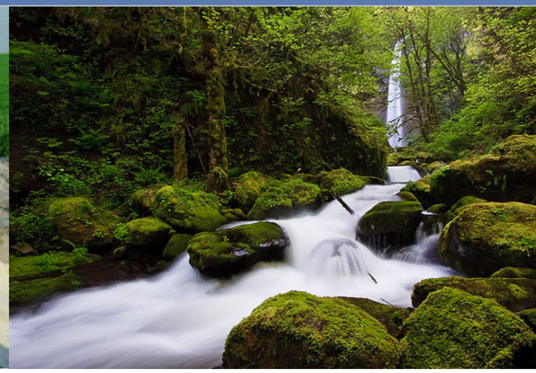


THE OREGON WATER CONFERENCE 2011

Evaluating and Managing Water Resources in a Climate of Uncertainty

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THE OREGON WATER CONFERENCE 2011 PROGRAM

Tuesday, May 24, 2011			
7:30 – 8:15 AM	Conference Registration and Continental Breakfast		
8:15 – 8:30 AM	Welcome, Announcements and Introduction – Michael E. Campana		
8:30 – 9:15 AM	Plenary Speaker: Dr. Philip Mote – Oregon Climate Change Research Institute "Envisioning Future Northwest Climate and Water Availability"		
Morning Sessions	**Groundwater Session** **Marshall Gannett – Chair** (11 Speakers)	**Climate Change Session** **Heejun Chang – Chair** (8 Speakers)	**Stream Restoration Session** **Ivars Steinblums – Chair** (5 Speakers)
9:30 – 10:00 AM	**Alison Aldous (TNC)** – How Much Groundwater Does a Wetland Need? Setting Ecological Water Requirements for Groundwater- Dependent Ecosystems	**David Curtis (WEST Consultants)** – Climate Change: Natural Variability is a Big Deal Too!	**Brian Chaffin (OSU)** – Characterizing Collaboration in the Klamath River Basin: An Exercise in Institutional Mapping
10:00 – 10:30	**Trish Carroll (USFS)** – Managing Ecological Water Requirements for Groundwater- Dependent Wetlands on National Forests: A View from the Bottom Up and the Top Down	**Shahrbanou Madadgar (PSU)** – Assessment of Climate Change Impacts on Drought Return Periods Using Copula Functions	**Wendy McDermott (CWU)** – The Life Cycle of Dams: An Analysis of Policy Change on the Rogue River, Oregon
10:30 – 11:00	**Suzanna Moellendorf (GSI, Inc.)** – A Collaborative Effort to Evaluate Water Resources in Lower Siuslaw Watershed	**II-Won Jung (PSU)** – Climate Change Impact on Drought Risk and Uncertainty in the Willamette River Basin	**Matthew Cox (OSU)**— Linkage Between Geomorphic and Biological Responses of a River to Dam Removal: A Case Study from the Chiloquin Dam on the Sprague River, Oregon
11:00 – 11:15	**Break**	**Break**	**Break**
11:15 – 11:45	**Jonathan La Marche (OWRD)** – Hydrologic Monitoring and Trends in the Upper Klamath Basin over the Last Decade	**M. Scott Waibel (PSU)** – Assessment of Hydrologic Response to Climate Change in the Upper Deschutes River Basin, Central Oregon	**Todd Reeve (BEF)** – Water Restoration Certificates: TM Building a Bridge Between Urban Water Users and Flow Restoration Needs in the Rural West
11:45 – 12:15 PM	**Tim Mayer (USFWS)** – Assessing Streamflow Response to Climate Change: Why Geology Matters	**John Risley (USGS)** – Hydrologic Response to Climate Change in the Sprague River Basin, Oregon	**Mark Buckley (ECONorthwest)** – Economic Implications of Climate Change on Ecosystem Restoration Projects with a Beaver Case Study
12:15 – 1:30 PM	**Luncheon**	**Luncheon**	**Luncheon**
Afternoon Sessions	**Groundwater Session** **Marshall Gannett – Chair** (Continued)	**Climate Change Session** **Heejun Chang – Chair** (Continued)	**Panel Session 1** Oregon's Integrated Water Resources Strategy

1:30 – 2:00 PM	**Gordon Grant (USFS-PNW Research Station)**—What Will Oregon's Future Streamflow Regimes Look Like? Integrating Snowpack and Groundwater Dynamics	**Cheryl Brown (EPA)**--Effects of Climate Change on Water Quality in the Yaquina Estuary, Oregon	**Brenda Bateman** (Senior Policy Coordinator-Oregon Water Resources Department) Moderator and Panelist **Bruce McIntosh** (Fish Division Deputy Administrator, Inland Fisheries-Oregon Department of Fish and Wildlife)
2:00 – 2:30	**Mohammed Safeeq (OSU) --** Sensitivity of Oregon's Watersheds to Streamflow Changes due to Climate Warming: A Geohydrological Approach	**Michael E. Campana (OSU)–** Climate Change and Oregon's Water Future	**Stephanie Paige** (Renewable Energy Specialist-Oregon Department of Agriculture)
2:30 – 3:00	**Evan Miles (OSU)**--GIS and Wells: An Examination of Groundwater in Benton County by Georeferencing Well Logs	**Heejun Chang (PSU)**--Climate Change and Shifts in Water-Related Ecosystem Services in the Tualatin and Yamhill River Basins	**Eugene Foster** (Manager, Water Management Section-Oregon Department of Environmental Quality)
3:00 – 3:30	**Break**	**Break**	**Break**
Afternoon Sessions	**Groundwater Session** **Marshall Gannett – Chair** (Continued)	**Hydrologic Monitoring Session** **Jolyne Lea—Chair**	**Panel Sessions, Cont'd.** **Panel Session 2** People, Beavers, Wolves, and Water: New Approaches to Restoring Complexity, Function and Water Storage Capability to Degraded Stream/Riparian Corridors on Public and Private Lands
3:30 – 4:00 PM	**Michael Cummings (PSU)** Groundwater Storage and Flow in an Unconfined Pumice Aquifer, Antelope Unit, Chemult Ranger District, Winema-Fremont National Forest, Oregon	**Rich Marvin (OWRD)** Tracking Oregon's Water Resources: An Overview of Available Data and a Pitch for a United Network	**Suzanne Fouty** (Hydrologist) --Moderator and Panelist
4:00 – 4:30	**Kenneth Lite (OWRD)--** Surface Water Interaction with "Confined" Columbia River Basalt Aquifers-Impacts to Streams from Declining Groundwater Levels Near Mosier, Oregon	**Daniel Dammann (BLM)--** Wolf Creek Monitoring	**Robert Beschta** (Professor Emeritus-OSU) **Rick Demmer** (Wildlife Biologist-Bureau of Land Management, Prineville District)

4:30 – 5:00	**Marshall Gannett (USGS)—** Coupled Simulation and Optimization Models for Managing Groundwater in the Upper Klamath Basin, Oregon and California	**Jonathon LaMarche (OWRD)**--Oregon Stream Gaging Network Evaluation-Meeting OWRD's Current and Future Data Needs	**Leonard Houston** (Beaver Advocacy Committee)
5:00 – 6:30	**Poster Session with Reception and No-Host Bar**		

Wednesday, May 25, 2011			
7:30 – 8:00 AM	Continental Breakfast		
Morning Sessions	**Water Quality Session** <u>**Rudd Turner-Chair**</u> (12 Speakers)	**Water Management Session** <u>**Michael E. Campana- Chair**</u> (12 Speakers)	**Panel Sessions, cont'd.** <u>**Panel Session 3**</u> Integrating Climate Adaptation Planning and Watershed Assessments to Improve Community-Engaged Watershed Management: A Case Study from the Klamath Basin, Oregon
8:00 – 8:30	**Jennifer Morace (USGS)**-- Reconnaissance Investigation of Emerging Contaminants in Wastewater Treatment Plant Effluent and Stormwater Runoff in the Columbia River Basin	**Julie Watson (OSU)**--A River Won: Tapping into Stakeholder Values and Identifying Points of Leverage for Holistic Shared Management of the Columbia River	**Ethan Rosenthal** (David Evans and Associates, Inc.)—Co-moderator **Stacy Vynne** (Climate Leadership Initiative)—Co-moderator
8:30 – 9:00	**Kristel Fesler (City of Hillsboro)**--A Greenhouse Gas Inventory of a Conventional Water Treatment Plant	**Aaron Wolf (OSU) and Dena Marshall (Marshall Mediation)**-- Water Conflict Management and Transformation in the Pacific Northwest and the World - 1	**Ken Bierly** (Deputy Director-Oregon Watershed Enhancement Board) **Terry Fisk** (Hydrologist-U.S. Fish and Wildlife Service, Klamath Falls office)
9:00 – 9:30	**Jason Keller (GeoSystems Analysis)**-- The Orange County Water District Riverbed Filtration Pilot Project: Solids and Organic Carbon Removal Using Induced Riverbed Infiltration	**Aaron Wolf (OSU) and Dena Marshall (Marshall Mediation)**-- Water Conflict Management and Transformation in the Pacific Northwest and the World - 2	**Greg Addington** (Director-Klamath Water Users Association) **Nathan Jackson** (Director-Klamath Watershed Partnership)
9:30 – 10:00	**Break**	**Break**	**Break**
Morning Sessions	**Water Quality Session** <u>**Rudd Turner-Chair**</u> (Continued)	**Water Management Session** <u>**Michael E. Campana- Chair**</u> (Continued)	**Panel Sessions, Cont'd.** <u>**Panel Session 4**</u> Transboundary River Governance – The Columbia River Treaty 2014/2024 Review

10:00 – 10:30 AM	**Madeline Steele (PSU)**--Spatial and Temporal Patterns in the Influence of Land Use on Water Quality in Five Portland Area Creeks Representing Differing Levels of Urbanization	**Monica Hubbard and Erika Wolters (OSU)**--Development of an Integrated Water Resources Strategy: Assessing the Public's Values, Knowledge, Perception of Risk, and Acceptability of Management Strategies	**John Shurts** (General Counsel-Northwest Power and Conservation Council)—Moderator and Panelist **John Hyde** (Technical Lead, Columbia River Treaty Review-Bonneville Power Administration)
10:30 – 11:00	**Baek Soo Lee (OSU)**--Water Quality Data Synthesis in the Metolius River Basin, Oregon	**Teresa Huntsinger (OEC)**--Developing an Agricultural Water Efficiency Strategy to Help Meet Oregon's Water Needs	**Matt Rea** (Program Manager, Columbia River Treaty-U.S. Army Corps of Engineers)
11:00 – 11:30	**Harmony Paulsen (OSU)**--Managing for Ecosystem Services Through Governance Networks: An Analysis of Oregon Senate Bill 513	**Mark Anderson (CH2M Hill)**--Building a Legacy: Integrated Water Resources Management in Damascus, Oregon	**Paul Lumley** (Executive Director-Columbia River Inter-Tribal Fish Commission)
11:30 – 12:00	**Renée Brooks (EPA)**--Seasonal and Elevational Variation of Surface Water $\delta_{18}O$ and $\delta_{2}H$ in the Willamette River Basin	**Adam Stebbins (Benton County)**--Willamette Basin Water Futures: County Partnerships with Scientists' Cutting-Edge Models	**Kindy Gosal** (Director, Water and Environment-Columbia Basin Trust)
12:00 – 1:30 PM	**Luncheon**	**Luncheon**	**Luncheon**
12:45 – 1:30 PM	**Matt Jones--Allen County (IN) Partnership for Water Quality, will show *A Watershed Mentality* , a PBS documentary film.**		
Afternoon Sessions	**Water Quality Session** **Rudd Turner-Chair** (Continued)	**Water Management Session** **Michael E. Campana- Chair** (Continued)	**Hydrologic Modeling Session** **Jolyne Lea- Chair** (5 Speakers)
1:30 – 2:00 PM	**James Coyle (ODEQ)**-- -Toxic Pollutants Measured in Surface Water and Fish Collected from the Willamette River Basin by the Oregon Department of Environmental Quality (2008 - 2010)	**Arturo León (OSU)**--A Novel Physically-Based Framework for the Intelligent Control of River Flooding	**Daniel Wise (USGS)**--Relating Surface Water Nutrients in the Pacific Northwest to Watershed Attributes Using the USGS SPARROW Model
2:00 – 2:30	**Elena Nilsen (USGS)**--Emerging and Legacy Contaminants in POCIS, SPMDs, and the Largescale Sucker (*Catostomus macrocheilus*) in the Lower Columbia River-USGS ConHab Project	**Karl Morgenstern (EWEB)**--Source Water Protection in a Climate of Change: Perspectives from a Publicly-Owned Utility	**Eset Alemu (WEST Consultants)**--A Decision Support System for Optimizing Reservoir Operations Using Ensemble Streamflow Forecasts

2:30 – 3:00	**Valerie Kelly (USGS)--** Integrated Water Quality Assessment Using Conventional, Passive Sampling, and Metabolic Assay Techniques: Approaching System-Level Understanding of Risk	**Jamison Cavallaro (Willamette Falls Watershed Assoc.)--**Growth Management-Oriented Water Conservation and Reuse in Oregon: Operationalizing Integrated Watershed and Water Resources Management	**Shali Bogavelli (WEST Consultants)--**Flood Forecast Modeling of the Willamette Basin using HEC-CWMS and HEC-ResSim
3:00 – 3:15	**Break**	**Break**	**Break**
3:15 – 3:45	**Michelle Jordan (OSU)--** Influence of Hydraulics and Streamflow Regime on the Habitat of *Manayunki speciosa* , the Definitive Host of the Salmonid Parasite *Ceratomyxa shasta*	**Jesse J. Richardson, Jr. (Water Systems Council/Virginia Tech)--** Exempt Wells in the Courts, Agencies and Legislatures	**Eric Sproles (OSU)—** Characterizing Rain/Snow Partitioning in Mountain Watersheds for Present-Day and Future Projected Climates
3:45 – 4:15	**Ricardo González-Pinzón (OSU)--** Quantitative Relationship Between Resazurin and Respiration in Stream Ecosystems	**Brian Watson (Tetra Tech)--**Assimilative Capacity Modeling in Support of the Georgia Comprehensive State-Wide Water Management Plan	**Rick Shimota (WEST Consultants)--** Continuous Hydrologic Simulation of the Johnson Creek Basin
4:15 PM	**Closing Remarks and Adjourn**	**Closing Remarks and Adjourn**	**Closing Remarks and Adjourn**

Poster Session – The Oregon Water Conference 2011

Caleb DeChant (PSU) – Enhancing Prediction of Streamflow in Snowmelt Dominated Basins through Assimilation of Remotely Sensed Data

Chris Gabrielli (OSU) – Bedrock Groundwater Contributions to Hillslope Runoff Processes: A Comparative Analysis

Brendan Galipeau (OSU) – Capitalizing on Uncertainty: Use of Scenario Development and Planning in Regional Dialogues of the Columbia River Treaty

Kelsey Gianou (OSU) – Building a Database on Best Management Practices for Pesticide Applications to Aquatic Environments and NOAA Trust Species

Andrew Halmstad (PSU) – Assessment of Climate Change Impacts over the Willamette River Basin Using NARCCAP Dynamically Downscaled Datasets

Jonathan La Marche (OWRD) – Hydrologic Monitoring and Trends in the Upper Klamath Basin over the Last Decade

Shahrbanou Madadgar (PSU) – Improving the Ensemble Streamflow Forecast Using a New ESP Adjustment Method

Mohammad Reza Najafi (PSU) – Incorporating Climate Signals for Improved Ensemble Streamflow Prediction

Tara O'Donnell (OSU) – Floodplain Groundwater Levels and River Restoration: Middle Fork John Day River, Oregon

Luke Pangle (OSU) – Climate Warming, Soil Moisture Dynamics, and Water Budget Partitioning: Experimental Results from a Willamette Valley Ecosystem

Jacob Scherberg (OSU) – Development of a Numerical Model for the Walla Walla Basin using IWFM

Lauren Senkyr (NOAA) – Using Partnership and Prioritization to Achieve Whole Watershed Restoration in the Pacific Northwest

Jamie Sheahan (OSU) – A Hydroecology Investigation of Two Incised Riparian Wet Meadows Relating Change in Vegetation Communities with Headcut Incision and Soil Properties, Ochoco Mountains, OR.

Cara Walter (OSU) – Processing of Sediment Pulses Following the Removal of Three Small, Gravel-Filled Barriers

Andrea A. Wirth (OSU) – Using Local Citation Data to Develop a Locally Relevant Water Resources Information Guide

Groundwater Session
Marshall W. Gannett, Chair
Tuesday, May 24
9:30 AM – 5 PM

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

How Much Groundwater does a Wetland Need? Setting Ecological Water Requirements for Groundwater-Dependent Ecosystems

Allison Aldous[1], Joe Gurrieri[2], Roger Congdon[3], Trish Carroll[4], Leslie Bach[1]

[1]The Nature Conservancy, Portland, OR; [2]USDA Forest Service, Golden, CO; [3]USDA Forest Service, Albuquerque, NM; [4]USDA Forest Service, Portland, OR

ABSTRACT

Many freshwater ecosystems are sustained by a continuous supply of clean groundwater. For example, groundwater may provide late season baseflow to rivers or a sustained high water table in wetlands. These ecosystems, termed GDEs, often are affected by management activities that reduce, interrupt, or contaminate their groundwater supply, including groundwater pumping and waste disposal. Despite these issues, no methods exist to set limits to groundwater extraction or contamination to protect these ecosystems. To address this need, The Nature Conservancy and USDA Forest Service are developing methods for setting thresholds to groundwater change, termed Ecological Water Requirements. Here we discuss this method applied to three wetlands from which water is extracted to water livestock in the Fremont and Winema National Forests.

We evaluated the Ecological Water Requirements for GDEs in two steps. First, we developed empirical relationships between the groundwater-driven hydroperiod, and two key ecological parameters: indicator plant distributions and peat accretion. We did this by collecting data on hydroperiod fluctuations, species distributions, and peat depths. We then used these quantitative relationships to determine water table thresholds beyond which these ecological parameters could be impaired. Second, we used MODFLOW to evaluate the potential dewatering effects of pumping on these wetlands. A 4-layer model was constructed (peat, muck, pumice, bedrock). The muck is simulated as a thin, leaky confining layer between the peat and pumice. Pumping was simulated in the pumice layer to evaluate effects to water table depth in the peat. This was compared to the threshold data obtained in the first step.

We identified 14 indicator species and peat accretion rates which only occur where the depth to water table was less than 15cm, thus we established this as our threshold for the model. Hydraulic parameters were varied, but for each scenario, pumping at predicted rates of 0.009 L/sec for 75 days produced a maximum drawdown in the peat that did not exceed the 15cm drawdown threshold. These data are being used to inform grazing management on this national forest. We plan to refine these methods to help evaluate ecological water requirements more broadly in a variety of settings.

Keywords: Groundwater; GDE; Ecological water requirements; Wetland; Peatland

Managing Ecological Water Requirements for Groundwater-dependent Wetlands on National Forests: A View from the Bottom Up and the Top Down

Trish Carroll[1], Mike Nevill[2], Allison Aldous[3], Leslie Bach[3], Joe Gurrieri[4]

[1]USDA Forest Service, Portland, OR; [2]USDA Forest Service, Paisley, OR; [3]The Nature Conservancy, Portland, OR; [4]USDA Forest Service, Albuquerque, NM

ABSTRACT

The USDA Forest Service and The Nature Conservancy are collaborating on developing a method for setting Ecological Water Requirements (EWRs) for groundwater-dependent wetlands on National Forests and Grasslands to inform groundwater management from the site to the national scale. This method is one piece in a growing Forest Service groundwater resource management program across the United States. The Forest Service has responsibility for management of more than 190 million acres of National Forests and Grasslands located in 42 states and Puerto Rico. In Oregon, approximately 25 percent of the land is managed by the Forest Service. Water from National Forests and Grasslands provides irreplaceable high quality habitat for aquatic, riparian, and terrestrial species, and a sustainable supply of water for humans. In the Western United States, over 65 percent of the water supply for domestic, agricultural, and industrial uses comes from National Forests. The need for a more comprehensive view of water resources is now critical. Until recently, the focus of Forest Service water management has been above ground, but attention has turned to including subsurface flows and groundwater resources. The Forest Service groundwater resource program is organized around management of groundwater-dependent ecosystems (GDEs). Considering the water needs of these GDEs is important to protect and sustain these ecosystems. Methods for determining EWRs for GDEs, is one piece of the inventory and monitoring component of the groundwater program. National protocols for two levels of inventory, broad level characterization and project level support, are completed. Field tests at five pilot sites across the country were completed in 2010. Level 3 Inventory and Monitoring and EWR protocols are under development. The methods for determining EWRs are being developed and tested as part of a grazing management plan revision on the Fremont-Winema National Forests. The concepts and lessons learned will be tested in other settings and refinement of the approach will translate into the National EWR protocol.

Keywords: Groundwater dependent ecosystems; Ecological water requirements, Forest Service; The Nature Conservancy; Management

A Collaborative Effort to Evaluate Water Resources in the Lower Siuslaw Watershed

Suzanne Moellendorf[1], Mike Miller[2], Dennis Nelson[1], Dave Livesay[1]

[1]GSI Water Solutions, Inc., Corvallis, OR; [2]City of Florence Public Works, Florence, OR

ABSTRACT

The City of Florence, local stakeholders, and partner agencies recently formed the Siuslaw Estuary Partnership (SEP) to address threats to drinking water quality and fish and wildlife habitat in the lower Siuslaw watershed. The Sole Source Dunal Aquifer within the lower Siuslaw watershed, which supplies the City 's drinking water, is characterized by rapid infiltration, a shallow water table, and hydrologic connection with area streams, wetlands, and the estuary. These characteristics make the watershed highly susceptible to contamination from surface activity in Florence, the only major urban center in the watershed, and to climate change. Possible sources of aquifer contamination include fuel storage tanks, septic tanks, stormwater runoff, pesticides, and fertilizers. Potential effects from climate change include altered precipitation patterns that increase winter flooding and decrease summer stream flows, increased air and surface water temperatures, and rising sea levels.

The SEP is funded by a 3-year US EPA grant and its objectives are: to collaborate, to conduct scientific investigations, to foster public education and stewardship, to protect water quality and quantity, to plan for ecological growth, and to protect wetlands, riparian areas, and key estuary wetlands. Many of these objectives led to a groundwater and surface water monitoring program to collect baseline data on water quality and quantity. A groundwater flow model was developed to provide hydrogeologic constraints. Sampling of 10 groundwater wells, located to reflect differing land uses and position along groundwater flow paths, and 2 streams began in October 2010 and will continue through November 2012. Parameters sampled regularly in one or both of the water types include: water temperature, conductivity, dissolved oxygen, pH, ORP, turbidity, *E.coli*, groundwater level, and stream flow. Periodically sampled parameters include nitrate, phosphates, volatile organic chemicals, inorganic chemicals, glyphosate,2,4-D, and caffeine. The SEP plans to use the data collected to respond to any contamination discovered, to monitor water quality and quantity over time, to develop sustainable water management practices, and to plan for potential future impacts of climate change. This initiative provides a model for addressing threats to water quality and fish and wildlife habitat using collaboration and scientific investigation.

Keywords: Groundwater; Surface water; Monitoring; Collaboration

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

Hydrologic Monitoring and Trends in the Upper Klamath Basin over the Last Decade

Jonathan L. La Marche, Edward B. Gates, and Kenneth E. Lite Jr.

Oregon Water Resources Department, Bend, OR

ABSTRACT

Over the last decade hydrologic monitoring efforts in the Upper Klamath Basin (UKB) of Oregon have increased in response to the continued strain on surface water and groundwater to meet competing biological and agricultural demands. The Oregon Water Resources Department (OWRD) increased its stream gaging network from three to ten gages, and approximately 80 long–term sites were added to the OWRD and US Geological Survey (USGS) well monitoring network to track both anthropogenic and climate related stresses to the hydrologic system. The expanded monitoring effort accompanied several hydrologic studies to better understand the basin hydrology. A major result of the hydrologic investigations was to quantify groundwater/surface water interactions in the UKB (e.g., Gannett, et. al. 2007). For example, the estimated gross groundwater discharge in UKB is roughly 2600 cubic feet per second (cfs), of which 1800 cfs occurs into or above Upper Klamath Lake—approximately 70 percent of the lakes' gross annual inflow.

Data collected over the last 10 years demonstrate that dry climate conditions persist in the UKB. Recorded precipitation at Crater Lake reveals below normal precipitation in seven of the last ten years. Although near normal precipitation has occurred in the last few years, this trend has only halted not reversed the decadal decline in summer baseflows and groundwater levels at most monitoring locations above Upper Klamath Lake (UKL). The trends in stream baseflows generally follow groundwater levels observed in nearby wells. Most monitoring locations reflect hydrologic lows similar to or slightly above the droughts of 1992 and 1994. USGS stream gages operated on the lower Sprague and Williamson Rivers reflect baseflows similar to those encountered during the drought of the late 1930s and early 1940s.

Below UKL, anthropogenic stresses are more prominent than climate influences on streamflow and groundwater. Streamflow below Link River Dam is entirely regulated. Groundwater monitoring shows the added pumping stresses from expanded use since 2001 have locally produced 15 to 20 feet of decline in the Klamath Valley and Tule Lake sub basin. The increased groundwater pumping has also resulted in a greater amount of seasonal fluctuation.

Keywords: Upper Klamath Basin; Hydrologic monitoring; Hydrologic trends; Anthropogenic stress

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

Assessing Streamflow Response to Climate Change: Why Geology Matters

Tim Mayer

U.S. Fish and Wildlife Service, Portland, OR

ABSTRACT

Climate change will continue to profoundly affect water supply and aquatic ecosystems in the Pacific Northwest. Changes such as warmer air temperatures, increases in the proportion of winter rain versus snow, reduced spring snowpack, and earlier snowmelt all affect streamflow. The response to these climate impacts includes earlier runoff peaks, decreased baseflows, increased summer water temperatures, and increased winter flooding from rain on snow events. Developing effective adaptation strategies to address these impacts requires knowledge on the climate vulnerability of stream ecosystems.

Not all streams in the region respond similarly to the same climate signal. Two important landscape factors influencing the streamflow response to climate are elevation and geology. Elevation and its effects on air temperature and the form of winter precipitation are widely recognized. It is generally thought that basins at intermediate elevations on the cusp of rain-snow transitions will be most susceptible to warmer winter temperatures and reduced snowpack. Less attention has been given to geology and the partitioning of hydrologic flowpaths between surface and sub-surface flow. This partitioning affects summer/fall baseflow volumes, the timing and attenuation of the snowmelt peak, water temperatures, flooding and geomorphic characteristics, and ultimately, the streamflow response to climate.

This study explores some of the streamflow characteristics and responses of groundwater-dominated versus surface-dominated streams to climate and climate change. Baseflows are much greater in groundwater streams and are seasonally very important for sustaining downstream mainstem flows during summer. But these same flows may also be more susceptible to reduced snowpack and earlier snowmelt. Summer water temperatures in groundwater streams are generally cooler and may be less sensitive to warming air temperatures. Flooding risks from rain-on-snow events may be lower as well, since streamflows in these systems are generally more stable and less flashy than in surface-dominated streams. The unique characteristics and responses of groundwater streams demonstrate the importance of considering geology as well as elevation when evaluating streamflow response to climate change, both past and future.

Keywords: Climate change/variability; Rivers/streams; Klamath Basin; Groundwater hydrology; Surface water/Groundwater interactions; Base flow reductions; Upper Klamath Lake

What Will Oregon's Future Streamflow Regimes Look Like? Integrating Snowpack and Groundwater Dynamics.

Gordon E. Grant [1], Christina Tague [2], Mohammad Safeeq, Sarah Lewis[3]

[1]USDA Forest Service, PNW Research Station, Corvallis, OR; [2]Bren School, University of California, Santa Barbara, Santa Barbara, CA;
[3]Oregon State University, Corvallis, OR

ABSTRACT

Spatial patterns of summer streamflow in the Cascade Mountains of Oregon vary dramatically between the geologically distinct High and Western Cascade regions. A key control is the partitioning of water input between a fast-draining shallow subsurface flow network (Western Cascades) versus a slow-draining deeper groundwater system (High Cascades). These differences result from large contrasts in rock permeability, porosity, and drainage density between landscapes dominated by the older Western Cascade versus younger High Cascade volcanic rocks.

How do these geologically-based differences in groundwater storage capacity affect streamflow response to projected climatic warming? We initially expected that for the High Cascades of Oregon and Northern California, large groundwater storage will lead to groundwater recharge independent of precipitation type (rain or snow), thereby buffering low flows against potential changes in snowpack volume due to warming climate. We also expected that low groundwater storage in the older volcanic and granitic landscapes of Oregon and California will result in greater sensitivity to diminished snowpacks and summer streamflow changes.

By coupling simple theory with hydrologic modeling, we found that interpreting low flow response to warming involves a convolution of both the snowpack and groundwater dynamics. Using this approach, the High Cascades displays much greater low flow sensitivity to climate change than the Western Cascades. Because the High Cascades discharge groundwater throughout the summer season, both timing of recession and annual fluctuations in total precipitation are reflected in changes in late summer streamflow. The Western Cascades in contrast, displays much less late season sensitivity to changing climate; streamflow is always very low in late summer regardless of winter recharge. We extend these results across the entire western Cordillera and consider implications for water supply in the future. These results imply that current models linking climate and streamflow changes need to account for differences in groundwater storage as a first-order control.

Keywords: Streamflow; Oregon; Climate Warming; Snowpack; Dynamics; Groundwater

Sensitivity of Oregon Watersheds to Streamflow Changes Due to Climate Warming: A Geohydrological Approach

M. Safeeq[1], G. Grant[2], S. Lewis[1], C. Tague[3]

[1]Department of Geosciences, Oregon State University, Corvallis, OR; [2]USDA Forest Service, PNW Research Station, Corvallis, OR; [3]Bren School, University of California, Santa Barbara, Santa Barbara, CA

ABSTRACT

A key challenge for resource and landscape managers is to predict the consequences of climate warming on streamflows and water resources. Different approaches are being developed to forecast the direction, magnitude, and timing of future streamflow changes in specific landscapes. One approach that is being utilized in the Pacific Northwest involves coupling downscaled climate predictions to macroscale hydrologic models, such as the Variable Infiltration Capacity (VIC) model. VIC is typically parameterized and calibrated in selected watersheds, and then applied to a regional scale that includes larger population of uncalibrated watersheds.

Summer streamflows are sensitive to both changes in the timing of snowpack accumulation and melt, and intrinsic, geologically-mediated differences in the efficiency of landscapes in transforming recharge (either as rain or snow) into discharge. Here we explore the importance of this effect by using geologically focused “bottom-up” approach to empirically characterize the sensitivity of late-summer streamflows to climate warming for a range of basins across Oregon. We define sensitivity as the slope of the relation between annual precipitation and summer streamflow, characterized as 7-day low flow and total summer flow. Drainage efficiency was defined in terms of the: 1) rate of recession (K) of the streamflow hydrograph; and 2) ratio of base flow to total flow (Base Flow Index or BFI). We compare our sensitivity results with those derived from VIC simulated streamflow.

Using the bottom-up approach, we found that the both K and BFI are good predictors for streamflow sensitivity to climate change. Fast-draining basins (high K / low BFI) are much less sensitive to changes in annual precipitation, whereas slow-draining basins (low K / high BFI) are much more sensitive. For basins where VIC was calibrated, downscaled VIC simulations are similar to empirical data. Uncalibrated basins, however, do not show a clear relationship with drainage efficiency, meaning that VIC may under predict sensitivity of summer stramflows to climate change in uncalibrated groundwater-dominated watersheds. This implies that spatial heterogeneity in aquifer properties must be explicitly incorporated into parameterization and calibration schemes if the full range of hydrologic response to warming is to be captured across the landscape.

Keywords: Climate change: Geologic framework, Streamflow

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

GIS and Wells: An Examination of Groundwater in Benton County by Georeferencing Well Logs

<u>Evan Miles</u>, Michael E. Campana

Department of Geosciences, Oregon State University, Corvallis, OR

ABSTRACT

A major challenge in understanding groundwater use, including exempt well use of groundwater, is the spatially disconnected nature of most groundwater studies. While individual consultants or contractors may be able to determine large amounts of information about the local subsurface at their work sites, little work has been performed to connect their local knowledge to an understanding of entire formations. Remarkable efforts put forth in the past decade by the USGS and OWRD have provided this type of understanding for the major formations in the Willamette Valley, but little has been done since the 1970's USGS Professional Papers to aggregate regional groundwater knowledge for the majority of relevant hydrogeologic units across the state.

However, the rapid advances in GIS and digital imagery over the past decade allow new opportunities to investigate hydrogeology at the aquifer scale. First, the Oregon Water Resources Department has painstakingly digitized well log information across the state, making these data available for investigation (including scanned copies of the original logs) based on spatial queries. Second, documentation to georeference domiciles has continued to improve, including historical addresses. Third, digitized geologic maps allow geographic subsetting of the well dataset into hydrogeologically-relevant categories. These converging advances allow for statistical analysis of the geographic variability across and within water-bearing formations.

Well data for Benton County have been georeferenced using an aliquot grid and identified address. These data have been spatially investigated using GIS to understand variability of initial depth to water, post static water level, specific yield, and specific capacity. While the resulting coverages need to be considered in conjunction with site-specific consultant reports, output maps are relevant to drillers and planners for the purposes of zoning and development. In particular, spatial analyses of this type are useful for examining hydrogeologic differences between adjacent formations.

Keywords: Groundwater; Hydrogeology; GIS, Well logs; Siletz River volcanics

Groundwater Storage and Flow in an Unconfined Pumice Aquifer, Antelope Unit, Chemult Ranger District, Winema-Fremont National Forest, Oregon

Michael Cummings

Department of Geology, Portland State University, Portland, OR

ABSTRACT

The study area lies north-northeast of Crater Lake National Park and is covered by 2 to 3 m of pumice deposited during the climactic eruption of Mount Mazama approximately 7700 years before present. The pumice deposit hosts unconfined, seasonally connected, perched aquifers that support groundwater dependent ecosystems at points of discharge in the 80 km^2 study area. Sparse bedrock outcrops are dominated by basalt lava flows, but cores from groundwater monitoring wells at four sites contain abundant moderately to weakly indurated, interlayered basalt hydroclastic- and pyroclastic-flow deposits, and matrix-rich tuff breccia. Although some water may enter the unconfined pumice aquifer from flow paths within bedrock units, the lithologies encountered in wells and little to no water in piezometers screened in bedrock suggest little contribution to the unconfined aquifer from bedrock-hosted flow paths.

Pre-Mazama surficial deposits are the local base or may locally augment storage in the unconfined aquifer. The distribution of these deposits is strongly influenced by the pre-eruption topography with poorly to moderately well sorted silt- and clay-rich sedimentary deposits common in pre-eruption valleys and shallow, bed-rock controlled depressions. Post-eruption landscape response included erosion of pumice with valley bottoms cut into pumice, pre-eruption surficial deposits, or bedrock. Where pumice is preserved, the coarser-grained upper pumice unit (moderately to poorly sorted coarse lapilli to blocks) has been removed and the erosion surface is cut into the finer-grained lower pumice unit (well-sorted, fine to coarse lapilli). This early-formed erosion surface is commonly buried by alluvium consisting of crystal-rich sand near the lower contact grading upward to rounded pumice-bearing glassy silt, silty sand, and pumice gravel. The contacts between the alluvium and valley walls cut into pumice deposits are commonly iron stained and locally intensely cemented by iron oxide. In some pre-eruption valley configurations, alluvial fans composed of glassy-silt, crystals, and rounded pumice extend across the valley bottom and overlie the complete pumice section. These deposits are 1.0 to 1.5 m thick in some fans.

Recharge of the unconfined pumice aquifer occurs during spring snow melt from direct contribution by snow melting on valley floors and upland depressions, runoff from partially frozen ground, and shallow flow paths in the pumice blanket. Once in the unconfined pumice aquifer groundwater may infiltrate to deeper levels, be consumed by evapotranspiration, migrate through the aquifer along seasonally connected flow pathways, or return to the surface at fens and springs. Where the water table within the pumice is within approximately 1 m of the surface during the dry season, grasses and sedges are common in well-vegetated meadows. Where year-round discharge takes place, fens characterized by high biodiversity and peat deposits are present. The location of these discharge sites appears to reflect ongoing response of the landscape to the eruption of Mount Mazama. At the discharge points, water is consumed by evapotranspiration through lush and diverse vegetation communities, evaporates, or infiltrates back into the unconfined aquifer down valley.

Groundwater temperature may provide an inexpensive way to define flow pathways in the unconfined pumice aquifer and to detect contribution of ground water contributed from deeper seated flow pathways in bedrock. Two monitoring sites, one at the Wilshire fen and the other at the Johnson Meadow fen, suggest cooler water entering the unconfined pumice aquifer in late summer.

Keywords: Groundwater; Pumice; Unconfined aquifer

Surface Water Interaction with "Confined" Columbia River Basalt Aquifers – Impacts to Streams from Declining Groundwater Levels near Mosier, Oregon

Kenneth E. Lite Jr.

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ABSTRACT

Columbia River Basalt Group (CRBG) aquifers are commonly thought to be relatively flat lying, laterally extensive, and mostly confined, and therefore not likely to be directly connected to surface water. However, many of the CRBG units in south-central Washington and north-central Oregon were deposited within evolving synclinal structures of the Yakima Fold Belt. The synclines hosted drainage systems that interacted with the encroaching lava flows, resulting in enhanced porosity and permeability where the flows encountered water or wet sediment. The geometry of the synclines also constrained the lateral extents of the lava flows.

Modern streams within the synclines have exposed some of the permeable flow contacts and locally allowed connectivity between the streams and aquifers. Where the elevation of the hydraulic head in the aquifer is above the elevation of the exposed contact, the aquifer typically discharges to the stream. Historically, this was the case in Mosier Creek.

In confined ($S= 10^{-4} – 10^{-5}$) and syncline-controlled ground-water flow systems like that near Mosier, seasonal and long-term changes in hydraulic head in aquifers can propagate rapidly to stream/aquifer boundaries. For example, as hydraulic head in the Mosier groundwater flow system declined over 150 feet in the last 4 decades, Mosier Creek has gone from a gaining stream to a losing stream in the vicinity of the exposed contacts. The exposed contacts in Mosier Creek represent head-dependent boundaries to the Mosier groundwater flow system.

Hydraulic head decline in the Mosier area is due to depressurization of aquifers by interaquifer flow through uncased sections of wells, and overdraft conditions in one of the aquifers. But regardless of the decline mechanism, any head decline in a CRBG aquifer connected to a gaining stream will result in diminished streamflow.

Keywords: Groundwater; Columbia River Basalt; Groundwater/surface water interaction

Coupled Simulation and Optimization Models for Managing Groundwater in the Upper Klamath Basin, Oregon and California

Marshall W. Gannett

U.S. Geological Survey, Oregon Water Science Center, Portland, OR

ABSTRACT

Managing limited surface water in the Klamath Basin of Oregon and California to satisfy needs of both agriculture and aquatic wildlife has been a challenge for resource managers in recent years, as well as a source of considerable contention. In the past decade, groundwater has been used (heavily at times) to supplement overtaxed surface water supplies, and groundwater use is being considered as part of a long-term water management strategy. Supplemental groundwater pumping, however, has the potential to diminish already stressed surface water supplies and to result in seasonal and long-term groundwater level declines.

Developing a groundwater management strategy, therefore, requires the ability to predict the temporal and spatial distribution of pumping-related drawdown and impacts to hydrologic boundaries such as streams, springs, lakes, wetlands, and agricultural drains. Also required is a method for efficiently determining the optimal groundwater pumping strategy with which to meet resource management objectives without causing impacts that are unacceptable to the community or in violation of water law.

To meet this need, the U.S. Geological Survey and the Oregon Water Resources Department have collaboratively developed a regional groundwater flow model of the 8,000 square mile upper Klamath Basin and a coupled groundwater management model that employs methods of constrained optimization. Initial work has provided information on the tradeoffs between pumping volumes, seasonal and long-term drawdown, and impacts to surface water, and suggests that useful volumes of groundwater can probably be pumped with minimal interference with existing uses. Initial work has also quantified impacts to agricultural drains (which are water sources for some irrigators and wildlife refuges) that may represent an unanticipated, and not fully understood, constraint on groundwater pumping.

Keywords: Groundwater modeling; Groundwater management, Optimization, Klamath Basin

Climate Change Session

Heejun Chang, Chair

Tuesday, May 24

9:30 AM – 3:00 PM

Climate Change: Natural Variability is a Big Deal Too!

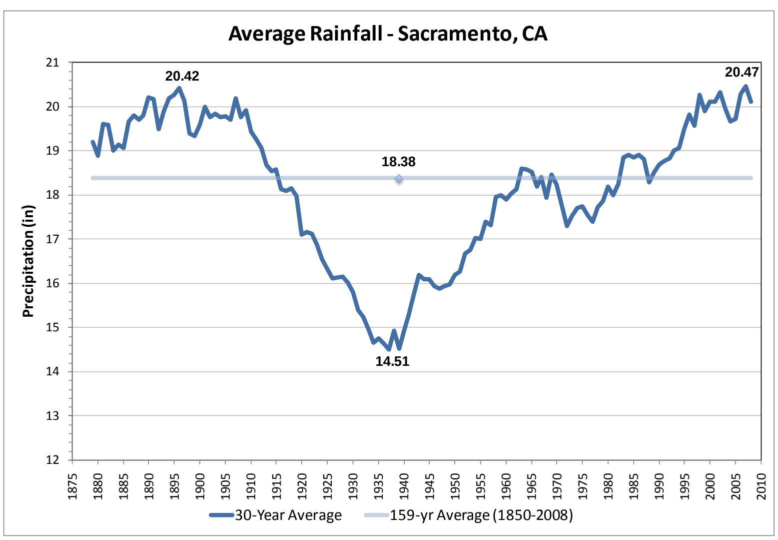
David C. Curtis, Om Prakash
WEST Consultants, Inc., Salem, OR

ABSTRACT

Climate changes. That's what climate does. It is a natural and dynamic process. The National Weather Service (NWS) recognizes on-going climate change by publishing new figures for average climate every ten years. Climate averages for precipitation, temperature, and other weather parameters are computed on a 30 year basis but only updated once per decade. From 2001-2010, the NWS average high temperature for July in Salem, OR, for example, was based on the 30 year period, 1971-2000. Now, in 2011, climate averages are reported for a new 30 year period, 1981-2010, which will remain the norm until 2021.

With all of the discussion about anthropogenic (i.e. man-made) climate change, it is easy to overlook just how variable our natural climate can be in the relatively short-term. Our climate can and does vary by significant amounts within one human lifetime and well within the design lifetime of our water infrastructure. Sometimes this fact gets lost in the noise of the climate change debate. Part of the reason is the relatively short records of our key meteorologic and hydrologic parameters.

Here's an example. Sacramento, CA, has one of the longest rainfall records in the western US. Annual rainfall totals are available from 1850 to present. Over the 159 year record from 1850-2008, the average annual rainfall was 18.38 inches. However, the 30-year moving average rainfall varies from 20.42 inches in 1896 down to 14.51 inches in 1937 and up again to 20.47 inches by 2007. That's 30-40% swing of 30-year average rainfall in a single lifetime. (Lifetime, not geologic time!) Most of our short records completely miss that signal. That such significant changes can occur relatively fast has major implications for water resources infrastructure design.



This paper explores and presents findings regarding rapid variation of "climate averages" in northern California and Oregon using long term rainfall records. The results suggest that not only is stationarity dead, it likely wasn't really alive in the first place. We simply assumed it was.

Keywords: Climate change; Rainfall; Hydrologic design

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Assessment of Climate Change Impacts on Drought Return Periods Using Copula Functions

Shahrbanou Mdadagar[1], Hamid Moradkhani[1]

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ABSTRACT

Drought events are usually characterized by their duration, severity, and intensity which are calculated based on different indices for drought recognition. Streamflow Drought Index (SDI) used in hydrological droughts is applied in this study to calculate drought variables of historical events in Upper Klamath River basin in Oregon. Historical extreme events in this area necessitate studies on possible potentials of future droughts in the region. While the return period of drought variables are mostly studied by separate probability distributions modeling individual variables, this study employs Copula functions as multivariate probability distributions to model correlated drought variables altogether within a single function. The analysis follows by development of trivariate return periods and conditional probabilities to assess drought occurrence based on joint behavior of its variables. The trivariate return period is developed for two different cases: either 1) all the variables exceed particular values or 2) each variable does. Furthermore, the impacts of climate change are investigated by application of six GCMs and one emission scenario for the future time period of 2020-2090. The results indicate less severe droughts with smaller duration in future for Upper Klamath River basin comparing to historical events which generally implies wetter climate for the region. Maximum duration of 8 months for historical droughts shrinks to 6 months for future droughts, and the maximum severity is reduced from 12 to 8 for employed index. Moreover, the GCM IPSL-CM4 predicts the most water availability in the region among other applied GCMs.

Keywords: Drought event; Copula function; Trivariate return period; Climate change impacts

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Climate Change Impact on Drought Risk and Uncertainty in the Willamette River Basin

Il-Won Jung[1], Heejun Chang[1]
[1]**Department of Geography, Portland State University, Portland, OR**

ABSTRACT

Climate change due to global warming could induce more frequent droughts in the Willamette River Basin because less snowfall in winter and earlier snowmelt due to temperature increase may lead to decreases in spring and summer streamflow. This study examines possible changes in drought risk using two drought indices, Standardized Precipitation Index (SPI) and Standardized Runoff Index (SRI). SPI represents a climatological drought index that considers only precipitation change, while SRI is a hydrological drought index that considers water balance change. In rainfall-dominated regions in the Willamette Valley, SPI is a useful drought index. In snow-dominated regions in the High Cascades, SRI can show more realistic drought risk change because SRI can represent snowmelt and geology effects.

Our results show that the Willamette Valley is more vulnerable to drought risk than the High Cascades in the 21st century. SPI shows increasing frequency and intensity of short-term drought over the whole Willamette River basin due to summer precipitation decrease, while SRI in the High Cascades shows no change because the High Cascades have young permeable volcanic rocks and gentle slopes, which create a deep groundwater system. Additionally, the frequency of short-term extreme drought, such as droughts lasting 1 to 3 months, is projected to increase in the Willamette Valley, but long-term extreme droughts are not expected to change significantly. The increase in short-term extreme droughts is attributed to decreases in summer precipitation, and the lack of change in long-term extreme droughts is caused by increased winter runoff prompted by earlier snowmelt and winter precipitation increases.

Keywords: Drought; Climate change; SPI; SRI; Uncertainty; Willamette River; Oregon

Assessment of the Hydrologic Response to Climate Change in the Upper Deschutes River Basin, Central Oregon

M. Scott Waibel[1], Marshall W. Gannett[2], Heejun Chang[3], Christina L. Hulbe[1]

[1]Department of Geology, Portland State University, Portland, OR; [2]US Geological Survey, Oregon Water Science Center, Portland, OR; [3]Department of Geography, Portland State University, Portland, OR

ABSTRACT

Effects of climate change in the Cascade Range will likely include more rain, less snow, and earlier snowmelt in the Cascade Range as compared to present conditions. These changes, in turn, will affect the timing of runoff, groundwater recharge, and groundwater discharge to spring-fed streams. This hydrologic response needs to be examined and understood due to implications for water management.

In this study, a water- and energy-balance model was used to explore 21st century changes in the water budget in the upper Deschutes Basin, and a groundwater model was used to evaluate the response of the groundwater system to those changes. A Deep Percolation Model (DPM) developed for the basin in the 1990s uses spatially distributed climate data to calculate a daily mass balance for the major components of the hydrologic budget. For this work, we drove the DPM using ensemble means of eight downscaled global climate models with the Intergovernmental Panel on Climate Change's A1B and B1 emission scenarios.

Although similar for both scenarios, greater changes in the timing of runoff and recharge as well as higher reductions in snowpack occur using the A1B scenario. Considering both scenarios, diminished snowpack results in reductions in spring runoff ranging from 40% to 63% and recharge from 21% to 37%. These reductions are offset by late fall and winter increases. Also, spatial changes in the mean annual ratio of recharge to runoff occur due to changes in soil infiltration rates.

The modeled response of the groundwater system to changes in the time and amount of recharge varies spatially. Short flow-path systems in the upper part of the basin are most sensitive to change in seasonality of recharge. At regional scales, diffusion along groundwater flow paths partially attenuates the effects of changes in recharge timing. Furthermore, slight increases in total annual groundwater discharge to smaller streams in the upper portion of the basin, and slight decreases in discharge to larger stream systems in the north-central portion of the basin are projected.

Keywords: Groundwater; Hydrology; Climate change; Global Climate Model (GCM)

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

Hydrologic Response to Climate Change in the Sprague River Basin, Oregon

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ABSTRACT

In 2008 the U.S. Geological Survey began a Global Change study that evaluated the watershed scale response to climate change in selected basins across the United States. Fourteen basins for which the Precipitation Runoff Modeling System (PRMS) had been calibrated and evaluated were selected as study sites. PRMS is a deterministic, distributed-parameter, watershed model developed to evaluate the effects of various combinations of precipitation, temperature, and land use on streamflow and general basin hydrology. PRMS results for the Sprague River basin located in the Upper Klamath Basin in south-central Oregon are summarized below.

Five General Circulation Models (GCMs) incorporating three climate change scenarios were used to develop an ensemble of climate change inputs to PRMS. Although the climate change projections for 2001–2099 showed a wide range of variability between the GCMs, which would indicate a large amount of uncertainty, the central tendency lines showed an increase in temperature and precipitation over the 21st century. Using these data as model input, simulated streamflow output from PRMS for the Sprague River indicate earlier spring high flows as a consequence of increased and decreased proportions of rainfall and snowfall, respectively. Supplying approximately 25 percent of inflow to the Upper Klamath Lake, the Sprague River basin is vital to environmental and human water needs within the Klamath River basin. As water demands increase, the reliability and timing of flow from the Sprague River becomes increasingly critical in water-management decisions. Potential alterations in flows to the Upper Klamath Lake as a result of climate change could necessitate (1) modifications to the operation of the lake as a storage reservoir and (2) creation of additional storage capacity to meet water demand during the summer.

Keywords: Watershed modeling; Climate change; Water management; General Circulation Models (GCM); Upper Klamath River Basin

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

Effects of Climate Change on Water Quality in the Yaquina Estuary, Oregon

Cheryl A. Brown[1], Darrin Sharp[2], Heejun Chang[3], and Madeline Steele[3]

[1]Western Ecology Division, U.S. EPA, Corvallis, OR; [2]Oregon Climate Change Research Institute, Oregon State University, Corvallis, OR; [3]Department of Geography, Portland State University, Portland, OR

ABSTRACT

As part of a larger study to examine the effect of climate change (CC) on estuarine resources, we simulated the effect of rising sea level, alterations in river discharge, and increasing atmospheric temperatures on water quality in the Yaquina Estuary. Due to uncertainty in the effects of climate change, initial model simulations were performed for different steady river discharge rates that span the historical range in inflow, and for a range of increases in sea level and atmospheric temperature. Model simulations suggest that in the central portion of the estuary (19 km from mouth), a 60-cm increase in sea level will result in a 2-3 psu change in salinity across a broad range of river discharges. For the oligohaline portion of the estuary, salinity increases associated with a rise in sea level of 60 cm are only apparent at low river discharge rates ($< 50\ m^3\ s^{-1}$). Simulations suggest that the water temperatures near the mouth of the estuary will decrease due to rising sea level, while water temperatures in upriver portions of the estuary will increase due to rising atmospheric temperatures. We present results which demonstrate how the interaction of changes in river discharge, rising sea level, and atmospheric temperature associated with climate change produce non-linear patterns in the response of estuarine salinity and temperature, which vary with location inside the estuary and season. We also will discuss the importance of presenting results in a manner that incorporates uncertainty in climate projections.

Keywords: Climate change; Estuary; Modeling; Temperature; Salinity

Climate Change and Oregon's Water Future

Michael E. Campana

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ABSTRACT

The specter of climate change looms large over Oregon. Although hydroclimatologic models predict a warmer Oregon, the total volume of precipitation may not change significantly. However, the character (rain vs. snow) and spatial and temporal distributions of precipitation will likely change. The state is already witnessing earlier snowmelt in the Oregon Cascade Range. Much of the Cascade snowpack occurs at relatively low elevations and is thus very sensitive to even slight temperature changes. Earlier than normal snowmelt can produce unseasonal flooding and landslides and lead to storage problems since the snowpack provides natural 'free' storage. Without additional storage the resulting reduced summer runoff will likely produce: water shortages; insufficient flows to dilute waste and for environmental needs; higher stream temperatures and reduced dissolved oxygen levels; increased aquatic invasive species; and reductions in hydroelectric power generation. Reduced streamflows may lead to increase usage of nonrenewable groundwater. The effects on groundwater recharge are unclear.

Oregon must now adapt to prepare for a potentially water-stressed future by: 1) further investigating the potential for aquifer storage recovery and artificial recharge (ASR & AR); 2) assessing its surface water and groundwater supplies; 3) ensuring that climate change is incorporated into its Integrated Water Resources Strategy, currently under development; 4) educating its citizenry; 5) preparing for the possible influx of climate refugees; 6) exploring, with its US Columbia Basin partners, the development of a Columbia River Compact; 7) investigating market-based strategies; and 8) implementing, updating and revising various laws, regulations, practices, and policies so as to better enable the state to cope with an uncertain water future.

Keywords: Global warming; Water resources; Snowpack; Groundwater recharge; Market strategies; Climate refugees

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

Climate Change and Shifts in Water Related Ecosystem Services in the Tualatin and Yamhill River Basins

Heejun Chang[1] Terrance Anthony[1] Driss Ennaanay[2] Manu Sharma[2]

[1]Department of Geography, Portland State University, Portland, OR

[1]Natural Capital Project, Stanford University, Stanford, CA

ABSTRACT

Water related ecosystem services (WES), such as flow regulation, drinking water supply, temperature regulation, and water recreational activities, are affected by anthropogenic climate change. Forecasting potential shifts in such WES is critical to identifying the form and magnitude of likely impacts. We quantified the levels and values of WES under multiple climate change scenarios in the two watersheds located in the Portland metropolitan area, Oregon, USA using the combination of a hydrologic model Better Assessment Science Integrating point and Non-point Sources - Soil and Water Assessment Tool (BASINS-SWAT) and an ecosystem evaluation model – Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST). Using the Intergovernmental Panel on Climate Change's AR4 climate change simulation results, we found that there is a slight relative increase in annual water yield, sediment yield, and dissolved phosphorus, but storm peak management does not change substantially by the 2050s. Spatial analysis shows that the locations of hot and cold spots remain relatively stable. It is also shown that there are high spatial and temporal uncertainties associated with climate change projections due to variations in precipitation projections toward the middle of the 21st century. The findings of our study provide useful information for water and land managers in identifying target areas for conservation to best sustain WES provision, use, and value under a range of climate change scenarios.

Keywords: Climate change; Ecosystem services; Spatial analysis; Tualatin and Yamhill Rivers,;Oregon

Stream Restoration Session
Ivars Steinblums, Chair
Tuesday, May 24
9:30 AM – 12:15 PM

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

Characterizing Collaboration in the Klamath River Basin, USA: An Exercise in Institutional Mapping

Brian C. Chaffin

Department of Geosciences, Oregon State University, Corvallis, OR

ABSTRACT

The Klamath Basin Restoration Agreement (KBRA) and the Klamath Hydroelectric Settlement Agreement (KHSA) forged between Klamath River Basin stakeholder groups in California and Oregon, when successfully implemented, will lead to the largest dam removal project in history. After a decade of intense legal and social conflict among disparate interests in the river basin, this collaborative agreement between local irrigators, tribes, Federal regulators, and a large utility company represents a temporally challenging and spatially diverse social-ecological restoration initiative. Underlying the agreement is a complex set of collaborative initiatives and co-management institutions often working independently of one another to improve Basin water quality, among other goals. Theories related to the concept of adaptive governance may provide a useful framework for exploring the potential for uniting individual collaborative institutions under the vision of improved basin water quality. This paper describes the results of an institutional mapping exercise to identify and characterize existing approaches to water quality improvement and Clean Water Act implementation in the Klamath River Basin. The institutional mapping framework includes a detailed identification of collaborative activities, public stakeholders, regulatory agencies, and co-management institutions associated with efforts to improve water quality in various geographic and legal contexts. I provide a typology of governance approaches and institutions and consider the ways in which they might be integrated under the KBRA drawing on the suggested framework of adaptive governance.

Keywords: Institutional mapping; Klamath River; Dam removal; Adaptive governance

Linkage Between Geomorphic and Biological Responses of a River to Dam Removal: a Case Study From the Chiloquin Dam on the Sprague River, Oregon.

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[1]Dept. of Biological and Ecological Engineering, Oregon State University, Corvallis, OR;
[1]Department of Crop and Soil Science, Oregon State University, Corvallis, OR

ABSTRACT

Chiloquin Dam, located on the Sprague River in southern Oregon, was removed in August of 2008. The processing of the sediment stored behind the dam (composed primarily of sand and fines) and the resulting bedform changes have been examined using repeat cross section surveys, yearly bathymetric surveys, and surface sediment characterization. Continuous suspended sediment concentrations have been estimated to inform a sediment budget over 3 years (1 year pre removal and 2 years post removal). These data allow for the description of spatial extents and longitudinal trends in sediment deposition. Repeat ground and bathymetric surveys are used for the quantification of uncertainty in field methods utilized and an understanding of how this uncertainty limits change detection. Invertebrate and habitat data have been collected using the EMAP protocol developed by the USEPA. Linkage between the river's processing of the sediment pulse and observed changes in invertebrate community composition and aquatic habitat metrics are explored.

Keywords: Chiloquin Dam; Sprague River; Dam removal.

Economic Implications of Climate Change on Ecosystem Restoration Projects With a Beaver Case Study

Mark Buckley

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ABSTRACT

Climate change alters the biophysical and socioeconomic context for ecological restoration efforts in ways with and without precedence. New and changing conditions affect restoration project costs and expected benefits, including shifts in the overall goals and extent of society's demand for restoration. Climate change increases restoration project costs as temperature and precipitation patterns increase the expected frequency and severity of water shortages, while scarce ecosystem services can increase the demand for restoration projects. Increasing uncertainty and ignorance regarding future water availability heightens these concerns. As a case study example, I explain and quantify the potential impacts on the ecosystem structures and functions of dam-building beaver populations. I estimate the value of potential economic benefits of beaver restoration in the context of climate impacts on water availability for example watersheds in the Southwest and Northwest.

Keywords: Climate change; Beaver dams.

Water Restoration Certificates™: Building a Bridge Between Urban Water Users and Flow Restoration Needs in the Rural West

Todd Reeve

Vice President, Watershed Programs, Bonneville Environmental Foundation, Portland, OR

ABSTRACT

Across Oregon and other PNW states thousands of miles of rivers, streams and adjacent wetlands are chronically de-watered as a result of over-appropriated water rights. In Montana alone, chronic or periodic de-watering occurs in over 4,000 miles of streams across 381 different river or stream systems. The ecological harm resulting from this hydrologic modification is manifold. In many locations throughout the West, chronic low flows exacerbate water quality; severely restrict the movement and productivity of fisheries and wildlife populations; reduce the vigor and function of riparian communities; and limit human recreational opportunities.

In 2008 the Bonneville Environmental Foundation (BEF) began exploring the potential for a market-based approach to support voluntary, incentive-based flow restoration efforts. The result is BEF's Water Restoration Certificate™ Program - the first nationally marketed, voluntary environmental flow restoration program. The WRC program is built on the premise that private enterprise and the voluntary market can solve large-scale environmental challenges when society is empowered to both understand and directly address those challenges. WRCs offer an innovative, market-based solution that allows companies and individuals to take responsibility for their water use by restoring to the environment an amount of water equal their own consumptive use of water.

This presentation will showcase BEF's WRC Program and will elaborate on: the challenges and potential of voluntary, incentive-based programs; instream flow as an important expansion opportunity for ecosystem services; and how potential financial gains may be used to reinforce long-term ecosystem restoration activities.

Keywords: Flow restoration incentives; Bonneville Environmental Foundation

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

The Life Cycle of Dams: An Analysis of Policy Change on the Rogue River, Oregon

Wendy D. McDermott

Central Washington University, Ellensburg, WA

With the convergence of several economic, social, and environmental factors, dam removal has emerged as a feasible river management option. The Rogue River, located in southwest Oregon, is one of the few river basins in the United States to remove a number of large dams in quick succession. This paper will analyze the policy changes in the Rogue River Basin that led to the removals of the Savage Rapids and Gold Ray Dams. A Theoretical Framework for Policy Changes offered by Lowry (2003) is used to identify the type of policy change that occurred with the two dam removals. This framework takes into account broad external factors that affect policy shifts such as socioeconomic conditions and broad public opinion as well as political receptivity to changes and the physical complexity of changes. To identify these factors, an extensive review of public documents, public testimony and comment letters, and newspaper articles and letters-to-the editor was conducted as were interviews. Application of the framework reveals the role of coalitions and socioeconomic conditions as critical factors in altering the status quo in both the Savage Rapids and Gold Ray Dam removal decisions. As watershed managers, governmental agencies, and community leaders negotiate the uncertainties of a changing climate, economy, and environment, dam re-operations and removals will continue to take place and variation within actual policy changes will occur.

Keywords: Rogue River; Savage Rapids Dam; Gold Ray Dam.

Hydrologic Monitoring Session
Jolyne Lea, Chair
Tuesday, May 24
3:30 PM – 5:00 PM

Tracking Oregon's Water Resources: An Overview of Available Data and a Pitch for a United Network

Richard K. Marvin, Lloyd VanGordon

Oregon Water Resources Department-Salem, OR

ABSTRACT

Numerous sources of water resource data for Oregon can be found if one knows where to look. Traditional providers such as the US Geological Survey (USGS), the Natural Resource Conservation Service (NRCS), and the Oregon Water Resources Department (OWRD) have made great strides in recent years to make historical and near real-time data readily available to the public through user-friendly webpage interfaces. But what about lesser known networks such as those run by counties, watershed councils, and university researchers? In this discussion, I plan to highlight lesser known resources around the state and to make the case that there's a need for a central clearinghouse, perhaps at one of the state universities, where one can go to learn about the various networks, view data-collection locations using an interactive map, and link to sites where datasets can be downloaded. If the data are not available on the web, then contact information can be provided for the entity that maintains a given network.

Keywords: Water data; Oregon web network

Wolf Creek Monitoring

Daniel Dammann

Bureau of Land Management-Roseburg District, Roseburg, OR

ABSTRACT

The Wolf Creek Restoration and Monitoring project is a large-scale restoration project that treated over 10 miles of stream with 900 logs and 3700 boulders over a two year period. Wolf Creek is a tributary to the Umpqua River west of Roseburg, Oregon. This presentation, designed for those involved in watershed (in-stream) restoration activities and monitoring, describes the monitoring effort associated with this project and how working with multiple partners has resulted in a robust, multifaceted monitoring approach, which will examine the effectiveness of improving aquatic habitat through in-stream restoration techniques. We know these techniques work, but how do you measure success? How do you quantify the improvements we make through these efforts? Wolf Creek will attempt to provide some answers to these questions. A summary of the monitoring methods used and some preliminary monitoring results will be presented. Use of total station mapping of restoration reaches compared to control reaches will be highlighted. As well as the use of photo points, stream temperature data, and biological monitoring.

Keywords: Aquatic restoration; Monitoring; Effectiveness

Oregon Stream Gaging Network Evaluation: Meeting the Oregon Water Resources Department's Current and Future Data Needs

Jonathan L. La Marche

Oregon Water Resources Department, Bend, OR

ABSTRACT

Oregon's stream gaging network was last evaluated in 1970 by the U.S. Geological Survey. Water management and scientific-related needs have changed significantly since 1970, including the recognition of instream water rights and implications of climate change on water resources. The Oregon Water Resources Department (OWRD) has recently undertaken an evaluation of the state's stream gaging network in order to meet OWRD current and future data needs.

The OWRD goals (or data needs) for the stream gaging network are broadly grouped into those associated with water management and those associated with scientific purposes. The water management goal for the gage network is to provide discharge data required for timely and effective distribution of water by the state, and to meet conjunctive use management needs. The scientific goals include providing discharge data for: 1) regional regression analysis; 2) defining hydrologic systems; 3) accurate forecasts; and 4) long term trend analysis.

The management component of the gaging evaluation is complete and is under internal peer review. A qualitative approach was used in the evaluation after quantitative methods proved difficult due to variability in regulatory settings across Oregon. Over 1,000 watersheds, storage facilities, diversions and stream reaches were examined in the management component of the gage network evaluation. The evaluation identified 225 locations needing stream gages to meet OWRD's water management goal. Currently there are active gages at 155 of these locations, leaving 70 sites where new gages are needed for surface water management. Of these locations, 31 were designated as high priority sites due to their regulatory, environmental, and logistical setting. These locations were predominately located in the south central and south eastern part of the state.

The stream gaging network is currently meeting today's conjunctive–use management needs. However, there are 26 identified sites that may need monitoring to meet future conjunctive–use needs, pending further study. Currently gages are in operation at 19 of these sites for other reasons.

Keywords: Stream gaging; Stream gaging network evaluation

Poster Session

Antonius Laenen, Chair

Reception: Tuesday, May 24

5:00 PM – 6:30 PM

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

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POSTER

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

Caleb DeChant[1], Hamid Moradkhani[2]

[1]PhD Student, [2]Assistant Professor, Portland State University, Department of Civil and Environmental Engineering, Portland, OR

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

C. Gabrielli[1], J. J. McDonnell[1,2],T. Jarvis[2]

[1]Dept of Forest Engineering, Resources and Management; [2]Institute for Water and Watersheds, Oregon State University, Corvallis, OR

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

Brendan Galipeau[1], Kim Ogren[2], Jacob Petersen-Perlman[3]

[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

POSTER

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

Kelsey Gianou[1], Robert Emanuel[2], Samuel Chan[1,2]

[1]Marine Resource Management, College of Oceanic and Atmospheric Sciences; [2]Oregon Sea Grant College Program and Extension Service, Oregon State University, Corvallis, OR

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

Department of Civil and Environmental Engineering, Portland State University, Portland, OR

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)

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

U.S. Geological Survey Oregon Water Science Center, Portland, OR

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

Water Resources Program, Oregon State University, Corvallis, OR

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

Shahrbanou Madadgar, Hamid Moradkhani

Portland State University, Department of Civil and Environmental Engineering, Portland, OR

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

Portland State University, Department of Civil and Environmental Engineering, Portland, OR

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

Jacob Scherberg

Oregon State University, Corvallis, OR

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

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

POSTER

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

Andrea A. Wirth, Margaret Mellinger

Oregon State University Libraries. Oregon State University, Corvallis, OR

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

Water Quality Session
Rudd Turner, Chair
Wednesday, May 25
8:00 AM – 4:15 PM

Reconnaissance Investigation of Emerging Contaminants in Wastewater-Treatment-Plant Effluent and Stormwater Runoff in the Columbia River Basin

Jennifer Morace

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ABSTRACT

In order to efficiently reduce toxic loading to the Columbia River basin, sources and pathways need to be identified. Little is known about the toxic loadings coming from wastewater-treatment facilities and stormwater runoff in the system. This study provides preliminary data on these sources and pathways throughout the basin. The cities sampled in Oregon and Washington were chosen for their diverse characteristics, including population density. Samples were collected from a wastewater-treatment facility in each of the cities and analyzed for wastewater-indicator compounds, pharmaceuticals, PCBs, PBDEs, organochlorine or legacy compounds, currently used pesticides, mercury, and estrogenicity. Currently, these treatment facilities are required to sample their effluent to meet their permit requirements, which are very limited. Little is known about the environmental implications of emerging contaminants in these effluents. Results indicate that a majority of these compounds are present in the effluent and some at environmentally relevant concentrations. Although the grab samples were not time-integrated and the effluent is expected to change in nature throughout time, the continuous input of this number of compounds and at these concentrations can have implications on the receiving waters, the foodweb reliant on these waters, and the ecosystem as a whole.

The second component of the sampling effort was directed at characterizing stormwater runoff for a slightly different set of emerging contaminants—PCBs, PBDEs, organochlorine compounds, PAHs, metals, currently used pesticides, and oil and grease. Studies have shown that stormwater, most often untreated before entering the receiving waters, can deliver significant loadings of these compounds. Unlike WWTP effluent, stormwater runoff is sporadic and unpredictable, and the sudden input of these contaminants has implications for the ecosystem. These two pathways are poorly understood in terms of their toxic contribution to the system, yet they act as integrators of human activities and offer an area where changes could be made to reduce harmful human impact on the environment.

Keywords: Emerging contaminants; Wastewater treatment plant; Stormwater; Effluent; Runoff; Columbia River basin

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A Greenhouse Gas Inventory of a Conventional Water Treatment Plant

Kristel Fesler, Kelly Hoell

City of Hillsboro, OR

ABSTRACT

The Joint Water Commission (JWC) in Forest Grove, Oregon completed a greenhouse gas (GHG) inventory of all the direct and indirect emissions associated with the daily operations of its 75 MGD conventional water treatment plant. Currently, very few water and wastewater facilities have completed a greenhouse gas inventory to date.

This analysis uses a variety of data sources and public-domain tools for emissions factors and calculation methods. Embodied emissions in purchased goods and services were calculated using dollar values spent and emissions factors based on averages for the U.S. economy. Emissions related to electricity consumption include analysis of utility specific, regional, and national electricity emissions factors. Emissions from disposal of solid waste are based on the weight and general type of the waste, and the operations of the receiving facility.

In 2007, the JWC's total emissions were 21,440 metric tons of carbon dioxide equivalent (MT CO_2e), roughly equal to the annual emissions of 4,099 passenger vehicles. Yearly variations (2007-2009) in emissions were very low and were due to construction projects. The JWC's largest GHG emissions source was the consumption of electricity (81% on average) and the embodied emissions within purchased water treatment chemicals (13% on average).

One climate change risk facing utilities is financial. If a "cost of carbon" (at levels currently anticipated) were passed along to JWC through its purchases of energy, goods, and services, the organization could pay an additional $313,000 each year. Reducing this financial risk can be accomplished by reducing purchases of high emission intensity goods, namely electricity and treatment chemicals. Limiting emissions due to electricity consumption can be done by replacing older equipment with high-efficiency equipment or utilizing electricity from less carbon intensive sources, such as creating renewable solar and micro-hydro energy on site.

Keywords: Water treatment; Greenhouse gas

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The Orange County Water District Riverbed Filtration Pilot Project: Solids and Organic Carbon Removal Using Induced Riverbed Infiltration

Jason Keller[1], Michael Milczarek[2], Greg Woodside[3], Adam Hutchinson[3], Robert Rice[2]

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ABSTRACT

In an effort to reduce suspended solids and organic carbon loading and to increase long-term groundwater recharge rates at Orange County Water District's spreading basins, a pilot project was conducted to evaluate riverbed filtration as a technology to treat river water prior to groundwater recharge. A shallow under-channel lateral drain system was constructed within a channel adjacent to the Santa Ana River to induce and capture infiltration. Water pumped from the drain system was analyzed for a variety of water quality parameters and then recharged into test spreading basins to evaluate recharge rates compared to Santa Ana River water without treatment. Riverbed filtered water and untreated water was also tested in percolation columns. At the pilot project drain system, phreatic surface and temperature were continuously monitored at thirteen points. River water inflow and outflow and drain system pumping rates were also monitored.

The pilot test was divided into two periods: Period 1 had shallow overflow (1- to 3-inches) within the river channel; Period 2 achieved deeper surface water depths (3- to 12-inches). Lateral drain system pumping during both test periods were incrementally increased to establish the maximum pumping capacity of the drain system for each test period. Monitoring data indicate that riverbed filtration effectively removed essentially all suspended solids and reduced organic carbon contents with the bulk of water captured by the under-channel drain system from induced infiltration. The phreatic surface and subsurface water movement within the drain system area was shown to be very sensitive to changes in surface water flow rates and depth, and drain system pumping rates. In addition, surface clogging was observed. The pilot project results indicate that riverbed filtration is a viable technology for treating surface water prior to recharge operations, however, additional testing and optimization is needed.

Keywords: Treatment, Recharge; Recycling; Stormwater management; Harvesting

Spatial and Temporal Patterns in the Influence of Land Use on Water Quality in Five Portland Area Creeks Representing Differing Levels of Urbanization

Madeline Steele, Zoe Bonak, Heejun Chang

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ABSTRACT

While the negative effects of urban development on freshwater systems are well documented, impacts of human disturbance on water quality vary depending on land cover, local climate, and temporal and spatial scales of analysis. To better understand this variation, we analyzed water quality data for a total of 15 sites from six Portland, Oregon area creeks at multiple spatial and temporal scales. The creeks are characterized by differing levels of urban development, from relatively pristine to highly developed. More than ten years of monthly data gathered by the Portland Bureau of Environmental Services were used to analyze temporal trends, and five years of these data were used to analyze spatial patterns. Analytes of interest were specific conductivity, dissolved oxygen, nitrate, phosphorus, total suspended solids, and temperature. These variables were compared to contributing area land use metrics at three scales: full contributing sub-basin, 100-meter riparian corridor, and 50-meter riparian corridor. We calculated seven land use metrics: population density, street density, Green Streets density, percent low density development, percent high density development, percent forested area, and percent agriculture. We found Spearman's Rank Correlation Coefficient between the water quality parameters for annual, wet, and dry seasons and the land use metrics at each spatial scale for each parameter. The same water quality data were also analyzed for correlations to same day as well as 3-, 5-, and 7-day antecedent precipitation to examine relationships between water quality and environmental moisture conditions. Additionally, we used a Seasonal Kendall test to search for temporal trends. For each site included in the temporal analysis, changes in population density and street density metrics from 2000 to 2010 were compared to changes in water quality. Results vary across space, but generally confirm that urban development has negatively impacted the creeks. Specific conductivity, total suspended solids and nitrate are particularly sensitive to the level of urban development, especially following rain events. This work will help to better understand and mitigate urbanization impacts on freshwater systems.

Keywords: Water quality; Land use; Antecedent precipitation; Urban hydrology

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Water Quality Data Synthesis in the Metolius River Basin, Oregon

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ABSTRACT

The Metolius River basin is a sub-basin of the Deschutes Basin within central Oregon. Considered one of the crown jewels of the state, this historically undisturbed basin drew attention in 2009 because the Oregon legislature designated the basin as the first Area of Critical State Concern (ACSC) under the state's land use laws. One of the factors in the historic land use designation was preserving the water quality of the Metolius River. This controversial action prevented both eco-resort and large scale destination resort development and generated much debate on state versus county roles in land use.

A leading non-profit conservation organization, the Friends of the Metolius, has been monitoring land use and water quality within the basin for over 20 years. Motivated by the ACSC and using the data collected throughout the basin, a comprehensive study on the water quality of the Metolius River basin was initiated for the first time.

This presentation will introduce the voluntary effort of a non-profit organization to synthesize and share its spatial data publicly through the Oregon Explorer portal, a large spatial data library. Also, a preliminary display of the water quality data and observations within the basin will be presented for the first time.

Keywords: Water quality; Data synthesis; Temperature; Nutrients

Managing for Ecosystem Services through Governance Networks: An Analysis of Oregon Senate Bill 513

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ABSTRACT

Human adaptation to change is an essential determinant in the resilience of complex social-ecological systems. In the field of water policy and management it has become increasingly clear that traditional government actors cannot fully address emerging water problems at every scale given a demonstrated lack of resources, increasing variability in available water supplies, and dependence on the actions of individual users. Theories of democratic network governance recognize that traditional mechanisms of governmental control, generally represented through top-down policy and bureaucratic oversight, do not fully realize the interests, resources and expertise offered by individuals and evolving social networks. Adaptive water management necessitates strong networks within and between local, state and regional organizations that have the institutional capacity to measure and respond to changing ecological and social conditions.

There are myriad local, state and federal agencies, in addition to private organizations in the state of Oregon that are responsible for managing the services performed by ecosystems in urban and rural landscapes. In 2009 the Oregon State Legislature recognized, however, that "these efforts are generally fragmented, uncoordinated and often work at cross-purposes." In the Oregon Senate Bill (SB) 513 the legislature calls for "new or improved regulatory schemes" that will result in greater coordination between existing public and private natural resource management organizations, though SB 513 does not explicitly define a new institutional arrangement. SB 513 advocates for an ecosystem-based approach to natural resource management that includes diverse stakeholders in policy development and implementation. Consequently, SB 513 has the potential to foster a complex network of public and private natural resource managers and professionals who rely on public, private and civil resources to implement large-scale conservation and restoration efforts. Any governance networks that emerge from SB 513 will have a significant impact on the future of water resources management in Oregon.

Keywords: Adaptive management; Water management; Ecosystem management; Democratic; Network governance; Resilience

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Seasonal and Elevational Variation of Surface Water δ^{18}O and δ^{2}H in the Willamette River Basin

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ABSTRACT

Climate change is expected to dramatically alter the timing and quantity of water within the nation's river systems. These changes are driven by variation in the form, location and amount of precipitation that will affect the temporal and spatial distribution of river source water over time. To manage the impact of climate change, we will need to understand how water sources for rivers are shifting over time. Yet methods for knowing where river water comes from within the drainage basin at various times of the year are not well developed. Because stable isotopes of precipitation vary geographically, variation in the stable isotopes of river water can indicate source water dynamics. We monitored the stable isotopes (□^{18}O and □^{2}H) of river and stream water within the southern Willamette River basin in Western Oregon over two years. We sampled sites along the Willamette River, and up six major river tributaries to the Willamette, and eight small catchments along each tributary that spanned the elevation range in the tributary. All sites were sampled four times a year, with a selected set of sites being sampled eight times a year. Seventy-five percent of the isotopic variation in stream water from the small catchments could be explained by the mean elevation of the catchment. A decrease in catchment water isotope values with increasing elevation is caused by Raleigh distillation of precipitation where heavy isotopes fall first, and rain is progressively lighter isotopically as storms move eastward from the Coast Range, across the Willamette Valley and up the Cascade Mountains. Coast Range catchments did not have a clear elevation pattern in the water isotopes.

Water within the lower Willamette River showed distinct isotopic seasonal patterns. Isotopic values were at their lowest during summer low flow and at their highest during Feb/March when snow was accumulating in the mountains. This seasonal variation likely comes from a change in source elevation for water in the river. During winter when rain occurs in the valley and snow is accumulating in the mountains, the river isotopic signal reflects the valley bottom rain sources. During the dry Mediterranean summer, valley soils are dry and the water comes from snow melt and high elevation spring water. Using our relationship between catchment elevation and water isotope values, we estimated that the mean elevation of the source water shifted upward approximately 350 m during the summer low flow period. Reliance on high-elevation snowmelt water during summer low flow highlight the vulnerability of this system to influences of climate change, where snowpacks in the Cascade Mountains are predicted to decrease in the coming years

Keywords: Willamette basin precipitation; Water stable isotopes; Climate change; Snowpack; Elevation

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Toxic Pollutants Measured in Surface Water and Fish Collected from the Willamette River Basin by the Oregon Department of Environmental Quality (2008 – 2010)

Jim Coyle, Allen Hamel, Ben Johnson

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ABSTRACT

In 2008 the Oregon Department of Environmental Quality (ODEQ) initiated a program to monitor Oregon's surface waters and aquatic biota for the presence of pollutants that pose risks to human and/or environmental health. ODEQ's Toxics Monitoring Program was first implemented in the Willamette River Basin (WRB) between 2008 and 2010. Surface water samples were at collected 20 locations 6 times during that period and fish were collected at 12 sites in 2008. A variety of organic compounds and metals were detected in WRB surface water samples as well as in fish fillet samples. Concentrations of toxic organic compounds in water were generally low. Herbicides were the most frequently detected pollutant class; insecticides were rarely detected. Multiple, "emerging contaminants" were detected in surface water. Generally, water collected at sites located lower in basin contained a higher number of detected compounds. Composited fillet samples (northern pike minnow and smallmouth bass) contained concentrations of dioxins and furans (expressed as total toxic equivalents) that exceeded EPA screening levels for recreational and subsistence anglers. Other contaminants detected in fish fillet samples included DDT (legacy pesticide), polychlorinated biphenyls (widely used in electrical generation/transmission, banned in 1970's), polybrominated biphenylethers (flame retardants) and mercury. Findings will be presented relative to established criteria or screening values (where available).

Keywords: Water quality monitoring; Toxic pollutants; Surface water; Freshwater resident fish

Emerging and Legacy Contaminants in POCIS, SPMDs, and the Largescale Sucker (*Catostomus macrocheilus*) in the Lower Columbia River – USGS ConHab Project

Elena B. Nilsen[1], David Alvarez[2], James E. Madsen[3], Steven D. Zaugg[3], Stephanie Perkins[2], Walter Cranor[2], Jennifer Morace[1]

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ABSTRACT

An interdisciplinary study, USGS Columbia River Contaminants and Habitat Characterization (ConHab) project, is underway to investigate transport pathways, chemical fate and effects of polybrominated diphenyl ethers (PBDEs) and endocrine disrupting chemicals (EDCs) in aquatic media and the foodweb in the lower Columbia River. Polar organic chemical integrative samplers (POCIS) and semipermeable membrane devices (SPMDs) were co-deployed at each of 10 sites to provide a measure of the dissolved concentrations of select PBDEs, chlorinated pesticides, and other EDCs. PBDE-47 was the most prevalent of the PBDEs detected. Numerous organochlorine pesticides, both banned and current-use, were measured at each site including hexachlorobenzene, pentachloroanisole, dichlorodiphenyltrichloroethane (DDT) and its degradates, chlorpyrifos, endosulfan, and the endosulfan degradation products. EDCs commonly detected included a series of polycyclic aromatic hydrocarbons (PAHs), fragrances (galaxolide), pesticides (chlorpyrifos and atrazine), plasticizers (phthalates), and flame retardants (phosphates). The site near Columbia City tended to have the highest concentrations of contaminants in the Lower Columbia River.

Resident largescale suckers (*Catostomus macrocheilus*) were collected at three of the ten sites. Brain, fillet, liver, stomach, and gonad tissues were analyzed. Concentrations of halogenated compounds in tissue samples ranged from <1 to 400 ng g^{-1} wet tissue. PBDEs, organochlorine pesticides, DDT and its degradates, and polychlorinated biphenyls (PCBs) were detected at all sites in nearly all organs tested. Concentrations increased moving downstream from Skamania to Columbia City to Longview. Chemical concentrations were highest in livers, followed by brain, stomach, gonad, and fillet. PBDE congeners most frequently detected and at the highest concentrations were BDE47 > BDE100 > BDE154 > BDE153. These congeners are some of the major constituents of the commercial penta-BDE formulation. Results support the hypothesis that contaminant concentrations in the environment correlate to bioaccumulation in the foodweb. The fish concentrations will be compared to concentrations in other levels of the foodweb and to biomarker results also determined as part of the ConHab project to improve understanding of bioaccumulation and effects of these contaminants in the lower Columbia River.

Keywords: Emerging contaminants; PBDEs; Endocrine disrupting chemicals; SPMDs; POCIS

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Integrated Water-Quality Assessment using Conventional, Passive-Sampling, and Metabolic Assay Techniques: Approaching System-Level Understanding of Risk

Valerie Kelly, Kathleen McCarthy

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ABSTRACT

Conventional monitoring to assess water quality of drinking water sources in streams and rivers is typically focused on identifying primary sources and conditions that are associated with mobilization of contaminants. This approach is often organized as a series of discrete samples collected in such a way as to capture the influence of specific land use activities or climatic events. Often streamflow data are included to facilitate calculation of loads, which allows the relative contribution from different sources and events to be compared. This approach is limited by the episodic nature of contaminant transport, so that integrating the health risk presented by observed concentrations is challenging with the limited data that are usually available. This limitation is especially pronounced because it does not account for synergistic effects among individual compounds. Other critical limitations include cost, considering the large number of compounds that may be relevant, and the analytical challenge of quantifying the very low concentrations that are typically present.

An alternative approach is provided by the use of passive sampling techniques that specifically address the detection level challenge by concentrating contaminants into sorbent material over a long period of deployment, generally on the order of 30 days. These samplers provide an integrated view of contaminant exposure over time, and can better detect trace amounts of chemicals because of the increased mass of material. Additional information on the synergistic effects of chemicals on biota is provided by analysis of metabolic assays, such as the yeast estrogen screen bioassay.

A combination of these three approaches in monitoring for drinking water source protection provides a more system-level perspective on transport and behavior of contaminants. This combined approach facilitates more complex understanding of contaminant occurrence and behavior than the simple monitoring of individual chemicals during targeted conditions, without sacrificing that more specific and detailed view. These three alternative modes of sampling are being used to evaluate risks to drinking-water quality in the McKenzie River. Early results demonstrate that the data complement each other and provide different insights. This approach is proposed as a useful foundation for monitoring a range of systems in Oregon that could provide a valuable opportunity for cost-effective collaboration by a number of drinking water providers.

Keywords: Drinking water; Water-Quality monitoring; Passive samplers; Yeast estrogen bioassay; Synergistic effects; System perspective

Influence of Hydraulics and Streamflow Regime on the Habitat of *Manayunkia speciosa*, the Definitive Host of the Salmonid Parasite *Ceratomyxa shasta*.

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ABSTRACT

Management strategies for parasites with complex lifecycles typically target not the parasite itself, but one of the alternate hosts. *Ceratomyxa shasta* is a myxozoan parasite of salmonids that requires a freshwater polychaete *Manayunkia speciosa* to complete its lifecycle. In the Klamath River, CA/OR, *C. shasta* causes significant mortality in juvenile salmon, imposing social and economic losses on sport and tribal fisheries. An interest in manipulating the polychaete host to decrease the abundance of *C. shasta* in this system has therefore developed. *Manayunkia speciosa* is a small (3mm) benthic filter-feeding worm that attaches itself perpendicularly to substrate through construction of a flexible tube. There are several hydropower dams on the Klamath River and pulsed flows as well as gravel augmentation have been proposed as methods to decrease *M. speciosa* populations through scouring action. The presence of the dams, and their projected deconstruction in 2020 have also raised questions of whether the dams are influencing disease dynamics and what changes might be anticipated with their removal. One hypothesis is that dam construction has increased polychaete habitat by modifying the natural flow regime, leading to amplification of *C. shasta*. Unfortunately, there are limited data on the life-cycle and habitat requirements of *M. speciosa* or the influence of streamflow regime and hydraulics on their population dynamics. This work aims to address the data need by characterizing the physical habitat utilized by *M. speciosa* and applying a hydraulic model at a study site to investigate how habitat changes under a range of flow conditions. Populations of *M. speciosa* are also being monitored year round for density and infection prevalence to better understand the influence of seasonal changes in temperature and flow.

Keywords: Salmonid parasite; Polychaete; Habitat characterization; Streamflow regime; Hydraulic modeling

Quantitative Relationship between Resazurin and Respiration in Stream Ecosystems

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ABSTRACT

After three decades of active research in hydrology and stream ecology, the connection between solute transport, stream metabolism and nutrient dynamics is still unresolved. This existing gap obscures the functionality of stream ecosystems and how they interact with other landscape processes. To date, determining rates of metabolism is accomplished with techniques that are not spatially representative, mainly because of the limited sample volume of the methods (e.g., benthic and hyporheic chambers) and the uncertainties associated with them (e.g., estimation of reaeration rates in the two-diel technique). On the other hand, correlations between solute transport and nutrient dynamics have shown weak or even contradictory results. Clearly, the finding of mechanistic relationships among solute transport, stream metabolism and nutrient retention is required to advance our understanding and predictive ability to assess the growing pressure that exists, worldwide, on stream ecosystems.

We hypothesize that most metabolism and nutrient retention is associated with key active areas within transient storage zones, where high hydraulic and biogeochemical gradients stimulate processing by microorganisms and macrophytes. These zones are located in the near-subsurface of hyporheic zones and in the benthos of pools and eddies in surface transient storage zones; they are referred to as metabolically active transient storage (MATS) zones. To quantify MATS, we characterized the use of the bio-reactive tracer resazurin (Raz). In the presence of respiration, Raz undergoes an irreversible reduction to strongly fluorescent resorufin (Rru). Laboratory and mesocosm experiments have shown that the transformation of Raz to Rru is negligible in the water column, but rapid in colonized sediments; this is consistent with previous independent findings about biogeochemical hot spots. Results from field experiments strongly suggest that the Raz to Rru transformation is correlated with whole-reach respiration and can differentiate metabolic activity in reaches with contrasting hydrological and biological characteristics.

Keywords: Resazurin; Transient storage; Nutrient retention; Stream ecosystems

Water Management Session
Michael E. Campana, Chair
Wednesday, May 25
8:00 AM – 4:15 PM

A River Won: Facilitating Cooperative Negotiation of Transboundary Water Resource Management in the Columbia River Basin through Documentary Film

Julie Elkins Watson

Water Resources Program – Policy/Management, Oregon State University, Corvallis, OR

ABSTRACT

The Columbia River Treaty has been in effect for over 45 years, but its future is uncertain. Starting in 2014, Canada and the United States will have the opportunity to announce ten years' notice for termination of the current arrangement. As this artificial deadline approaches, stakeholders are working to determine future scenarios for the shared management of the Columbia. The success of these scenarios is contingent upon a comprehensive understanding of the "basket of benefits" in the Columbia Basin. Accordingly, the stakeholders in a basin must have meaningful dialogue that goes beyond positions to identify the underlying values and interests in the basin. For facilitators, this requires the development of a process for constructive engagement that facilitates mutual understanding and respect. Media, such as documentary films, are one channel for expressing values, interests, and positions that can potentially influence recipients' understanding of the issue. I plan to test the effectiveness of documentary media as a facilitation tool in the Columbia River Basin (CRB) to examine whether it facilitates understanding, promotes constructive dialogue, and sparks brainstorming of new scenarios for the basin. I will create a documentary film that integrates facilitative techniques, encouraging the viewer to elaborate and learn from the different values. I will give surveys before and after the documentary viewing (at the next CRB Symposium in autumn 2011) and analyze the data to determine whether the film influenced the cooperation variables. This study can shed light on the potential of integrating dynamic media into water resource facilitation, which in turn can help facilitators and water resource professionals fine-tune facilitation techniques.

Keywords: Columbia River; Shared management; Stakeholder values; Basket of benefits; Holistic; Transboundary water management; Cooperative negotiation, Facilitation; Documentary; Media; Film

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Water Conflict Management and Transformation in the Pacific Northwest and the World

Aaron Wolf[1], Dena Marshall[2]

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ABSTRACT

With the advance of climate change and growth of human populations and economies, the amount of freshwater in the world remains roughly the same as it has been throughout history. The amount economically available for human use is only 0.007% of the total, or about 13,500 km3, which is about 2300 m3 per a person—a 37% drop since 1970. This increasing scarcity is made more complex because almost half the earth's land surface lies within international watersheds—the land that contributes to the world's 263 transboundary waterways. Both water quantity and water quality have been neglected to the point of catastrophe. More than a billion people lack access to safe water supplies. Almost three billion do not have access to adequate sanitation. Five to ten million people die each year from water-related diseases or inadequate sanitation. Twenty percent of the world's irrigated lands are salt laden, affecting crop production. The pressures on water resources development leads to intense political pressure often referred to as water stress, or water poverty. Furthermore, water ignores political boundaries, evades institutional classification, and eludes legal generalizations. Water demands are increasing, groundwater levels are dropping, surface water supplies are increasingly contaminated, and delivery and treatment infrastructure is aging. Collectively, these issues provide compelling arguments for considering the security implications of water resources management.

If the challenges are both subtler and more local in nature then so too are the potential solutions. Throughout this presentation, we will note that shared water does lead to tensions, threats, and even to some localized violence—and we will offer strategies for preventing and mitigating these tensions—but not to war. Moreover, these tense "flashpoints" generally induce the parties to enter negotiations, often resulting in dialogue and, occasionally, to building creative and resilient working arrangements. We note also that shared water provides compelling inducements to dialogue and cooperation, even while hostilities rage over other issues.

We will: (1) Provide a brief overview of the nature of conflict and experiences of cooperation over transboundary resources; (2) Provide a conceptual basis for understanding cooperation and the costs of noncooperation over water; (3) Indicate the possible triggers for conflict over water sharing and the implications on the livelihoods of ordinary communities; (4) Offer evidence on the potential costs of noncooperation or even conflict over water resources; (5) Analyze different examples of cases where basin stakeholders have successfully managed the competition for water resources; (6) Propose general principles and conclusions on conflict and cooperation.

Keywords: Transboundary water, Water conflict and cooperation; Collaborative use agreements, Integrated Water Resources Management (IWRM)

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Development of an Integrated Water Resources Strategy: Assessing the Public's Values, Knowledge, Perception of Risk, and Acceptability of Management Strategies.

Monica Hubbard, Erika Allen Wolters

Environmental Science Program and Department of Political Science, Oregon State University, Corvallis, OR

ABSTRACT

Oregon is perceived as a water rich state; however, as the 2001 Klamath Basin crisis demonstrated, Oregon is not immune to water conflict and problems. Due to its seasonal fluctuations in water availability and geographical variation, Oregon can be considered a water scarce state, with the majority of surface water already fully, or in some places, over allocated during summer months. Climate change, population growth, and increased demand for water in Oregon are stressors compromising water quantity and quality for water users, ecosystem services, as well as limiting resources available for fish and wildlife. In 2009, the 75th Legislative Assembly passed HB 3369 authorizing the Oregon Water Resources Department (in conjunction with Oregon Department of Fish and Wildlife, the Department of Environmental Quality, and the Department of Agriculture) to develop a statewide, integrated water resources strategy, signifying the need for an assessment of water use and availability, as well as a projection for future water needs.

In order to develop a statewide, integrated water resource plan, it is important to determine how Oregonians perceive water issues in Oregon. As such, as assessment of Oregonians' risk perception, knowledge, values and adaptability to changing water conditions is imperative to plan for future water needs of people and ecosystems. Further, it is necessary to understand just how climate change will impact the amount, timing and availability of snowpack runoff that supplies the majority of water to the residents and wildlife in Oregon. We will therefore highlight results from two statewide surveys and interviews of Oregon residents, elected officials, and agency personnel in order to describe the socio-political perceptions of Oregonians.

Keywords: Integrated Water Resources Strategies; Public knowledge; Socio-political; Water consumption

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

Developing an Agricultural Water Efficiency Strategy to Help Meet Oregon's Water Needs

Teresa Huntsinger

Clean & Healthy Rivers Program, Oregon Environmental Council, Portland, OR

ABSTRACT

In 2010 Oregon Environmental Council (OEC) embarked on a research effort to develop strategic, practical recommendations for advancing agricultural water efficiency in Oregon. While OEC's report on this project will not be published until July 2011, we will share some of our initial findings at the Oregon Water Conference.

As climate change and population growth place increasing pressure on Oregon's already strained water resources, improved agricultural water conservation and efficiency will need to be a critical component of the solution, for the benefit of farmers and fish. Agricultural irrigation makes up at least 80% of Oregon's water withdrawals and about half of all cropland in Oregon is irrigated.

While many people agree that conservation is a laudable goal, and many growers and irrigation districts have made significant progress in improving the efficiency of irrigation and water delivery systems, there has been little consensus about what the state could do to strategically expand more efficient practices. OEC has been reaching out to agricultural stakeholders and irrigation experts to solicit their ideas and investigate existing barriers, with the aim of developing practical solutions that will benefit growers and the environment. Recommendations may include policy changes, incentives, educational programs and pilot projects. These recommendations will inform our participation in the state's Integrated Water Resources Strategy Policy Advisory Group.

Keywords: Conservation; Efficiency; Agriculture; Irrigation

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

Building a Legacy: Integrated Water Resources Management in Damascus, Oregon

Steve Gaschler[1], Mark A. Anderson[2], Emily Callaway[2], David Green[2]

[1]City of Damascus, OR; [2]CH2M Hill, Inc., Portland, OR

ABSTRACT

The City of Damascus, Oregon has a current population of nearly 10,000 people and expects to grow to 50,000 residents by 2060. On the eastern edge of the Portland metropolitan area, the City is located in the Clackamas and Willamette basins with an area of almost 12,000 acres. Semi-rural in character, the recently incorporated city will require water, wastewater, and stormwater infrastructure to serve expected growth. The City developed an Integrated Water Resource Management (IWRM) Plan, in cooperation with several regional service providers, to capitalize on a unique opportunity to consider urban water management from a local watershed perspective, while considering water supply, environmental health, drainage and flood control, water reuse, treatment, and disposal as part of a single system.

The IWRM Plan used a structured decision process, community and stakeholder outreach, and a water balance simulation model to develop and evaluate fifteen financial and non-financial criteria for eleven scenarios, including sensitivity analysis of regulatory uncertainty and climate change impacts on recommended solutions. Scenarios included treatment, storage and conveyance infrastructure for potable use, indirect non-potable reuse, and discharge at local basin, city-wide, and regional scales to find an efficient and resilient system solution. Rainwater capture, environmental flow requirements, groundwater availability, and use of existing ecosystem services to provide stormwater and wastewater treatment and disposal were also considered in the analysis.

The IWRM Plan built on the City's core values and an earlier Public Facilities Plan that identified ecosystem services as both a "facility" to be protected and developed, as well as a possible alternative to built infrastructure solutions. The Voyage™ model used for simulation and reporting of results facilitates decision-making and assists to visualize alternatives. The IWRM Plan builds a portfolio for water management that balances risk, cost, and long-term uncertainty to establish a fundamental direction for water management in the next century in Damascus.

Keywords: Watershed planning; Integrated Water Resources Management (IWRM); Reuse; Systems modeling

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Willamette Basin Water Futures: County Partnerships with Scientists' Cutting-Edge Models

Adam Stebbins

Benton County and Benton-Lane-Linn Water Resources Study Group, Corvallis, OR

ABSTRACT

The elected County Commissioner-led Benton-Lane-Linn Water Resources Study Group evolved in early 2009 to help counties, their partners, and area residents understand, pursue projects and offer recommendations to governing bodies concerning the region's water quality and quantity. The Study Group is building on 2009-2010 successes including community engagement to support goals of the Oregon Integrated Water Resources Strategy. Participants of the Benton-Lane-Linn Water Resources Study Group will be working as part of the multi-year Oregon State University "Willamette Water 2100" NSF grant project. The five-year OSU led project is unique in the level of integration among several leading water resources academics from science, engineering, and socioeconomic disciplines.

Elected officials in the Willamette Basin often have to make short term wagers on water issues, against the backdrop of long term uncertainties over the quantity of and quality of water in the face changing land uses, population growth and climate change. The year-round water flow of the Willamette River and heavy winter rains make the impacts from a changing climate seem small in comparison to immediate economic and environmental issues. Meanwhile, scientists across the water resources disciplines are struggling to inform State and Local government and the citizens they serve, regarding the effects that a changing climate will likely have on water resources. Modeling of water supply and quality provides a means to bridge the climate change knowledge gap and risks under different scenarios. The Benton-Lane-Linn County Water Resources Study Group is starting a pilot project that brings Oregon State University scientists, elected officials and water-use decision makers into a "knowledge-to-action network" partnership, to develop tools and project the potential consequences of climate change.

Participating Study Group members in this knowledge to action network will have the ability to create a process and forum aided by science to weigh policy scenarios as the region faces tradeoffs involving water resources. The result is a pilot project where the latest science-based models are formed with policy choices that help inform improvements to local and regional policies for alleviating potential water scarcity.

Keywords: Legal and institutional issues; Water resources; Willamette Basin; Modeling

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

A Novel Physically-Based Framework for the Intelligent Control of River Flooding

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ABSTRACT

River flooding is a recurrent threat and its control and management continues to be a challenge. It has been recognized that effective flooding control requires a real-time strategy that combines optimization with a physically-based simulation model. Current real-time frameworks that combine simulation and optimization have two main drawbacks. The first drawback is that they attain the best operation strategy based on short-time forecasting only (few hours – few days). This may lead to a wrong operation strategy that may result in flooding or to an unnecessary water release from the reservoirs which would be in conflict with non-real time objectives of the system, such as those of maximizing water storage for irrigation and hydropower production. The second drawback is that they do not account for system flow dynamics. These frameworks instead simply perform mass balance analyses in the reservoirs and assume that the water levels in the reservoirs are horizontal. This is a strong limitation given that a flooding event is highly dynamic and may start from anywhere in the river system. It may start from upstream (e.g., large inflows), from downstream (i.e., high water levels at downstream) or laterally from the connecting reaches (e.g., water levels at river junctions are near the reach banks). Accounting for system flow dynamics is also important because the flow conveyance from one reservoir to another is not instantaneous but depends on the capacity of the connecting reaches, the capacity of the associated gates and outlet structures and the dynamic hydraulic gradients. We present a novel simulation-optimization real-time framework that (1) accounts for system flow dynamics, (2) maximizes the benefits of non-real time objectives of the regulated river system at all times, except during a period, determined automatically trough sampling for a long forecasting, in which the objective of the system will switch to minimize flooding and (3) allows controlled flooding only after the capacity of the entire river system has been exceeded. This controlled flooding is based on hierarchy of risk areas to losses associated with flooding. This means that river reaches (or their areas of influence) that are less prone to losses will be assigned higher preferences for locations of flooding. Once the sampling determines that there is no danger for flooding, the proposed framework automatically switches to maximizing the non-real time objectives of the system. This sampling accounts for unsteady boundary conditions and for system flow dynamics, in particular for computing the conveyance capacity of the system. We demonstrate the proof of concept of this new framework using a hypothetical river system.

Keywords: Flooding; Hydraulic routing; Optimization; Real-time control; Reservoirs; River operation; River systems; Genetic algorithms.

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Source Water Protection in a Climate of Change: Perspectives from a Publicly-Owned Utility

Karl Morgenstern and Jared G. Rubin

Eugene Water & Electric Board. Eugene, OR

ABSTRACT

The McKenzie River serves as the sole source of drinking water for nearly 200,000 residents in Eugene, OR. The McKenzie River is also home to a number of threatened and endangered fish species. Whereas the majority of the upper watershed is forested, areas of rural development and agriculture occur along the valley floor. The cities of Springfield and Eugene are located near the river's mouth. There are numerous dams in the system that provides flood control and hydroelectric power for the region. Climate change has the potential to affect the river and the services provided by it to local residents and aquatic life. Models predict that climate change will dramatically affect storm and weather patterns as well as the timing and extent of the seasonal snowmelt. The area is also experiencing significant population growth, a trend that is anticipated to continue over the course of the next few decades. The development pressures accompanying population growth and rural expansion can also have profound impacts on the river. This impact is perhaps most evident when considering changes to the ecologically-critical riparian and floodplain areas. EWEB has taken an active role in assessing the McKenzie's water quality and the health of the riparian zone in face of developmental pressures. EWEB oversees an extensive water quality monitoring program that tracks conventional water quality parameters as well as some of the emerging contaminants of concern often associated with increased development such as flame retardants and pharmaceuticals. EWEB and its partners also conducted an extensive critique of the existing regulations pertaining to floodplains and riparian zones and identified significant gaps that allowed for the continued degradation of these ecologically sensitive resources. Effective riparian and floodplain management are critical for economic stability, ecologic resiliency, and adaptation in response to a climate of change. Recent experiences suggest that increased regulations may not be the most effective means for achieving riparian/floodplain protection due to property rights concerns. In the long run, voluntary incentives such as the promotion of agricultural and ecosystem services may prove to be more effective mechanisms for protecting these resources.

Keywords: Water quality; Climate change: Ecosystem services, Agriculture; Riparian; Floodplain

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Growth Management-oriented Water Conservation and Reuse in Oregon: Operationalizing Integrated Watershed and Water Resources Management

Jamison Cavallaro
Willamette Falls Watershed Association, Clackamas County, OR

ABSTRACT

Oregon's largest metropolitan region, Greater Portland, is home to a diverse array of water utilities though few have sufficiently robust water reuse and conservation goals. In determining the most beneficial way to allocate water-related public goods and natural resource management services, Oregonians are adapting to stronger legal standards among other principles such as sustainable development, public participation, and more. Despite the climate of uncertainties, the region is experimenting with full-cost accounting for water consumption, storm/wastewater assimilation, and ecosystem recovery.

For over 30 years the Portland metropolitan area has experienced different urbanization patterns and regional management regimes while impacting the ecology of multiple watersheds within the Lower Willamette River Estuary (and Columbia River from the Sandy River sub-basin to the Columbia's confluence with the Willamette). Focused on lessons learned from the 2004 Portland metro area Updated Regional Water Supply Plan, water purveyor targets for infrastructure connectivity, demand management, and new supplies are compared to that of other regions.

From a growth management perspective, this paper analyzes Integrated Water Resources Management (IWRM) as both a regulatory process as well as an intermodal water system infrastructure policy. Academic findings indicate that non-potable water reclamation and reuse options, nodal water storage and distribution infrastructure, systems of water pricing and land use permitting/zoning codes/comprehensive plans, and demand management should receive greater attention in the 21st century. This paper also offers criteria to aid in the analytical evaluation of Oregon's transition towards sustainable IWRM. Year by year, the commitment to IWRM (or "getting the right flows to the right places at the right time") can be measured by the following:

1) Increased application of water reclamation and conservation programs;
2) Reduced consumption of potable water by shifting to non-potable water for certain industrial and municipal, agricultural, and community system demands; and
3) Improved ecological in-stream flows and conditions.

Federal and state regulatory frameworks (both requirements like NEPA, ESA, and CWA as well as other watershed and public involvement guidelines like Statewide Goals 1-6 and 11) are explored by the author and local practitioners to generate recommendations for future studies and greater IWRM policy implementation improvements in Oregon

Keywords: Demand management; Non-potable: Water reclamation; Water recycling and reuse; Integrated watershed and water resources management: Watershed and floodplain restoration; Smart growth; TMDL, Salmon and steelhead recovery: Infrastructure optimization

Exempt Wells in the Courts, Agencies and Legislatures

Jesse J. Richardson, Jr.

Water Systems Council/Virginia Tech, Blacksburg, VA

ABSTRACT

"Exempt wells" are water wells that are exempt from one or more permit or other requirements in seventeen western states. Important policy considerations underlie the exemption, and only Utah does not exempt any water uses. However, some have expressed concerns about exempt water wells and the impact of the exemptions on water planning and growth management.

The proliferation of exempt wells in the West has generated a considerable amount of litigation, as well as administrative actions and legislative activity. This presentation examines and analyzes the most recent litigation and other activity on exempt wells, analyzing the possible impacts in Oregon.

Most prominently, in Bounds v. New Mexico, the Court of Appeals of New Mexico, No. 28,860 (October 29, 2010) opinion overruled a lower court decision that was decided in 2008. The lower court ruled that New Mexico's exempt well statute was unconstitutional on its face. The Court of Appeals decision has been appealed to the New Mexico Supreme Court.

In Washington State, litigation has been filed challenging the Washington Attorney General's opinion that the exempt well provision in that state provides an unlimited exemption for "stock watering". The exemption is being used by large concentrated animal facilities to allegedly pump over a million gallons of water a day. In addition, litigation involving Washington State's growth management statute, but focused on exempt wells, has been argued before the Washington Supreme Court in Kittitas County, et al. v. Eastern Washington Growth Management Hearings Board (Case No. 84187-0). Finally, A moratorium on exempt wells in Upper Kittitas County has generated significant controversy.

In Montana, the Department of Natural Resources rejected an administrative challenge to the exempt well rules, but in a settlement of court action challenging that action agreed to institute rulemaking to change the regulation. Legislative activity is expected this coming session.

This presentation synthesizes the present activity. The author attempts to provide a forecast of the outcomes of this activity.

Keywords: Exempt wells; Constitutional law; Water law

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Assimilative Capacity Modeling in Support of the Georgia Comprehensive State-Wide Water Management Plan

Brian Watson, Jeremy Wyss, Steven Davie, Elizabeth A. Booth

Water Resources Group, Tetra Tech, Atlanta, GA

ABSTRACT

In January 2008, the Georgia Water Council approved the Georgia Comprehensive State-Wide Water Management Plan (GA Water Plan). The purpose of GA Water Plan is to guide the state of Georgia with managing its water resources in a sustainable manner. This means not only allowing growth in Georgia, but also maintaining the ecological and biological health of the State's rivers, lakes and estuaries, as well as protecting state water quality standards. In order to evaluate the State's resources, the Georgia Environmental Protection Division (GAEPD) with the assistance of other state agencies, the University System of Georgia and other research institutions, the U.S. Geological Survey and contractors are conducting water resource assessments to determine Surface Water Availability, Groundwater Availability, and Assimilative Capacity of the surface water resources. The assessments will include the compilation and management of data, computer modeling of both current and future needs, and additional monitoring if needed. Results of the assessments will be provided Regional Planning Councils as a starting point for the development of a recommended Water Development and Conservation Plan. The Assimilative Capacity resource assessment included the development and calibration of a series of linked models including GADosag, EPDRIV-1D, LSPC, and EFDC. Once calibrated these models were used to evaluate a number of scenarios such as impacts due to the projected land use and point source discharges in 2050, non-point source management strategies, U.S. Army Corps of Engineering reservoir operation changes. These models were also used in the development and/or evaluation of nutrient criteria.

As our water resources become more taxed (both quantity and quality), and nutrient criteria development are being developed, the approach taken by Georgia will serve as guide to other agencies in long-term water planning.

Keywords: Modeling; Assimilative capacity; Water planning

Hydrologic Modeling Session
Jolyne Lea, Chair
Wednesday, May 25
1:30 PM – 4:15 PM

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

Relating Surface-Water Nutrients in the Pacific Northwest To Watershed Attributes Using the USGS SPARROW Model

Daniel Wise, Hank Johnson

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ABSTRACT

The USGS SPARROW model (SPAtially Referenced Regression On Watershed attributes) was used to predict the long-term, average loads, yields, and concentrations of total nitrogen and total phosphorus for stream reaches located in the Pacific Northwest (the Columbia basin, Puget Sound basin, and Pacific drainages of Oregon and Washington), and to identify the important sources and watershed properties that control the transport of nutrients through these stream reaches. The modeling results were used to identify stream reaches that were nutrient-enriched relative to the suggested U.S. Environmental Protection Agency reference criteria and determine the relative contribution of different source categories to annual instream nutrient load. The results from this analysis will be linked to an online decision support system that regional water-quality managers and other stakeholders can use to assess water-quality conditions where no water-quality monitoring results are available and predict changes in water-quality conditions under different management scenarios.

Keywords: Watershed modeling; Water quality; Nutrient loads; Geospatial analysis: Decision support system

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

Continuous Hydrologic Simulation of Johnson Creek Basin

Richard J. Shimota and Hans R. Hadley

WEST Consultants, Inc., Salem, OR

ABSTRACT

Peak discharge estimates are fundamental in the design of hydraulic structures, embankment protection, and stream restoration efforts, as well as flood risk analysis. Historic stream gage records are commonly used in the development of peak discharge estimates for a particular watershed. Use of an entire stream gage record assumes hydrologic stationarity within the basin of interest. However, changes in land use or climatic conditions may invalidate the assumption of hydrologic stationarity. An alternative to estimation from historic gage records is the development of peak discharges from a continuous hydrologic simulation and incorporating known or predicted changes to the hydrologic regime of the basin.

This presentation addresses an application of long-term continuous hydrologic simulation using Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS). A long term simulation of Johnson Creek basin was developed using current land use conditions in order estimate peak discharges for the City of Gresham flood study. The calibrated HEC-HMS model used a precipitation record of 61 years. The HEC-HMS model setup, calibration and verification are described. The non-stationarity of the Johnson Creek basin, the computed 100-year peak discharge estimate derived from long term simulation, and stream gage records are compared.

Keywords: Hydrologic modeling; Peak discharge estimation; Flood risk; Stationarity; Land use

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Flood Forecast Modeling of the Willamette Basin Using HEC-CWMS and HEC-ResSim

Shali Bogavelli, Daniel Christensen, Chris Goodell

WEST Consultants, Inc., Portland, OR

ABSTRACT

WEST Consultants, Inc. (WEST) worked with the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) to enhance the flood forecasting capability and management strategies for the Willamette Basin. Specifically, WEST was contracted by the HEC to modify the existing HEC-ResSim model of the Willamette Basin. Reservoir operation schemes were updated and the resolution of data inputs and outputs were increased to better represent flood control, fish passage, and power production operations. This new HEC-ResSim model was incorporated into the Corps' Water Management System (CWMS) at the Portland District, for real-time simulations during flood events.

The USACE Portland District is interested in using the HEC-ResSim within the CWMS to predict the amount of rise expected at the Willamette Basin Reservoirs and to enhance their decision-making regarding controlled releases from the reservoirs during flooding events. The new CWMS model operates in real-time, and uses forecasted flows from the NOAA-National Weather Service River Forecast Center as input to predict releases from the projects and resulting flow at stream gages. The model spans eleven counties, contains thirteen flood control reservoirs (three are re-regulating projects), and has a basin area of over 11,000 square miles. WEST configured, calibrated, validated, and tested the ResSim component and stress-tested the overall CWMS model to confirm the real-time forecasting capabilities.

The presentation demonstrates the final ResSim model with calibration and validation results, and how the model was incorporated into HEC-CWMS for real-time flood forecasting.

Keywords: Hydrologic modeling; Real-time flood forecasting; Reservoir regulation

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Characterizing Rain/snow Partitioning in Mountain Watersheds for Present-day and Future Projected Climates

Eric A. Sproles, Anne W. Nolin

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ABSTRACT

The western slope of the Oregon Cascades receives up to 3500 mm of precipitation annually, with a majority falling between the months of November-March. In this maritime climate, the partitioning of precipitation between rain and snow is highly sensitive to temperature. Climate models generally agree that winter temperatures in the Pacific Northwest will increase in the next few decades. In this model-based study we apply a classification system based upon rain-snow probability, seasonal precipitation variability, land cover, landscape position, and geology for sub-basins of the McKenzie River Basin. Using a "delta" approach, we apply monthly projected changes in temperature and precipitation to the meteorological data that forces a spatially distributed snow model. The model distributes precipitation over the landscape as rain or snow depending on grid cell temperature. The metric for rain-snow probability uses the dimensionless ratio of Snow Water Equivalent (SWE) to precipitation (P; with the ratio referred to as SWE/P hereafter). This metric minimizes the effects of variable precipitation, while still accounting for impacts of warmer temperatures on snowmelt. Combining SWE/P likelihood with landscape metrics provides a probabilistic approach characterizing sub-basins and their spatiotemporal responses to warmer temperatures.

Keywords: Water resources; Climate change; Watershed characterization; Snow

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A Decision Support System for Optimizing Reservoir Operations Using Ensemble Streamflow Forecasts (ESP)

Eset T. Alemu[1], Richard N. Palmer[2], Austin Polebitski[2], Bruce Meeker[3]

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ABSTRACT

The presentation discusses the economic value of Ensemble Streamflow Predictions (ESP) streamflow and energy price forecasts in the operation of the Jackson Hydropower Project in western Washington. A decision support system (DSS) was constructed for this multipurpose reservoir system for the evaluation of operational alternatives and improvement of operational procedures. The DSS is composed of two integrated operating models: a simulation model that replicates general operating rules for the hydropower system and captures the daily fluctuations and constraints in the system and an optimization model that refines operations based upon forecasts of state variables such as streamflow and energy price forecasts. The DSS uses an ensemble streamflow forecast and energy prices to generate a range of optimal reservoir releases that maximizes the economic value of the hydroelectric power, while meeting regulatory and operational requirements. Forecasts of streamflow and energy prices are used to schedule the quantity and timing of reservoir releases for daily, weekly, and seasonal operations while maintaining the project in accordance with regulatory constraints for flood control and environmental flows.

Streamflow forecasts influence reservoir operations in that they are used to determine the quantity of water available for hydroelectric power generation and environmental releases while energy price forecasts help identify periods in which generation is optimal. The research evaluated the extent to which these forecasts can enhance reservoir operations in terms of economic benefits. The economic value of improvement in skill is evaluated through comparison of the revenue generated from using different combinations of retrospective or "perfect" and available forecasts of streamflow and energy prices. The use of ensemble streamflow forecasts also provides operators with additional information on the probabilistic distribution of storage levels of the project. The results from the investigation show how the decision support system can be used for the evaluation of operational alternatives and improvement of skills in operating the reservoir system.

Keywords: Streamflow forecasting; Ensemble Streamflow Predictions (ESP); Decision support system; Reservoir operations; Simulation and optimization models

Panel Sessions
James Ruff, Chair
Tuesday and Wednesday, May 24-25

Panel 1: Oregon's Integrated Water Resources Strategy (IWRS)

Moderator: Brenda O. Bateman, Tuesday, 1:30 – 3 PM

Panel 2: People, Beavers, Wolves, and Water: New Approaches to Restoring Complexity, Function and Water Storage Capability to Degraded Stream/Riparian Corridors on Public and Private Lands

Moderator: Suzanne Fouty, Tuesday, 3:30 – 5 PM

Panel 3: Integrating Climate Adaptation Planning and Watershed Assessments to Improve Community-Engaged Watershed Management: A Case Study from the Klamath Basin, Oregon

Moderators: Ethan Rosenthal and Stacy Vynne
Wednesday, 8 AM – 9:30 AM

Panel 4: Transboundary River Governance – The Columbia River Treaty 2014/2024 Review

Moderator: John Shurts
Wednesday, 10 AM – 12 noon

Panel 1

Panel Discussion: Oregon's Integrated Water Resources Strategy (IWRS)

ABSTRACT

During 2009, the 75th Legislative Assembly passed House Bill 3369, directing the Oregon Water Resources Department to develop a state-wide, Integrated Water Resources Strategy (IWRS) to help Oregon meet its future water quantity, water quality, and ecosystem needs, while taking into account coming pressures such as population growth, changing land use patterns, and climate conditions.

Along with the Oregon Water Resources Department, the Department of Environmental Quality, Department of Fish and Wildlife, and Department of Agriculture are key partners in these efforts. Tribes, along with public and private sector stakeholders, also have an important voice in this process, as do other local, state, and federal agencies.

The focus during 2009-2012 is on the development of a statewide framework and recommended actions that help the state better understand and meet its water resource needs. The Framework identifies several potential critical issues that could be addressed during the first iteration of this Strategy (2012-2017).

A set of recommended actions will also be developed during 2011 to address these issues. Based on input gathered thus far, such actions would presumably focus on addressing data and information gaps, integrating decision-making and planning efforts, supporting basin planning, strengthening water conservation and water management approaches, improving natural and built storage, protecting instream flows and restoration work, and more.

A panel, comprised of project participants, will discuss these potential recommended actions and invite audience input about the direction and scope of each.

Moderator and Panelist: **Brenda O. Bateman**, IWRS Project Manager
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Panel 2

Panel Discussion: People, Beavers, Wolves, and Water: New Approaches to Restoring Complexity, Function and Water Storage Capability to Degraded Stream/Riparian Corridors on Public and Private Lands

ABSTRACT

Variability is a defining principle of our global climate and stream/riparian ecosystems and species developed in the presence of that reality. Species life cycles and survival strategies, combined with complex, widely-distributed, stable water-rich ecosystems, allowed species to survive even when local groups disappeared. Beavers were key in the development of those ecosystems, and as the work in Yellowstone National Park shows, so were wolves. However, the rapid and systematic removal by Euro-Americans of both these animals, combined with later land uses, triggered a series of changes that transformed stream/riparian ecosystems and corridors in function and appearance. Stripped of their vegetative and channel complexity, their stream-valley floor hydrologic connections and water storage capabilities, stream/riparian corridors have become highly responsive to climate variability and their watersheds increasingly water-poor.

Given the magnitude of the historic degradation, restoration of watershed health and function requires large-scale changes in public and private land-use patterns, priorities and management, in State beaver trapping policies, and in attitudes about wolves and beavers. Incorporating beavers back into the story fundamentally alters our science and perceptions of how healthy stream/riparian systems should look and behave. Incorporating wolves back into the story presents political and social challenges, but is needed ecologically to release riparian vegetation at a landscape scale from the relentless browse pressure of elk and deer – vegetation needed by beavers to build and maintain their dams. These dams in turn lead to diverse, ecologically stable, water-lush stream/riparian corridors capable of providing water during periods of drought years and flood control during wet years.

The panel will present examples from private and public lands of how beavers and/or wolves are restoring water abundance, water quality, and ecosystem services and complexity across a diversity of landscapes, the speed of those changes, and factors limiting accelerated restoration.

Moderator and panelist: **Dr. Suzanne Fouty** (Hydrologist)

Panelists:

Dr. Robert Beschta (Professor Emeritus, Oregon State University)

Rick Demmer (Wildlife Biologist-Bureau of Land Management, Prineville District)

Leonard Houston (Beaver Advocacy Committee)

Panel 3

Panel Discussion: Integrating Climate Adaptation Planning and Watershed Assessments to Improve Community-Engaged Watershed Management: A Case Study from the Klamath Basin, Oregon

ABSTRACT

The Klamath Basin is rich in history, culture, and biological diversity. Upper Klamath Lake is fed primarily by the Williamson and Sprague rivers. Below the lake's outlet, the Klamath River begins a 263 mile journey, cutting through both the Cascade and Coast mountain ranges to the Pacific Ocean. The Basin drains 15,571 square miles and encompasses parts of three Oregon and five California counties. The Klamath Basin provides a habitat for numerous fish and wildlife species, energy generation for local communities, an irrigation source for the extensive agricultural systems, recreational opportunities for locals and visitors, and plays a strong role in the cultural traditions of many Native American communities living in the region. The Klamath Basin has faced ongoing catastrophic droughts, competition for water resources, and loss of key habitat for fish, birds and other wildlife. While major strides have been made to improve management and reduce competition over water resources, climate change will bring even greater stress with increased temperatures, loss of snowpack, and reduced stream flow. This panel will discuss how watershed partnerships, state agencies, and local stakeholders can use climate change adaptation assessment and watershed assessment processes to inform stakeholder discussions and management efforts in the region. Lessons learned from Klamath Basin efforts will be presented to demonstrate how local climate projections can be used in conjunction with watershed assessments to improve watershed management in other areas of the state and across the country.

Co-moderator: **Ethan Rosenthal** (David Evans and Associates, Inc.)

Co-moderator: **Stacy Vynne** (Climate Leadership Initiative)

Panelist: **Ken Bierly** (Deputy Director-Oregon Watershed Enhancement Board)

Panelist: **Terry Fisk** (Hydrologist-U.S. Fish and Wildlife Service, Klamath Falls office)

Panelist: **Greg Addington** (Director-Klamath Water Users Association)

Panelist: **Nathan Jackson** (Director-Klamath Watershed Partnership)

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

Panel 4

Panel Discussion: Transboundary River Governance – The Columbia River Treaty 2014/2024 Review

ABSTRACT

The Columbia River Treaty (CRT) between Canada and the United States is an example of international cooperation enabling flood control and hydropower benefits affecting both countries. The CRT required the construction and operation of three large dams in the upper Columbia River Basin in British Columbia, and allowed the U.S. to construct Libby Dam in Montana. CRT dams more than doubled the amount of reservoir storage in the basin, which has greatly increased downstream hydropower generation and flood control, providing billions of dollars of benefits for the two countries. Signed in 1961 and implemented in 1964, the CRT is known throughout the world as one of the most successful transboundary water treaties based on equitable sharing of downstream benefits of hydropower generation and flood risk management. Unfortunately, the broader impacts to ecosystem function were not recognized or considered during the negotiation of the CRT, nor were the tribes in the United States or the First Nations in Canada consulted regarding the potential effects of the CRT on their natural and cultural resources. The benefits of coordinated power generation and flood risk management came at substantial costs to other ecosystem functions. The costly and detrimental effects of the implementation of the CRT on the river ecosystem and cultural resources are now better understood, but the ability to secure substantive changes to the CRT or its implementation in a manner that adequately addresses these impacts is limited.

The CRT has several provisions that are enabled only after September 2024, including changes to flood control obligations and an option for either government to terminate the CRT if at least 10-years prior notice is given. These provisions, and changing needs and obligations for hydropower, ecosystem restoration, resident and anadromous fish, and other water uses, make the future of the CRT uncertain. The Canadian and U.S. Entities, the agencies that implement the CRT, initiated a 2014/2024 Columbia River Treaty Review (Treaty Review) process in 2008. The purpose of the Treaty Phase I Review was to examine the CRT's 2024 provisions and develop hydro-regulation studies to help understand the post-2024 conditions with and without the CRT from the narrow perspective of the two purposes of the CRT, power and flood control, and inform the process for developing future studies. The Treaty Entities published their Phase I report last summer. Notwithstanding the CRT, the U.S. portion of the hydropower system is still subject to domestic laws and obligations, such as the Endangered Species Act (ESA). The Federal Columbia River Power System (FCRPS) was reviewed for its impacts on fish listed under the ESA and a Biological Opinion was issued by NOAA Fisheries. The U.S. Entity (the Administrator of Bonneville Power Administration as Chair and Northwestern Division Engineer for the U.S. Army Corps of Engineers as Member) published a Supplemental Report in September 2010 that overlaid an analysis of the obligations of the Biological Opinion requirements on the Phase I studies. Neither the joint Phase 1 Report nor the U.S. Entity's

Supplemental Report undertook a baseline analysis of the effects of the CRT on other ecosystem functions or cultural resources.

The U.S. Entity is currently engaged throughout the region in a public outreach program to better understand sovereign and stakeholder interests and define Phase II studies regarding various scenarios of potential Treaty futures. As a consequence of expected changes to Canadian flood control obligations under the CRT, the Corps has initiated studies that will examine the need for, and potential changes to, basin-wide flood risk management. Values in the region have changed over the last 50 years, continuing trust obligations to tribes in the U.S. are now recognized, and new issues need to be considered that were not part of the Treaty debate 50 years ago. The U.S. Entity is establishing management structures to engage and address the interests of other Federal agencies, regional sovereigns and non-sovereign stakeholders to develop a recommendation to be provided to the State Department in fall 2013.

Moderator and Panelist: **John Shurts** (General Counsel-Northwest Power and Conservation Council)

Panelist: **John Hyde, P.E.** (Technical Lead, Columbia River Treaty Review-Bonneville Power Administration)

Panelist: **Matthew Rea** (Program Manager, Columbia River Treaty-U.S. Army Corps of Engineers)

Panelist: **Paul Lumley** (Executive Director-Columbia River Inter-Tribal Fish Commission)

Panelist: **Kindy Gosal** (Director, Water and Environment-Columbia Basin Trust)