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

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

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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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Continuous Hydrologic Simulation of Johnson Creek Basin

Richard J. Shimota and Hans R. Hadley

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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

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

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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

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

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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)

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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