American Water Resources Association
2009 SPRING SPECIALTY CONFERENCE
Managing Water Resources Development in a Changing Climate
May 4-6, 2009
Anchorage, AK

Monday, May 4
10:30 AM – 12:00 Noon
Session 2: Balancing Water and Energy Resources

1. Integrated Management of Water and Energy Resources - Kristine Shaw, HDR, Austin, TX (co-authors: Peter Newell, Brooke Garcia, Adam Kessler, Seth Turner)

Water and energy represent elemental and vital resources to growing economies and are intricately linked. Historically, water and power entities have developed and managed their resources independently. Water is used to generate electricity through hydropower, providing nearly 10% of electrical generation throughout the US, but is also a critical resource for thermoelectric generation which accounted for 39% of all national freshwater withdrawals in 2000. Energy forecasts anticipate US thermoelectric generating capacity to grow 21% by 2030 while total electricity consumption will grow 30% by 2030. With the increase of generating capacity, freshwater withdrawals could increase to 155.4 billion gallons per day in 2030. An HDR study reviewed a number of existing power projects to identify water resource related issues. The study looked at water requirements for coal, natural gas, nuclear, and ethanol plants as well as renewable energy. The study indicated several water resource related issues associated with power project including identifying and supplying water for cooling, resource extraction; design considerations for water quality of cooling water, blowdown water and water returned to surface water sources and aquatic species concerns. Water managers in a majority of states, and in particular the drought-prone southwest region of the United States where population growth far exceeds national averages, expect water availability concerns by 2013. To meet the demand, thermoelectric capacity in southern Nevada, New Mexico, Arizona, California, and Oregon is expected to increase by 50% in incremental capacity by 2030. As public pressure grows to reduce water withdrawals and competition increases among municipal, irrigation, and industrial water users for already strained water resources, water supply for energy production becomes more limited requiring both resources to be viewed collectively. Additionally, future climate uncertainty and resulting impacts on water resources further exaggerates the need for efficient, integrated management of these resources. It is evident that the power sector will continue to draw on water as a resource in energy production and will require innovative and sustainable solutions to meet the future demand. Meeting future water and energy demands will require integrated management of water and energy resources.

2. Assessing Hydrologic Vulnerability of Sierra Nevada Watersheds with Climate Warming Conditions and Hydropower Operations - David Rheinheimer, Department of Civil & Environmental Engineering, University of California, Davis, CA (co-authors: Joshua H. Viers, Jay R. Lund, Jeffrey F. Mount, Vishal Mehta)

The natural flow regimes of the rivers of the western slope of the Sierra Nevada Mountains will change significantly under climate warming scenarios. However, most major streams of the Sierra Nevada do not flow naturally, as they are highly modified by a network of dams and diversions for multiple uses, including hydropower. How modified flow regimes are likely to change under climate warming is poorly understood; however, a better understanding is needed for effective regional hydropower operations planning. In this study, we used simulation models of unimpaired and impaired river flows in the American, Bear, and Yuba (ABY) River watersheds under four warming scenarios (+0, 2, 4, and 6°C) to determine the impact of existing infrastructure and operating rules on the vulnerability of the hydrologic regime to climate warming. The two models were developed with the Water Evaluation and Planning System (WEAP21), which integrates rainfall-runoff and water management models, by the Stockholm Environment Institute. Both models compute surface water runoff at a weekly time step by using vegetation cover mixes between 250m elevation bands within subwatersheds defined by pour points of management interest. The second model includes reservoirs, diversions, powerhouses, demands, and flow requirements. We compare spatial trends in hydrologic vulnerability of the unimpaired system with the current infrastructure and explore the impact of modifications on vulnerability, where vulnerability measures potential changes in 1) high, low and mean annual and weekly flows, 2) seasonality of flows, 3) weekly rates of change, and 4) duration of base flow. This analysis reveals where the hydrologic regime of the current ABY water system will be more or less resilient to climate warming, informing identification of hydropower structural and operational modification opportunities to reduce adverse impacts on aquatic ecosystems. Future work includes expanding the range of this comparative analysis to other contiguous watersheds in the Sierra Nevada.

3. Potential Water Constraints on Energy Production in the Colorado River Basin Under Climate Change Scenarios - Timothy McPherson, Los Alamos National Laboratory, Los Alamos, NM (co-authors: Michael Rivera, David Judi, Darrin Visarraga)

Many regions in the Western United States rely on winter snow pack for summer water availability. This water has multiple beneficial uses including drinking water and cooling water for power generation (hydroelectric and thermal). There is concern the warming trends projected for these regions under climate change scenarios will impact not only the hydrologic cycle but also energy systems relying on water for cooling. Recently, potential energy impacts of climate change have been evaluated through the use of regional-scale hydrologic models that track mass balance in reservoirs. To understand the implications of climate change on thermal generation plants using riverine water for cooling, we need a simulation framework that accounts for the riverine surface water hydrodynamics, impact of dams, the multiplicity of function of those dams such as electric power generation, and the socioeconomic forces that control the operation of those facilities. Additionally, we need to understand the relative importance of snowmelt hydrology, surface water evaporation, and biosphere hydrology on these heavily controlled systems. We evaluate these issues through sensitivity analyses of the Colorado River system using a complete one-dimensional hydrodynamic model of the river. Emphasis will be placed on the importance of snowpack and dam operations.

4. Oil Shale Development in the Western United States: Water Resources Challenges, Impacts and Solutions - Steven Burian, University of Utah, Salt Lake City, UT (co-authors: Eric Jones, Ramesh Goel, Andy Hong, Liang Li, Zhixiong Cha, Beth Dudley-Murphy, Greg Nash)

Currently, oil supplies more than 40% of the energy demands in the United States and more than 99% of the fuel used in the transportation sector. Energy policy in the U.S. is focused on evaluating domestic oil resources to increase energy independence and to mitigate future energy crises. The broadened energy policy has included renewed interest in unconventional hydrocarbon resources, e.g., oil sands and oil shale. The Green River Formation in Colorado, Utah, and Wyoming is volumetrically the largest oil shale resource in North America, enough to eventually produce one quarter of the current U.S. daily oil demand. Oil shale production would be located in the Upper Colorado River Basin, impacting western water resources, already challenged by rapid urbanization, degrading quality, and climate change. Using updated data on urban water use, water requirements for coal-fired power plants, and emerging technologies for oil shale extraction and processing, estimates of water requirements have been generated. Under the scenario of 1 million barrels of oil per day production, water demand from oil industry spurred urban growth is estimated to be 0.06 million acre-ft/yr, oil shale industry water needs are estimated to be 0.26 million ac-ft/yr, and water needs for coal-fired power plants to support the urban and oil shale industry growth are estimated to be 0.20 million ac-ft/yr. The total regional water requirements sum to nearly 30% of the Utah allocation of the Colorado River (1.73 million ac-ft/yr). An analysis of the range of regional water management solutions to reduce water demands through urban water conservation, alternative energy generation, water reuse, and advances in oil shale extraction and processing technologies will be presented. A second key part of our effort is the development of novel approaches to treat water produced during conventional and unconventional oil and gas extraction and processing. The presentation will highlight the integrated treatment scheme based on advanced biological treatment and an innovative micro-bubble ozonation approach. Test results from the two techniques will be reported and the potential for reuse of treated produced water will be presented in the context of regional water requirements.