

**American Water Resources Association**  
**2009 SUMMER SPECIALTY CONFERENCE**  
***Adaptive Management of Water Resources II***  
**June 29 – July 1, 2009**  
Snowbird, UT

**Wednesday, July 1**

**10:30 AM – 12:00 Noon**

**SESSION 34: Climate Change Adaptation - Uncertainty, Policy & Legal Considerations**

**1. Estimated Increases in Municipal Water Demands in Colorado due to Climate Change - Gordon McCurry, CDM, Denver, CO**

As part of its ongoing assessment of statewide long term water supply needs, the Colorado Water Conservation Board and Basin Roundtables are identifying water demands through the year 2050, including an assessment of the potential effects that climate change could have on municipal water demands. In Colorado, temperatures are projected to increase by 2.5 to 5.5 degrees F by 2050, with relatively more warming in summer. The projected increases in temperature will lead to increased municipal demands due to higher consumptive use demands from residential landscaping. The approach to estimating changes in municipal water demands involved obtaining data on predicted temperatures for representative municipal locations in Colorado, using the temperature data to calculate increases in consumptive use water demand at each location, and then estimating changes in municipal demand based on year 2030 population and per capita water use projections. Predicted monthly temperature data was obtained from 16 global climate models for the mid-range (A1B) greenhouse gas emissions scenario. Downscaled results were obtained for representative cities across the state. Bluegrass consumptive use was used to represent outdoor water demand and was estimated using the modified Blaney-Criddle equation. Results computed for the individual cities were applied to municipal demands for their basin or adjacent basins. Results of the analysis indicate that bluegrass consumptive use is projected to increase water needs by approximately 5 percent in year 2030 relative to year 2000, increasing to about 8 percent by 2050. The higher elevation watersheds showed the largest increases. Combining the consumptive use increase with municipal demand projections indicates that there will be an increase in municipal water demand of approximately 41,000 acre-feet per year due to increases in temperature associated with climate change by the year 2030. In addition, the climate change models show more rapid increases in temperature by 2050 and beyond so the impact of climate change on municipal demands is likely to be relatively larger in the latter half of the 21st century compared to the year 2030. Including reductions in summer precipitation, as suggested by the climate models, will further increase consumptive demands in the municipal sector.

**2. Adapting to Climate Change in Water Resources and Water Services Eugene Z. Stakhiv, IJC Upper Lakes Study, Institute for Water Resources, USACE, Alexandria, VA**

Management, by definition, includes the planning and implementation of adaptive measures as well as anticipatory ones. Water resources managers have historically been in the forefront of adapting to considerable natural climate variability; shifts in population and resultant demands; as well as profound changes in social preferences for economic, environmental and recreational uses of water. There is no direct linear correlation between the highly uncertain hydrologic response sensitivity of watersheds, as suggested by the GCMs, and assessments of water sector vulnerability. Preparing for and ameliorating future climate change vulnerability is very much dependent on the current state and capacity of water management, for it will serve as the platform for effective adaptation to future anticipated changes.

A 'proactive adaptive management' response is advocated, as a starting point, for most water management aspects associated with existing water-based infrastructure, such as irrigated agriculture and developed floodplains and urban areas. The 'operating agencies', i.e. those responsible for investing in, managing and operating water infrastructure need to take the lead in promoting adaptation, in conjunction with the science agencies of their respective countries. Irrigated agriculture uses the largest amount of water resources – nearly 80% worldwide, and densely populated urban floodplains are

currently the most vulnerable to contemporary flooding. Fortunately, both are inherently activities that can be upgraded incrementally, through the introduction of adaptive management techniques over time, as new information and technologies become available, and as resources allow.

However, because of the long design lives of new, large-scale water infrastructure projects that are being planned and designed today, such as multipurpose dams and levee systems that protect urban infrastructure, urban water and wastewater distribution systems (pipelines and tunnels, sewerage systems) - these require different approaches that are more problematic, for they are not amenable to an incremental 'adaptive management' strategy. New hydraulic infrastructure inherently must deal with large uncertainties related to future climate changes, and would require a 'paradigm shift' in the way this infrastructure is planned, designed and justified on traditional economic decision criteria. Furthermore, this is where IWRM is needed to provide the 'enabling environment' for developing acceptable, stakeholder driven robust solutions. In addition, a concerted and collaborative applied research effort is needed to revise the fundamental evaluation principles that have guided water resources planning and management for the past 50 years, focusing on how the highly uncertain GCM information is used in a rigorous evaluation and decision-making process.

### **3. Planning for Reliable Water Supply in the Face of Uncertainty and Climate Change - Dan Rodrigo, CDM, Los Angeles, CA (co-author: Gregory Heiertz)**

Providing for a reliable water supply for water utilities in California has become increasingly more challenging due to prolonged droughts, aging infrastructure, and increasing environmental regulations concerning endangered species. This coupled with the potential threat of global climate change and major seismic events requires water utilities to be proactive in the development of new water supplies and demand-side management. One difficulty of advanced planning is that some ratepayers may challenge the need for new water supply projects, often looking at current conditions or comparing demands and supplies under ideal or normal weather scenarios. But the variable nature of water supply and demand, coupled with uncertainties such as earthquakes, climate change, and future environmental regulations often reveals that water supplies are not sufficient in meeting demands. The Irvine Ranch Water District (IRWD)'s sources of potable supply include local groundwater and purchases of imported water from the Metropolitan Water District of Southern California (MWD). MWD is imported water from Northern California and the Colorado River. Both of these sources have significant hydrologic variability, are potentially limited by environmental regulations, and are vulnerable to seismic events that could result in system outages. In addition, potential climate change could further limit these supplies. Although IRWD has always developed capital improvement plans to assure a reliable water supply, no formal policy had ever been developed to define how much supply is required. The purpose of this study was to determine the reliability of the district's current water supplies under known and unknown uncertainties. The results of the study will also guide in the development of a policy goal that could guide future capital improvement programs. Using probability analysis and monte carlo simulation, this study estimated the overall reliability for IRWD based on the variability in water demands and supplies under historical weather and hydrology, potential climate change, impacts of environmental restrictions in imported water due to endangered species, and seismic events. Based on the results of this study, the IRWD Board established a reliability policy which will be used to guide future water supply planning.