American Water Resources Association
2009 SPRING SPECIALTY CONFERENCE
Managing Water Resources Development in a Changing Climate
May 4-6, 2009
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Monday, May 4
1:30 PM – 2:00 PM
Session 4: Regional Watershed Responses II

1. Watershed Scale Response to Climate Change: Flint River Basin, Georgia - Lauren Hay, U.S. Geological Survey, Lakewood, CO (co-author: Steven L. Markstrom)

The U.S. Geological Survey Global Change study "An integrated watershed scale response to climate change in selected basins across the United States" was started in 2008. The long term goal of this study is to provide the foundation for hydrologically-based climate-change studies across the nation. Fourteen basins for which the Precipitation Runoff Modeling System (PRMS) has 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 upper Flint River in Georgia are summarized below. Six General Circulation Models (GCMs) incorporating four climate change scenarios were used to develop an ensemble of climate change scenarios for PRMS. Results indicate an overall increase in temperature for the upper Flint River. However, there are large uncertainties (especially maximum temperature) associated with these GCM projections. Changes in precipitation for the Flint River are highly variable, with a slight tendency towards a decrease in precipitation in the later half of the 21st century. The large range in the precipitation projections also indicates a large amount of uncertainty. The broader-scale effects of climate change on the flow regime of the Flint River indicate an overall slight drying of the basin. These results do not address potential land-cover changes. Extensive urban growth in the headwaters and increasing demands for offstream water-use, combined with the effects of climate change will potentially affect future flow regimes and biological diversity of aquatic communities in the upper Flint River basin. Future works needs to address the combined effects of climate and land-cover dynamics on streamflow regimes.

2. Watershed Scale Response to Climate Change—South Fork Flathead River, Montana - Katherine Chase, U.S. Geological Survey, Helena, MT

In 2008, the U.S. Geological Survey Global Change Program funded a study to examine integrated watershed scale response to global change in selected watersheds across the United States. Fourteen watersheds for which hydrologic models had been created using the Precipitation Runoff Modeling System (PRMS) 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 basin hydrology. The portion of the South Fork Flathead River watershed located upstream from Hungry Horse Dam in northwestern Montana is 1 of the 14 study sites. Results from six General Circulation Models (GCMs), each using three GCM scenarios, were used to develop climate change scenarios for 2001-2099 for input to the existing PRMS model for the South Fork Flathead River. These PRMS simulations using the GCM scenarios were compared to PRMS simulations for current (1988-2000) conditions. All GCM simulations project an overall increase in temperature, although the magnitude is variable. Projected changes in precipitation for the South Fork Flathead River watershed were variable, with a slight tendency towards an increase in precipitation in the latter half of the 21st century. Uncertainties associated with precipitation projections for the South Fork Flathead River watershed are smaller than for most of the other watersheds in the study. PRMS simulations using the GCM scenarios project slightly increased mean annual streamflow in the South Fork Flathead River from about 2020-2099. However, these simulations project that less precipitation falls as snow, so projected mean monthly streamflow increases January through April and decreases June through September. These simulations did not consider land-cover dynamics, such as changes in the watershed due to forest fires. Information from these climate-change simulations will be useful for long-term management of Hungry Horse Reservoir and for downstream water users.

3. Climate Change: A Tale of Two Colorado Ski Areas - William Battaglin, U.S. Geological Survey, Lakewood, CO (co-authors: Lauren Hay, Steven Markstrom)

The U.S. Geological Survey Global Change study, "An integrated watershed-scale response to climate change in selected basins across the United States," was started in 2008 to provide assessments of hydrologic response to climate-change scenarios across the nation. The Precipitation Runoff Modeling System (PRMS) has been calibrated and evaluated at selected study sites. PRMS is a deterministic, distributed-parameter, watershed model developed to simulate the effects of various combinations of precipitation, temperature, and land use on streamflow and general basin hydrology. For this study, simulations from six General Circulation Models (GCMs) of one current condition and three future condition scenarios were used to develop inputs for PRMS for 2001 through 2099. This presentation summarizes the PRMS simulation results for the East and Yampa Rivers in Colorado and considers how potential climate change might affect snowfall in the watersheds. Steamboat ski area is in the Yampa River at Steamboat, Colorado watershed and Crested Butte ski area is in the East River at Almont, Colorado watershed, which have mean elevations of 2,674 and 3,099 meters, respectively. Model simulations for the East and Yampa River watersheds indicate a relatively uniform increase in mean monthly maximum and mean monthly minimum air temperature of several degrees by 2099. Little change is expected in mean annual runoff, but the timing of peak streamflow shifts to a month earlier. Of most concern to ski areas is winter snow accumulation and the percentage of precipitation that falls as snow. In the Yampa, mean monthly snowfall for December, January, and February is expected to increase, but due to rising temperatures, more precipitation would fall as rain in November, March, and April. In the East, mean monthly snowfall for December, January, and February is expected to increase, and little change is expected for March and April. More precipitation would fall as rain and less as snow in May, June, and October. This study demonstrates the utility of PRMS for simulating potential effects of climate change at a local scale.

4. Watershed Scale Response to Climate Change: Sagehen Creek, California - Steve Regan, U.S. Geological Survey, Lakewood, CO (co-authors: R. Steven Regan, Steven L. Markstrom, Lauren E. Hay, Richard Niswonger)

The U.S. Geological Survey Global Change study "An integrated watershed scale response to climate change in selected basins across the United States" was started in 2008. The long term goal of this study is to provide the foundation for hydrologically-based climate-change studies across the nation. The Precipitation Runoff Modeling System (PRMS) and the Coupled Ground-Water and Surface-Water Flow Model (GSFLOW) have been calibrated and evaluated at selected study sites. PRMS is a deterministic, distributed-parameter, watershed model developed to simulate the effects of various combinations of precipitation, temperature, and land use on streamflow and general basin hydrology. GSFLOW is an integration of PRMS and the Modular Ground-Water Flow Model (MODFLOW). This presentation summarizes the PRMS and GSFLOW simulation results for Sagehen Creek in California. Simulations from six General Circulation Models (GCMs), for four climate scenarios were used to develop inputs for PRMS and GSFLOW. Results for Sagehen Creek indicate an overall increase in temperature, with large uncertainties (especially for maximum temperature) associated with these projections. Changes in precipitation for Sagehen Creek are highly variable across climate scenarios, but indicate an alternating wet/dry oscillation with a multi-decadel return period. The large range in the precipitation projections also indicates a large amount of uncertainty. PRMS effectively simulates short-term changes in stream flow in response to changing precipitation patterns. However, in watersheds where the ground-water residence times are long, such as the decadal variations in base flow seen in Sagehen Creek, GSFLOW may provide improved results as compared to a PRMS-only simulation.