TIP 309: Comprehensive Assessment of Climate Change Impact on the Hydrology of the Columbia River Basin: *Characterizing and Reducing the Uncertainties from Various Sources on Streamflow Projection*

Context

Global climate change, largely caused by burning of fossil fuel and changes in land use, is expected to lead to a significant warming of the planet over the coming decades, particularly in the polar and alpine regions of the planet.

This increase in temperature will be accompanied by changes in other aspects of the climate system, such as atmospheric circulation and precipitation. Resulting changes in hydrological fluxes (streamflow, evapotranspiration) and states (snow water equivalent, soil moisture) are likely to change the flow regime of many rivers around the world.

The Columbia River, whose flow regime is heavily dependent on seasonal snow melt, will likely experience significant changes in the timing of the streamflow and possibly in total flow volume.

Recent studies of climate forecasts have shown that combining multiple models reduces the uncertainty in climate forecasts and clearly demonstrates that using a synthetic model setup with multimodel forecasts greatly outperforms the best single model. This is partly because a multimodel combination reduces the overconfidence of the individual models.

Description

In 2009-2010, members of River Management Joint Operating Committee (RMJOC) including BPA, US Army Corps of Engineers (USACE) and US Bureau of Reclamation (USBR) collaborated on the adoption of a set of climate change scenarios, hydrology datasets, and modeling efforts in support of their longer-term planning activities in the Columbia River Basin (CRB). Although there is an abundance of expertise in hydroregulation in the RMJOC agencies, the focus of their studies tend toward operational planning and optimization of day-day hydroregulation. Recent advances made in the field of hydroclimate modeling, statistical methods, multimodeling and uncertainty analysis will be applied in this 3-year project for comprehensive assessment of future climate change impacts across the Columbia River Basin

The project uses the latest climate scenarios available by Couple Model Intercomparison Project Phase 5 (CMIP5) and new methods to more accurately characterize the uncertainties in hydroclimate modeling.

The project procedure is carried out in several steps to properly characterize the uncertainties in different layers of climate change streamflow modeling.

To characterize the uncertainty associated with General Circulation Models (GCMs) and Greenhouse Gases Emissions Scenarios,the project will use a multimodeling/model-selection approach such that better performing GCMs are chosen according to their posterior probabilities.

Given the bias or inconsistency of the GCM simulations with respect to gridded observations, the climate scenarios need to be bias-corrected or postprocessed. A new postprocessing procedure which can also be used for bias correction will be employed for this purpose. Downscaling of selected GCMs are conducted using two methods to incorporate the downscaling uncertainties into the modeling framework.

This is followed by hydrologic projections using three widely used distributed hydrologic models. After postprocessing the model outputs, the multimodeling is conducted by means of Bayesian model averaging of streamflow projections to reduce the uncertainty in hydrologic modeling. Different scenarios are designed and each evaluated using various metrics (performance measures).

Why It Matters

While multimodel combination studies have focused exclusively on reducing uncertainty of climate change forecasts or of hydrologic models, there is no systematic approach available on how to reduce the combined uncertainty in streamflow forecasts arising from both climate forecasts and hydrological models.

Long-term planning efforts need access to the best possible estimates of future climate change. Climate change scenarios based on the latest climate science are not only relevant to water resources management decisions made by the RMJOC, but are also required for National Environmental Policy Act (NEPA) analyses of large capital projects by BPA business lines such as Transmission and Environment, Fish, and Wildlife.

Large organizations such as BPA will make use of the latest emission pathways, climate model simulations, and related scientific advances that form the basis of Intergovernmental Panel on Climate Change (IPCC) reports. This means the existing datasets need to be updated to reflect the CMIP5 model simulations.

Goals and Objectives

The goal of this project is to produce scenario analysis and model outputs that can be directly applicable in hydroregulation modeling with confidence. The streamflow projections will be provided at one of the representative locations determined by BPA so that the applicability of the model results can be examined.

To that end, the deliverables for this project will be the streamflow time series and hydrological data sets for the period 1950-2100. These data sets will be delivered in a format that can be used by BPA and its partners as input to their hydroregulation models.

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Project Start Date: October 1, 2013

Project End Date: September 30, 2015

Reports & References (Optional)

Links (Optional)

Participating Organizations

Portland State University
Oregon Water Science Center
Pacific Northwest Ecosystem Research Consortium

Funding

Total Project Cost:	$1,111,668
BPA Share:	$555,823
External Share:	$555,845
BPA FY2014 Budget:	$313,078

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